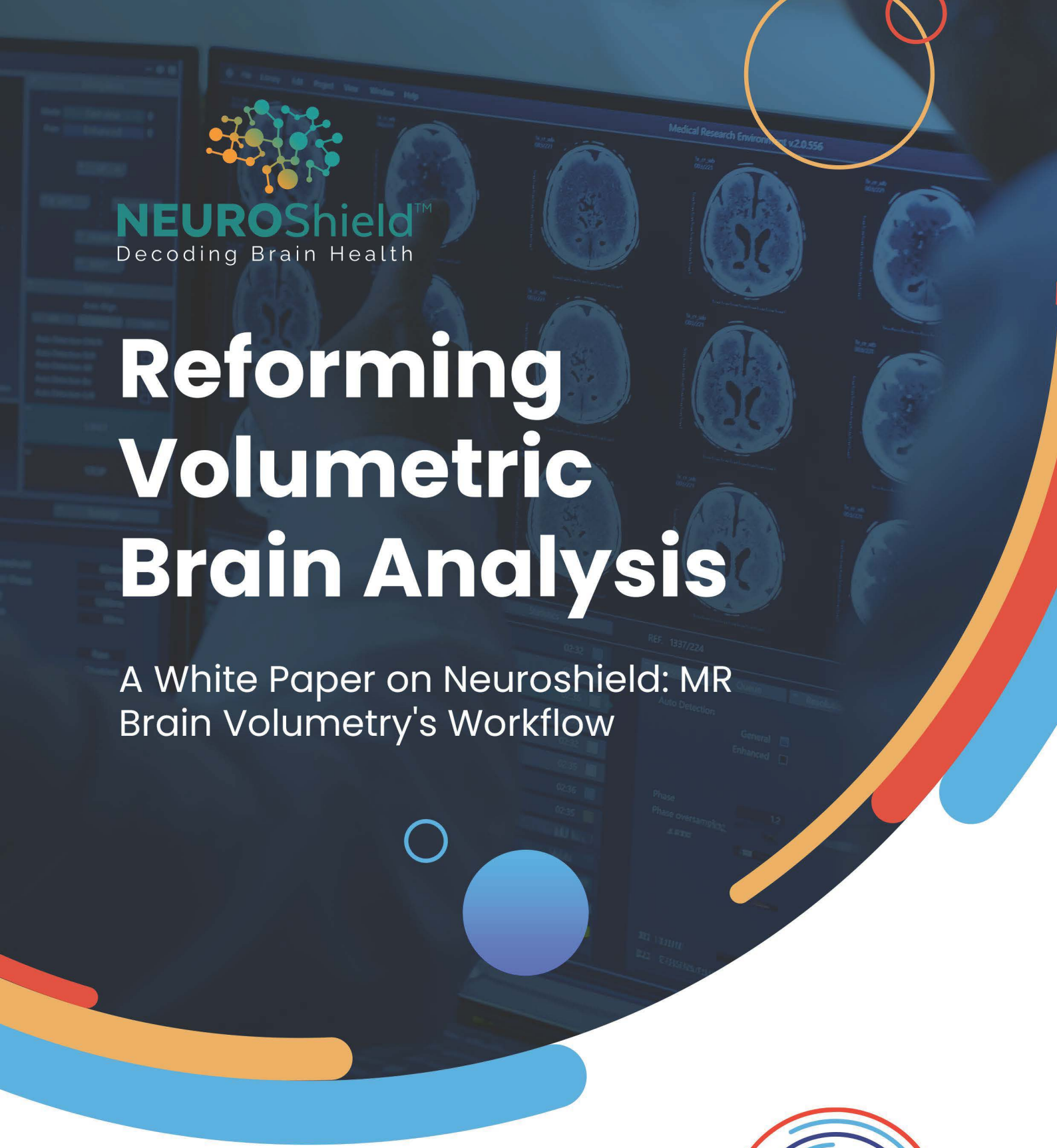

NEUROShield™
Decoding Brain Health

Reforming Volumetric Brain Analysis

A White Paper on Neuroshield: MR Brain Volumetry's Workflow

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Executive Summary

Neurodegenerative disorders, characterized by slow progression and irreversible damage, lack perfect diagnostic accuracy. Diagnosing these conditions requires strong evidence, often provided by MRI-based volumes, which are clinically valuable metrics. However, manually computing these volumes is cumbersome and time-consuming. This labor-intensive process is also prone to inter and intra-operator errors sabotaging diagnosis and patient care.

Existing automated solutions are not ethnicity specific and often rely on training data biased toward the general population. Additionally, solutions developed in high-resource settings may not be readily applicable in emerging markets. These markets lack standardized workflows and present unique demands, making it challenging to implement such solutions effectively.

By using AI in healthcare, we're aiming to make diagnoses better and faster. NeuroShield MR Brain Volumetry is a big step forward, solving real issues in brain studies. NeuroShield MR Brain Volumetry is an AI-powered tool that automates the segmentation and volume calculation of brain structures swiftly, completing the process within minutes. Recently approved by the US FDA, it is currently widely utilized in various markets. The tool offers reference ranges tailored to age, gender, and ethnicity, ensuring personalized insights. This versatile tool can be fully integrated and customized as per individual requirements. Moreover, it provides flexibility by offering both cloud-based and on-premises deployment options and can be integrated with PACS/RIS and Modality systems.

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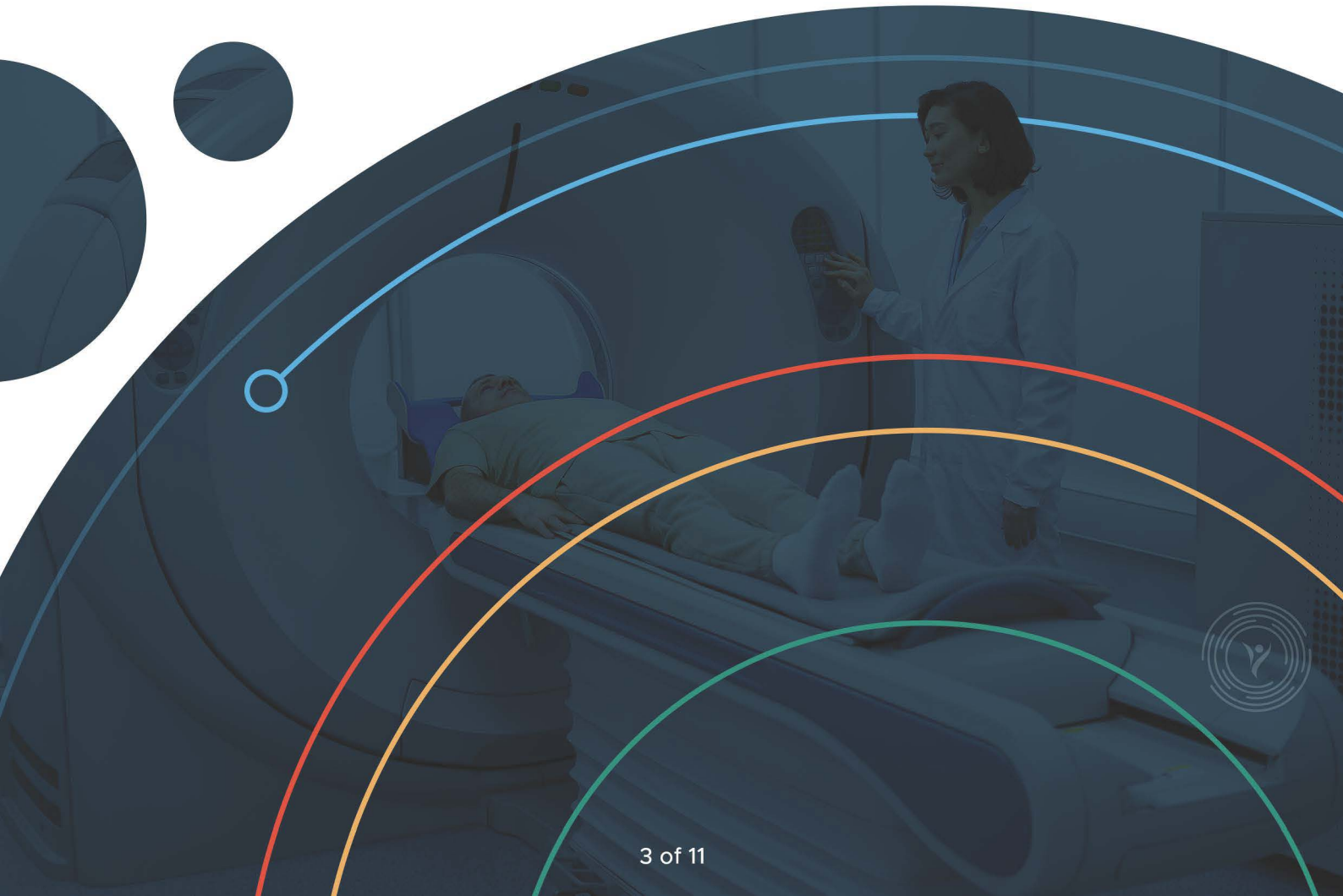
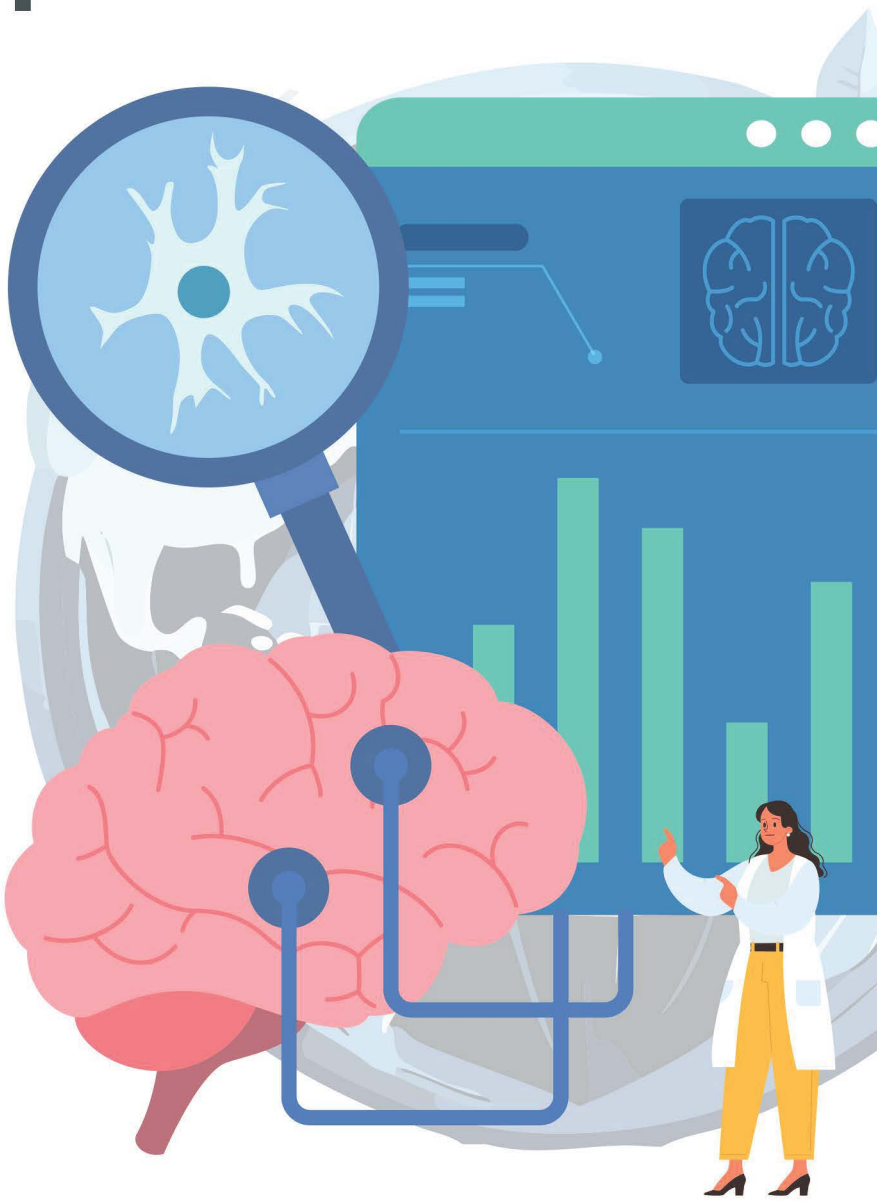


Introduction



In the swiftly evolving landscape of digital healthcare, AI has become the go-to solution for emerging challenges. It's the new-age fruit, ripening over time. Imaging diagnostics, a nutrient-rich field, is fostering the growth of AI-enabled solutions.

Neurological disorders pose a growing global public health challenge, especially with an aging population. They are the leading cause of disability-adjusted life years (DALYs) and contribute to about 9 million deaths annually. As the population ages, the rates of neurodegenerative diseases are on the rise. Unfortunately, these conditions are often underestimated, as their symptoms go unnoticed and ignored. [1,2]

In the realm of medical imaging, MRI represents a technological leap, offering a non-invasive window into the human body's complexity. Beyond visualization, MRI holds promise for quantitative precision through volumetric analysis, particularly crucial in the rising prevalence of neurodegenerative disorders.

Magnetic Resonance Imaging (MRI) has significantly advanced our understanding of brain injury and anatomy, creating vast datasets that challenge clinicians in manual data extraction, a time-consuming and error-prone task. To overcome these challenges, computerized methods have emerged, aiding doctors in qualitative diagnosis. [3]

NEUROShield™

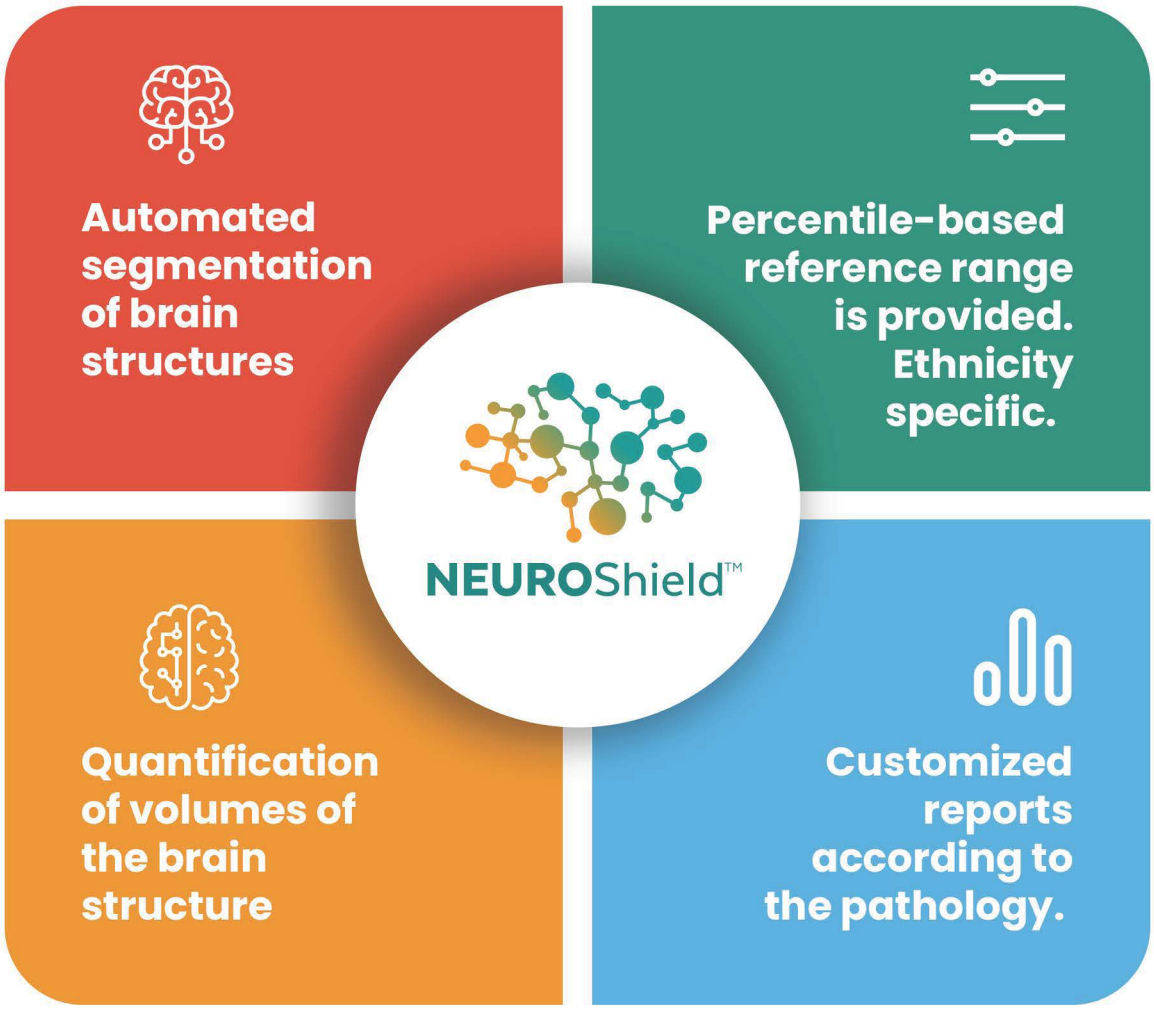
Volumetric analysis is changing how we analyze 3D structures across different clinical fields. By extracting the dimension of anatomical structures, it aids in early disease detection and enhances treatment planning and monitoring. However, conventional segmentation techniques have limitations such as subjectivity, inter-rater variability, and time-consuming nature, highlighting the need for automation. Interest and advances in medical AI applications have surged in recent years due to the substantially enhanced computing power of modern computers and the vast amount of digital data available for collection and utilization. [4]

Bridging this gap, NeuroShield, a pioneering AI-based platform, offers a streamlined workflow converting MRI data into actionable insights. This integration of AI into imaging diagnostics is crucial for advancing neurology, where volumetry, encompassing modalities like MRI, CT, and PET, plays a pivotal role in neurological diagnosis.

NeuroShield is an automated alternative to conventional brain structure segmentation and volumetric analysis. With its FDA clearance, NeuroShield has been implemented at many sites in India and/or globally. To understand the workings of this ultimate tool better, this white entails the workflow of Neuroshield in detail.

Key Features

Neuroshield is a clinical decision support tool for automated volumetric analysis of brain structures. It assists the neurologists by automatically segmenting the brain structures and calculating the volumes of those structures. The tool is designed to process the MRI scans, segment the brain structures, calculate their volumes, and generate a customized report. It also provides ethnicity-specific reference ranges.



Workflow Overview

The different modules of frontend – backend are explained in detail below:

1 Image conversion:

In this initial step, the uploaded DICOM images are transformed into the more accessible NIfTI format.(6) This conversion not only ensures data anonymization by removing personal metadata but also prepares the data for subsequent image-processing tasks. The image is realigned for optimal viewing, preserving the original voxel spacing for accurate volume calculation. This realignment centers the image and adjusts voxel spacing, ensuring cosmetic improvements without altering volumetric features.

2 Image Preprocessing:

Image preprocessing is a crucial step undertaken to format images before they are utilized for model training and inference. This process is essential to enhance image quality, suppress undesired distortions, and highlight necessary features.

Preprocessing includes:

a) **Image padding:** Image padding helps in mitigating information loss at the borders of the input feature map, improving model performance. This step precedes image realignment, ensuring that volumetric changes are avoided.

b) **Intensity normalization:** Intensity normalization standardizes the range of image intensity values across a data set which is a vital due to variations in MR image acquisition. Different scanners may be used for different subjects or the same subject at different times, leading to substantial intensity variations. Z-score normalization is applied, addressing these variations and ensuring consistency in preprocessing.

3 Deep Net Model:

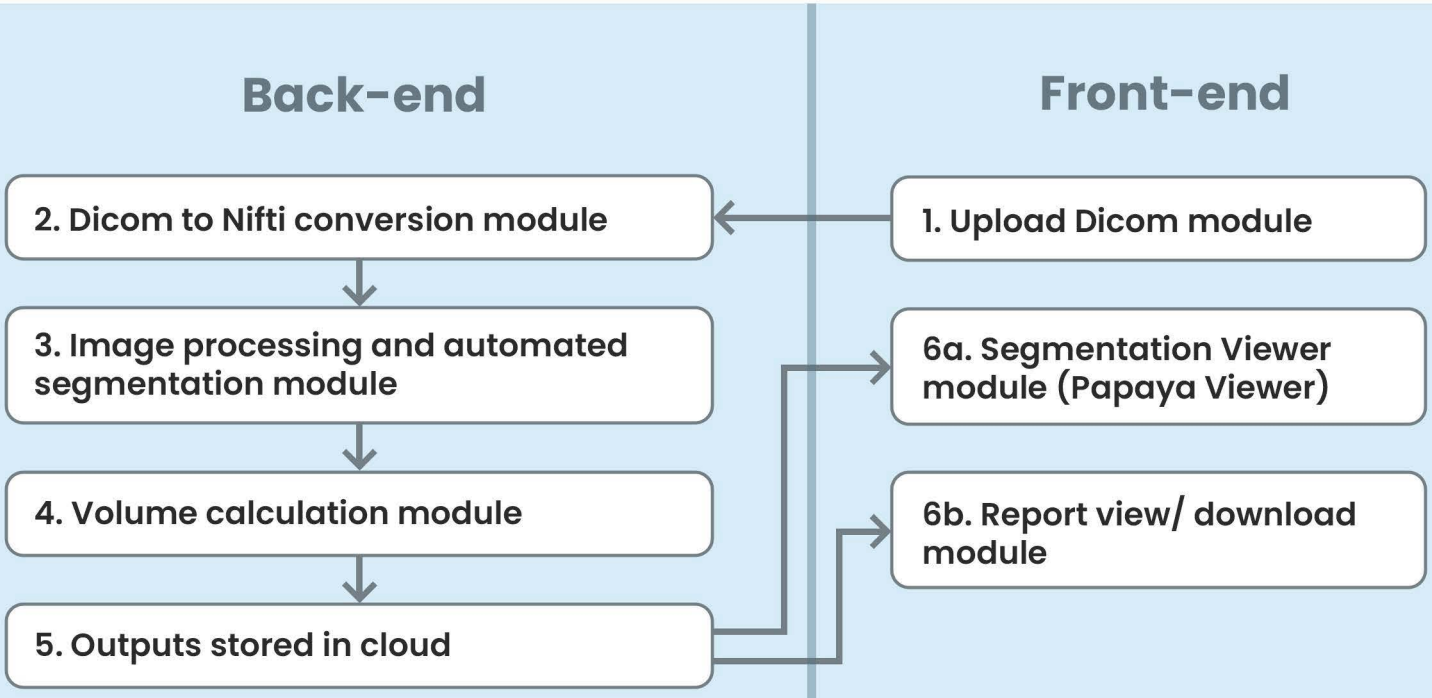
Following preprocessing, the image undergoes a deep net model designed for specific brain structures.(7) These slices are then combined and reconstructed into a 3D mask. Different labels are crafted for the segmentation of each brain structure. The semantic segmentation technique is employed to segment the brain structures based on the NIfTI image precisely.

4 Volume and Reference range calculation:

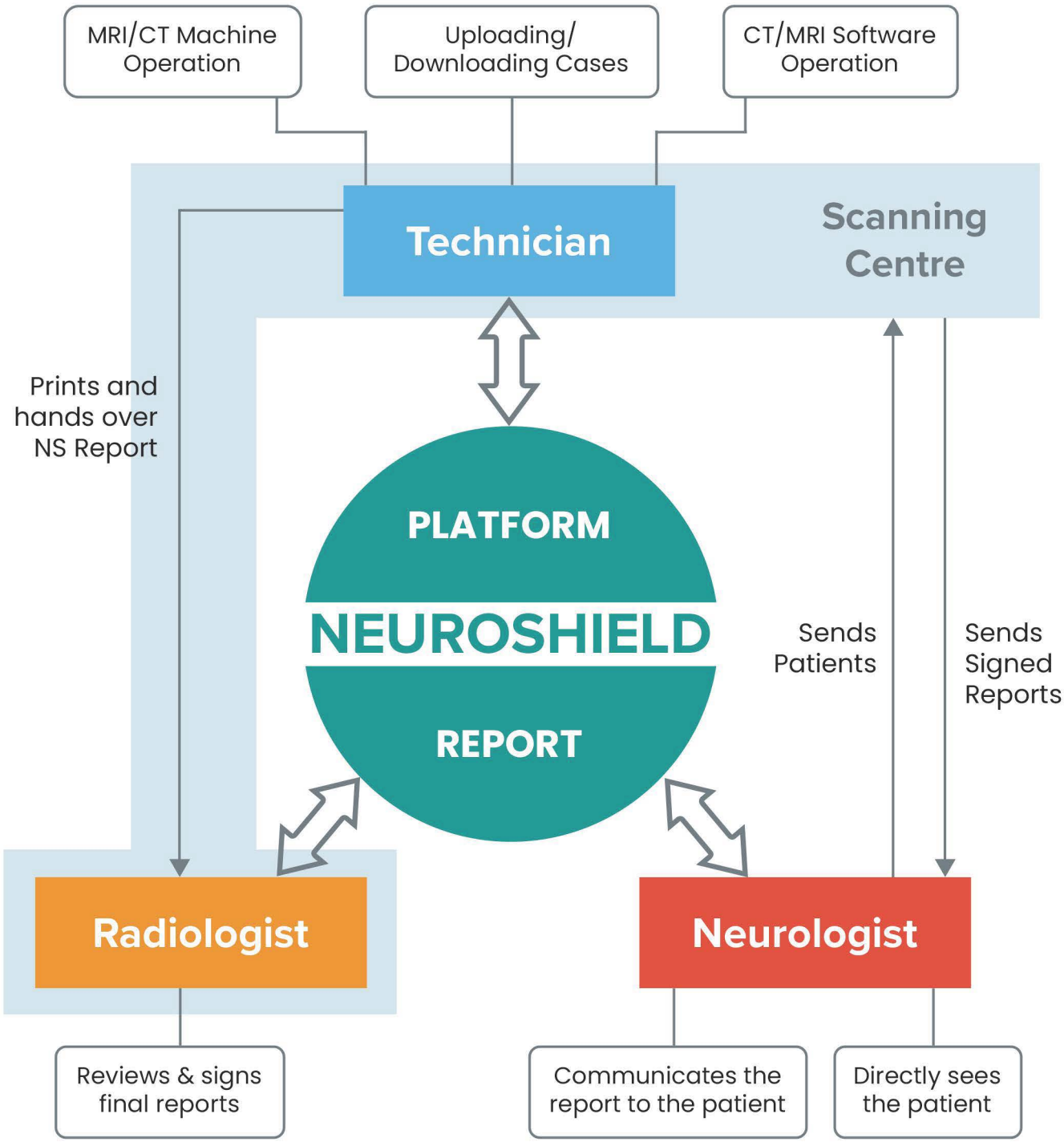
After generating the masks, volumes are calculated based on the voxel spacing of the image. This is followed by intracranial volume normalization for each structure to align the volumes with the population.

5 Report Generation:

Finally, all parameters are compiled into a Word report, which is then converted into both a frontend-style and PDF-style report. These reports include normalized values according to population reference ranges.



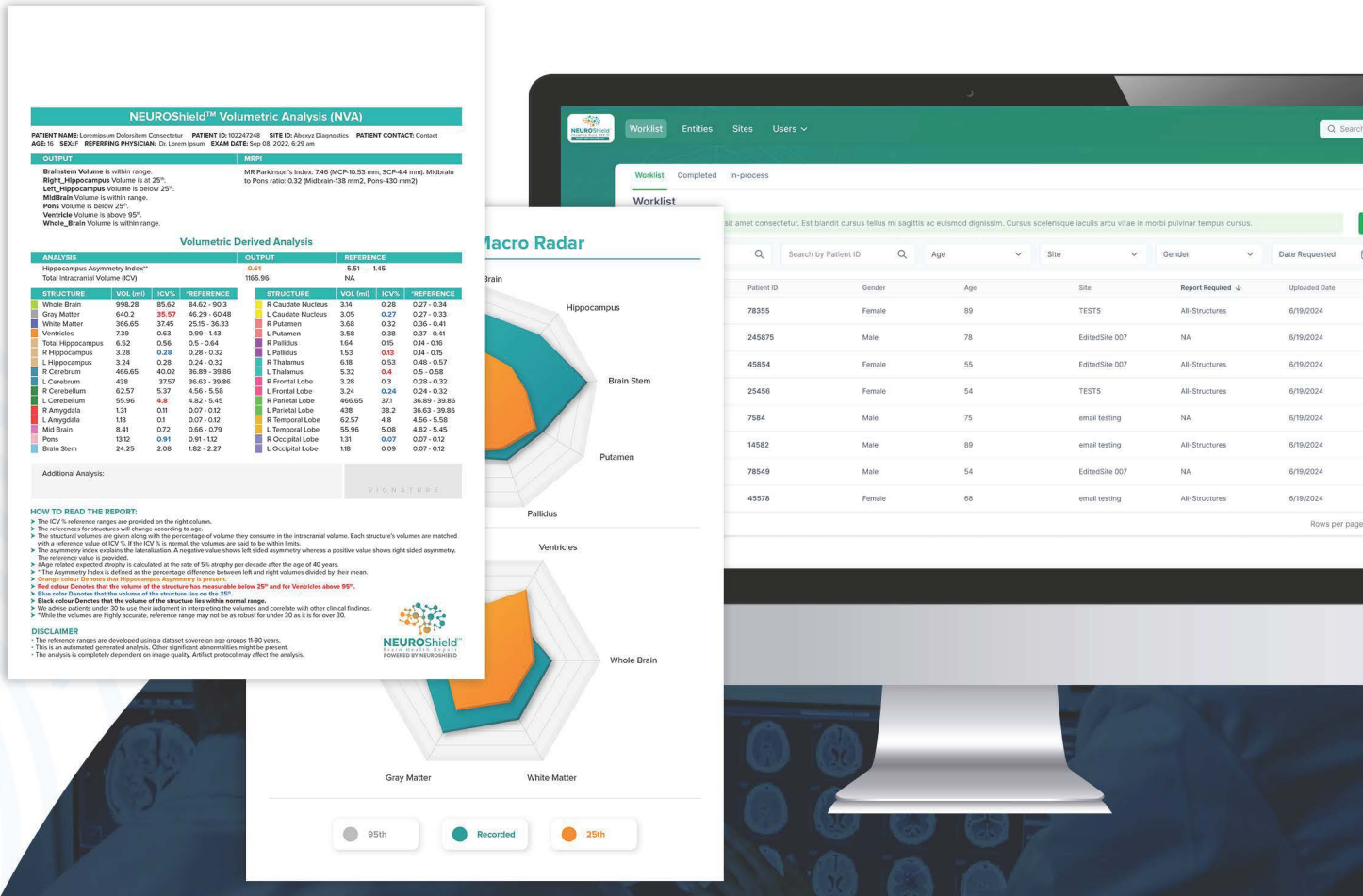
Conceptual Framework



Applications and Clinical Validation

NeuroShield is actively utilized in over 280 sites across India, Africa, and the Middle East, with an upcoming launch in the US market as we have received FDA clearance. The platform integrates with various MRI imaging formats, accommodating major manufacturers and different Tesla strengths as well as slice thicknesses, contributing to model generalization.

NeuroShield's user-friendly platform enables tailored reports, offering options for comprehensive all-structures reports and condition-specific reports. This versatility positions NeuroShield for application in various clinical settings, including diagnosis and prognosis, enabling early detection and continuous monitoring of neurodegenerative diseases.



Conclusion

In conclusion, we strongly encourage the adoption and exploration of NeuroShield MRI Volumetry, a novel tool designed to reform neuroimaging analysis.

As a call to action, we invite our audience to consider integrating NeuroShield into their clinical practice or research endeavours. Should further information be needed, this document comprehensively details the NEUROShield: MRI's workflow, offering insights into the segmentation (Deep Net) algorithm and the various supporting modules. NeuroShield stands ready to empower and advance your neurodiagnostic journey.

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