Unlocking Precision Medicine: Streamlining Data Management for Multi-Site Traumatic Brain Injury Research

Neurologists treating patients with traumatic brain injury (TBI) have long faced a significant challenge: determining which patients with mild or moderate head injuries are at increased future risk of developing neurological problems such as dementia, mood disorders, and Parkinson's disease, and which are not. Both in classification and outcome assessments, TBI scores are often exclusively symptom-based, and therefore too general to catch some brain injuries and prognoses.

To improve the diagnosis, treatment and rehabilitation of patients with TBI, Dr. Geoffrey Manley, Vice Chairman of Neurological Surgery at the University of California, San Francisco, set up the Transforming Research and Clinical Knowledge in Traumatic Brain Injury (TRACK-TBI) study 10 years ago. Today, 19 institutional partners in the TRACK-TBI NETWORK collect more than 3,000 data fields per subject, including outcome measures assessed at four time points post-injury: medical imaging, biospecimen samples, proteome test results and genomic information.

Dr. Manley and colleagues participating in this study needed to collaborate across disciplines and institutions and collect large volumes of biomedical data, including CT and MRI imaging.

The TRACK-TBI leaders engaged Flywheel, a biomedical research data platform, to collaborate on a centralized platform that could aggregate and securely share medical imaging and related data across multiple sites.

Collecting, *de-identifying, and curating data* for a shared image research repository

Dr. Manley and his colleagues initially tried online data transfer among the participating centers, but the large files would sometimes take days to process and would often fail. His team sometimes even resorted to sharing data by physically transporting hard drives to collaborators at other institutions.

“We were struggling with the complexity and the granularity of our imaging data sets, which was a significant obstacle to the collaboration needed to carry out a study of this magnitude,” said Dr. Manley.

With Flywheel as their platform, each of the 19 collaborating sites could upload CT and MRI data to a secure, site-specific cloud project where the data was de-identified using Flywheel templates customized for each institution’s unique situation.

The configurable patient de-identification capabilities in Flywheel allow researchers to set unique whitelists, blacklists, and other rules to ensure that all patient data is regulatory compliant and ready for research. Flywheel offers tools for high-performance bulk loading and a simple web browser upload with no software installation required.

After the data is uploaded, automated processing pipelines ensure that data is quality checked, validated for completeness, and curated for consistency. Once a site’s data has passed a quality control process, it is copied to the main access-controlled TRACK-TBI project area where it is ready for analysis.

> “There’s a whole lot of disparate data that we are trying to capure with these studies. You really need robust solutions — particularly for multi-center research — to be able to acquire this data and to curate and manage it, in a reproducible and secure fashion.”

- Dr. Geoffrey Manley, Vice Chairman of Neurological Surgery, University of California, San Francisco

Maximize the value of data for analysis & reuse

Flywheel's cloud-based platform automates processing and machine learning pipelines and offers the TRACK-TBI consortium complete scalability for data storage and compute needs.

"Our collaboration is really allowing us to achieve things that not one of us individually or one university could do. Flywheel's automation of data capture and de-identification of patient personal information were critical time-savers," said Dr. Manley.

Flywheel's tools for data analysis include powerful search features to select data subsets using, for example, metadata, tags, or analytical results. Additionally, Flywheel integrates with many electronic data capture (EDC) systems, and can correlate clinical data collected through TRACK-TBI's EDC to imaging data in future phases of the study.

Contributing researchers can then develop models or containerized algorithms, known as Gears, that can run on individual site data or on the combined data repository if users have the appropriate permissions. Gears track algorithm inputs, versions, and outputs and run the same way every time, helping the TRACK-TBI network standardize analysis of data from multiple equipment types, with many protocols, and across many populations.

A centralized medical imaging dataset to *improve TBI outcomes*

With Flywheel, the longitudinal Phase 2 TRACK-TBI research study has now collected and processed large volumes of TBI data on more than 3,000 patients, and has established a multi-modal imaging dataset easily accessible to researchers for precision medicine research. From the very beginning, Dr. Manley says, the TRACK-TBI study was designed to create a shared image repository meeting all regulatory requirements — essentially an "information commons" to promote collaboration and acceleration of TBI imaging research.

Dr. Manley says targeted clinical trials using repository data should ultimately improve classification and outcomes assessment of mild and moderate brain injuries and develop precision medicine treatments to help clinicians better manage long-term neurological problems in patients.

Dr. Manley and his collaborators are grateful they have discovered important results from the TRACK-TBI study.

"Imaging now really drives much of the decision-making in traumatic brain injury. Using

Flywheel to manage our CT and MRI images, we have discovered that certain patterns in brain CT occur in patients with mild TBI that are associated with worse outcomes than others," said Dr. Manley.

The TRACK-TBI study has also found indications that a technique called neurite orientation dispersion and density imaging (NODDI) may be a more sensitive biomarker for mild TBI than previous methods.

As Dr. Manley explains, "these datasets are going to drive machine learning and AI and a lot of things we are all very excited about. With our imaging data managed on Flywheel, we have explored diagnostic models grouping biomarkers discovered in the TRACK-TBI study and hope to one day see more individualized treatments for brain injury."

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*Visit **flywheel.io** for more on how Flywheel is enabling research in high gear.*

Results referenced were published in JAMA Neurology and Science Advances.