

An Urban Transdisciplinary Concussion Center

A Model for Clinical Care, Education, and Research

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Abstract

Background

Public awareness of concussion has grown significantly over the past 2 decades, driven largely by media coverage of sports-related injuries. This has paralleled a rise in traumatic brain injury (TBI)-related emergency department visits, underscoring the need for specialized concussion care centers. Despite this, most existing programs focus on sports or pediatric populations, leaving critical care gaps.

Recent Findings

The NYU Langone Concussion Center was established in 2013 to address these gaps by providing interdisciplinary care for both sports-related and non-sports-related concussions. Approximately 60% of cases seen at the center are not sports related. This article outlines the center's inception, operational model, patient demographics, and evolution over the past decade.

Implications for Practice

Lessons learned from the NYU Langone model offer valuable guidance for developing comprehensive concussion programs that can serve diverse urban populations. Key strategies include cross-specialty collaboration, flexible infrastructure, and systems-level integration to address heterogeneous mechanisms of injury and outcomes.

Introduction

Over the past 2 decades, widespread media attention, especially related to the National Football League (NFL) and sports-related brain injuries, has heightened public awareness of concussions and their long-term risks. This increased recognition has led to a nationwide rise in traumatic brain injury (TBI)-related emergency department (ED) visits,¹ expanded research funding,² and evolving care practices.³ From 2001 to 2010, TBI-related ED visits rose by 70% nationally, with rates in New York State (NYS) more than doubling between 2005 and 2013.¹ The NYS Department of Health reports that approximately 157 TBIs occur daily, resulting in over 2,200 deaths, 17,000 hospitalizations, and 38,000 ED visits each year. Although much of our current understanding of concussion stems from sports-related studies, urban areas such as New York City (NYC) present more varied injury mechanisms, including falls, assaults, and motor vehicle or bicycle accidents. This diversity leads to greater clinical and neuropathologic heterogeneity, with outcomes shaped by genetics, cultural factors, and systemic barriers common in underserved, demographically diverse populations. These challenges underscore the need for a comprehensive, personalized, and statewide approach to TBI care. In response, the New York University Langone Concussion Center

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(NYUL-CC) was created to address a critical gap in care for concussion, the most common form of TBI.⁴ Drawing patients from across NYC, the surrounding suburbs, and beyond, the center was established as a specialized hub for interdisciplinary concussion management. Although initially guided by expert consensus, emerging evidence now supports the effectiveness of such interdisciplinary models in improving outcomes. In this review, we describe the development and structure of the NYUL-CC, offering a framework for scalable, patient-centered concussion care.

Inception of the NYUL-CC

The center was founded through the collaborative efforts of a steering committee composed of leaders in rehabilitation medicine, sports medicine, neurology/sports neurology, and business development and strategy. To inform the center's development, the committee conducted a comprehensive gap analysis to evaluate the incidence of concussions in NYC and the surrounding counties, as well as the services available to this population. This analysis revealed a significant lack of interdisciplinary care options, even within the hospital system itself. Using these findings, the steering committee developed a detailed business plan outlining the center's proposed structure, workflow, and operational model. This plan was presented to hospital leadership and subsequently approved, paving the way for creating a center dedicated to providing integrated, patient-centered concussion care.

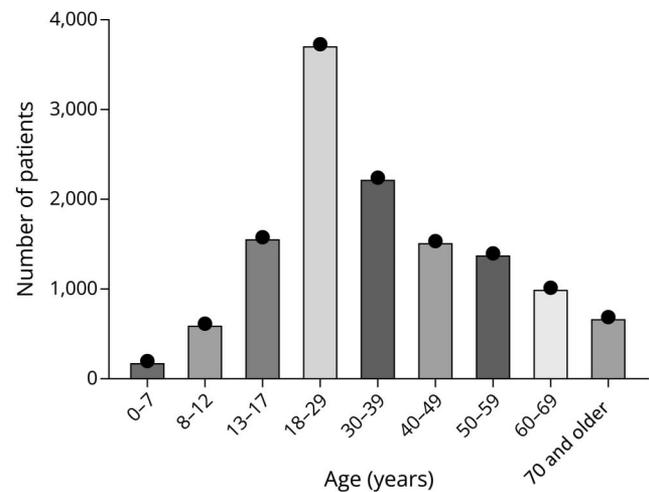
Patient Population

Since its founding in March 2013, the NYUL-CC has provided care for nearly 13,000 individual patients as of December 2023, with approximately 60% of cases presenting with non-sports-related concussions. The NYUL-CC serves a broad and diverse patient population, with 66.5% residing in NYC, 18.4% from other areas within NYS, and 15% traveling from out of state (e.g., MA, NJ, CA, and NV). Among these patients, 58% are female, and 18% are pediatric patients younger than 18 years. A detailed breakdown of age demographics is illustrated in the Figure, highlighting the center's ability to deliver interdisciplinary care tailored to various age groups. In recent years, most patients have scheduled appointments with physical medicine and rehabilitation (PMNR), and neurology providers within these specialties are typically the main point of entry to the center. Table 1 provides further details. In addition, the NYUL-CC accommodates a wide range of insurance plans, supporting accessibility for individuals from diverse health care backgrounds (Table 2).

Patient Point of Entry

To streamline patient access to the NYUL-CC, a toll-free call line was established through Physician Referral Services, the

Figure Patients by Age Group Between 2013 and 2023



Total number of patients (N = 13,000) presenting to the NYUL-CC between 2013 and 2023 by age group. NYUL-CC = New York University Langone Concussion Center.

hospital's central referral hub. Initially managed by nurses, it is now staffed by nonclinical referral specialists after institutional restructuring. Approximately 80% of patients enter the NYUL-CC through this line, which supports triage, appointment scheduling, and general inquiries. Patients are screened for emergent symptoms requiring ED referral. Those without urgent needs complete a structured intake to determine appropriate provider assignment based on symptom duration (acute <72 hours, subacute 72 hours–3 months, chronic >3 months), clinical presentation, availability, and insurance coverage. Referrals are made to specialists in PMNR, primary care sports medicine, or neurology. For instance, acute sports injuries are typically referred to primary care sports medicine, while chronic postconcussive symptoms may be directed to neurology or headache specialists. To enhance access, appointments are offered across multiple sites in NYC and Long Island, and digital waitlists are used to reduce delays. Initial visits are generally in person, with follow-ups often conducted through telemedicine, a model adopted during the COVID-19 pandemic and maintained thereafter, accounting for 41% of visits between 2020 and 2023. During the public health emergency, we delivered the following therapies virtually: physical therapy (vestibular, general, and cervical), occupational therapy (vision rehabilitation), speech-language pathology, and psychology intake and treatment; formal neuropsychological evaluations remained in person. After interstate telehealth waivers expired, out-of-state telehealth was limited to jurisdictions in which the treating clinician held an active license; otherwise, patients were scheduled for in-person care or referred to local providers. Currently, most physical and occupational therapy sessions are delivered in person, whereas speech-language pathology and psychology continue to provide telehealth regularly. This hybrid approach improves accessibility while preserving care quality. The NYUL-CC

Table 1 Total Number of Appointments Booked Under Each Specialty per Year Between 2013 and 2023

	2013 (N = 744)	2014 (N = 1,690)	2015 (N = 2,213)	2016 (N = 2,660)	2017 (N = 3,154)	2018 (N = 3,876)	2019 (N = 4,199)	2020 (N = 3,190)	2021 (N = 3,854)	2022 (N = 3,482)	2023 (N = 3,772)
PMNR	333	552	795	913	802	1,153	1,014	585	595	1,329	1,788
Orthopaedics	46	149	148	103	145	239	445	178	258	304	318
Sports medicine	66	126	130	158	154	103	119	39	77	61	76
ENT	2	8	22	17	6	5	7	10	16	4	4
IM	0	0	0	0	0	5	2	4	6	2	6
Pulmonology	0	0	0	0	0	0	2	9	9	8	1
Sleep medicine	2	0	0	0	0	0	0	1	2	3	0
Endocrinology	0	0	0	10	9	10	13	21	31	37	20
Neurology	208	732	975	1,320	1859	2,177	2,455	2,260	2,767	1,641	1,486
Epilepsy	65	61	78	83	68	62	50	20	27	13	10
Cognitive neurology	0	0	0	7	24	38	37	41	35	32	11
Psychiatry	0	0	0	0	19	9	8	2	0	0	13
Pediatric neurology	20	59	40	35	40	65	40	15	24	33	18
Sports medicine	0	2	12	6	12	1	0	0	0	0	0
Pediatric PMNR	2	1	13	8	16	9	7	5	7	15	21

Abbreviations: ENT = otolaryngology; IM = internal medicine; PMNR = physical medicine and rehabilitation.

operates as a primarily virtual center; while some adult therapies and administrative functions are housed in a dedicated space, most clinical services are distributed across separate locations. This model supports interdisciplinary collaboration and centralized coordination of care. Seamless transitions from the ED to NYUL-CC are supported by integrated workflows, and referrals are also facilitated through partnerships with local schools, universities, and community organizations. Patients may alternatively schedule directly using NYU Langone’s “Find a Doctor” platform.

Clinical Structure

Advanced practice provider (APP) services, including those provided by nurse practitioners and physician assistants, are offered through NYU Langone Health Faculty Group Practices, which comprises over 3,000 health care providers. The NYUL-CC’s interdisciplinary model supports holistic, patient-centered care with evaluations by specialists in neurology/sports neurology, PMNR, or sports medicine. Patients first see a physician or APP in one of these specialties, who may then refer them to experts in endocrinology, otolaryngology, ophthalmology, psychiatry, sleep medicine, neuroradiology, neurosurgery, pediatrics, and various rehabilitation services. A nurse clinical coordinator streamlines care by managing appointments, coordinating services, and ensuring that the care plan is followed, providing a seamless, high-quality patient experience.

The medical team at NYUL-CC has developed a standardized minimum data set for clinical assessment at the physician/APP level, grounded in this research evidence and clinical expertise. This core assessment includes components of the *Sports Concussion Office Assessment Tool 6 (SCOAT6)*,⁵ including the Symptom Checklist, cognitive testing, balance assessment, oculomotor assessment, and cervical spine assessment. Beyond oculomotor testing in the SCOAT6, the Mobile Universal Lexicon Evaluation System (MULES)^{6,7} and the Staggered Uneven Number (SUN)⁸ test may be used. The MULES and SUN tests are rapid automated naming tests for pictures and numbers, respectively, designed to capture subtle impairments in visual processing and performance. These tools collectively provide a comprehensive, evidence-based framework for assessing patients with concussion. Our team of experts continuously reviews and refines protocols to ensure that they remain aligned with the latest scientific advancements. As new evidence-based or consensus-based assessment tools emerge, they are seamlessly integrated into our evaluation process, ensuring the delivery of the most up-to-date and evidence-driven care.

Our interdisciplinary model integrates specialized rehabilitation services, including sports, orthopaedic, and vestibular physical therapy; occupational therapy; vision rehabilitation; neuropsychology; speech-language pathology; social work; and vocational rehabilitation, offered for

Table 2 Insurance Plans Used by Patients Between 2013 and 2023 Are Represented as Percentages of the Total Number of Appointments Completed Each Year

	2013 (%)	2014 (%)	2015 (%)	2016 (%)	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021 (%)	2022 (%)	2023 (%)
Child health plus	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00
EPO	2.83	0.88	0.90	1.39	1.21	1.64	2.88	1.79	2.90	2.42	2.99
HMO	4.59	7.39	9.04	8.69	11.28	10.73	10.76	10.74	10.03	13.89	13.47
Indemnity	1.06	1.68	0.90	0.48	0.96	1.14	0.79	0.39	0.79	0.56	0.34
Managed care	0.00	0.73	2.07	3.18	2.03	0.99	0.82	0.77	0.94	0.81	0.80
Medicaid	1.06	0.29	0.48	0.60	0.46	0.67	0.64	0.48	0.21	0.28	0.26
Medicaid managed care	0.35	2.19	3.51	5.24	7.33	9.44	10.07	10.00	10.15	12.27	11.93
Medicare	7.07	6.51	6.38	8.81	6.48	8.07	8.11	8.66	10.29	8.00	7.23
Medicare managed care	1.06	0.73	1.01	1.43	1.39	1.72	2.01	1.90	2.20	2.17	1.99
No fault	6.36	8.12	6.01	9.61	8.51	9.12	7.85	10.47	10.79	6.86	6.21
POS	9.89	12.22	17.45	18.34	17.26	15.32	17.08	17.88	16.92	16.61	17.86
PPO	61.84	53.04	48.99	40.13	40.89	39.70	37.25	35.08	32.70	33.88	34.43
Workers comp	3.89	6.22	3.24	2.10	2.21	1.46	1.68	1.84	2.08	2.28	2.48

Abbreviations: EPO = Exclusive Provider Organization; HMO = Health Maintenance Organization; POS = Point of Service plans; PPO = Preferred Provider Organization.

both adult and pediatric populations across 6 geographic locations within the NYU Langone Health system. Guided by the best evidence supporting timely evaluation after a concussion,⁹⁻¹³ when warranted, referrals to these therapies are typically initiated within 2–3 weeks of the injury and patients are evaluated within a few weeks, depending on the type of therapy. This proactive approach is designed to mitigate the development of persistent symptoms and enhance recovery outcomes. By integrating these specialized services into the care pathway, the NYUL-CC delivers coordinated, evidence-based care tailored to the unique needs of each patient with a concussion.

Sports orthopaedic physical therapists address musculoskeletal issues such as neck pain and headaches, while vestibular therapists treat postconcussive balance problems, dizziness, vertigo, motion sensitivity, and photophobia. They also guide patients through aerobic testing and progressive exercise to support return to activity and sport. Given the overlap between visual and vestibular systems in maintaining visual stability, vestibular and occupational therapists frequently collaborate to manage these symptoms effectively. Occupational therapy is particularly focused on addressing visual deficits experienced after a concussion and their impact on functional independence. Visual deficits include—but are not limited to—difficulty with smooth pursuits, saccades, eye teaming insufficiency, light sensitivity, eye strain, and the perception of movement in stationary objects. Occupational therapy aims to improve patients' functional independence and participation in meaningful activities (i.e., work, reading,

screen use, and household management) while providing education on managing symptoms. Both the occupational therapy for vision and vestibular physical therapy teams have integrated the MULES and the SUN test of rapid automatized naming into their practice, further enhancing the precision of their assessments and treatment strategies.

Our neuropsychologists specialize in treating both cognitive and emotional symptoms after concussion. These may include memory deficits, slowed processing speed, attention problems, and impaired executive function, factors that can disrupt daily functioning and quality of life. Emotional lability, such as mood swings, irritability, or anxiety, is also common and addressed through targeted assessment and management. Our speech-language pathologists work closely with neuropsychologists to treat social communication deficits, which may be subtle but significantly affect social interactions and well-being. These challenges often involve word retrieval, attention, processing speed, and thought organization. Communication anxiety, difficulty engaging in conversation due to fear or stress, can further affect expressive abilities. Speech-language pathologists use tailored therapies to improve speech fluency, listening skills, and thought organization, helping patients express themselves more clearly and confidently. Through this interdisciplinary collaboration, patients receive integrated care that addresses both cognitive and communicative barriers to recovery.

At NYUL-CC, patients are referred to a social worker to address psychosocial needs arising from persistent symptoms,

chronic conditions, and emotional challenges. These interventions include personalized reintegration plans, such as return-to-learn programs tailored for students and return-to-work strategies designed for employed individuals, ensuring a gradual and supportive transition back to daily activities. Involving a social worker early in the process helps address barriers to recovery and provides support. In addition, our vocational therapists evaluate a patient's capacity to perform job-related tasks by conducting comprehensive assessments that consider physical, cognitive, and emotional factors affecting workplace performance. They identify specific challenges and recommend tailored accommodations, such as modified work schedules, ergonomic adjustments, or assistive technologies, to facilitate the patient's ability to maintain or return to employment. These recommendations are shared with employers, when appropriate, to ensure a supportive work environment and promote long-term professional success. To further support our patient population with chronic symptoms, we have established a Functional Neurological Disorders Clinic, designed to address the complex needs of patients with brain injuries, particularly those with premorbid psychiatric conditions or other predisposing risk factors. These services are staffed by clinicians who are dual boarded in psychiatry and neurology, with specialized training and a strong clinical interest in brain injury. This holistic approach ensures that visible and less apparent symptoms of concussion are effectively managed to promote an optimal recovery trajectory while emphasizing the importance of early intervention in improving long-term outcomes.

Research

Research is central to the NYUL-CC mission, advancing basic, clinical, and population-based studies to improve outcomes in brain injury care. The center fosters interdisciplinary and multicenter collaborations across neurology, population health, neuroscience, radiology, psychiatry, and PMNR. These partnerships promote innovative approaches to understanding brain injury mechanisms and informing evidence-based care. To support research and quality improvement, NYUL-CC established an IRB-approved registry at its inception. Patients receiving concussion care may consent to share clinical data, including injury details, symptoms, referrals, and treatment, entered into a REDCap database. Data collection is performed by both research and clinical staff, enabling continuous evaluation of care practices and supporting future discovery.

Education, Community Outreach, and Advocacy

To remain at the forefront of concussion care, NYUL-CC has established robust educational initiatives. Monthly journal clubs and grand rounds foster continuous learning across disciplines. The journal club, led by a senior faculty member (Brian Hainline) with national and international expertise,

guides residents and allied health professionals in critically appraising research and shaping presentations. Grand rounds feature internal and external speakers, promoting cross-institutional collaboration and offering a platform for staff to share ongoing work. Together, these programs support interdisciplinary learning and evidence-based care. NYUL-CC also prioritizes community engagement. Since its founding, the team has delivered over 150 tailored lectures to schools, health care professionals, and parents to raise awareness and promote safer practices, especially for children. Since 2014, the center has hosted an annual CME-accredited concussion conference, available in-person and virtually, drawing national and international attendees and educating over 3,000 learners. Advocacy is also central to NYUL-CC's mission. The team collaborates with organizations such as the Brain Injury Association of NYS and Safe Kids NYC to influence policy on injury prevention and health care access. Efforts have included advocating for legislation permitting APPs to make return-to-play decisions and promoting access to athletic trainers and mandatory concussion education in schools. NYUL-CC team members also serve on the Health Equity Council, working to address barriers to care by assessing social determinants of health and ensuring that the services reflect the city's diverse population.

What We Have Learned in the First 10 Years

The NYUL-CC's decade of success reflects its interdisciplinary, patient-centered model and the commitment of its clinical team. The clinical coordinator plays a central role in managing complex cases and ensuring continuity of care. Educational efforts have helped integrate emerging evidence, particularly in vision and neuroimaging, into clinical practice, whereas partnerships with external organizations have advanced research, care, and policy. A multispecialty model is essential to comprehensive concussion care, but balancing coordination and accessibility is critical. Although a single-site model offers real-time collaboration, it is limited by spatial and logistical constraints. Instead, NYUL-CC uses a virtually centralized system, where care is coordinated across locations by the clinical coordinator. This flexible approach maintains high-quality, integrated care while adapting to operational realities, offering a scalable model for concussion care delivery.

Future Planning

Increased awareness of TBI has positively influenced clinical, research, and educational practices. Yet, significant work remains to address the clinical, social, and educational needs of diverse communities. Building on over a decade of success, the NYUL-CC remains committed to advancing interdisciplinary care while expanding access for NYC's diverse population. In collaboration with the Health Equity Council, we are analyzing

TAKE-HOME POINTS

- The NYU Langone Concussion Center was established in 2013 to address the unmet need for interdisciplinary concussion care in a diverse, urban population, with over 13,000 patients served to date.
- Unlike many existing centers focused on sports-related or pediatric concussions, NYU Langone Concussion Center treats both sports-related and non-sports-related injuries across the lifespan, with approximately 60% of cases being non-sports-related.
- The center operates as a virtually centralized model, integrating neurology, rehabilitation, sports medicine, mental health, and specialty therapies across multiple sites, coordinated by a dedicated clinical team.
- Key pillars of the program include the following: evidence-informed clinical care, a research registry, interdisciplinary education, community engagement, and advocacy efforts aimed at reducing disparities and informing public policy.
- Future plans focus on expanding geographic access, enhancing health equity, and leading national efforts in clinical innovation, neuropsychiatric care, and research in concussion diagnosis and recovery.

patient demographics to identify barriers to care and guide the expansion of services across the NYU Langone Health system. Concussion management poses unique challenges. Our team is focused on key areas including the development of predictive outcome metrics, tailoring therapies to patient subgroups, recovery in older adults, the role of women's health, and differences between sports-related and non-sports-related concussions. These efforts aim to inform treatment innovations and reduce the global burden of concussion. Strategic goals include expanding clinical reach; building national partnerships in clinical care, education, and research; and ensuring seamless patient transitions across care settings. Through targeted collaborations, publications, educational programs, and media outreach, the NYUL-CC seeks to strengthen its national impact. We are also standardizing evidence-based practices across disciplines to ensure consistent, high-quality care. Our continued investment in clinical, basic, and population health research is supported by growing philanthropic partnerships. In parallel, we are advocating for policy and legislative change to improve concussion care at a broader scale. Through these efforts, the NYUL-CC is positioned to lead the next generation of innovation in concussion care and research.

Author Contributions

A. Olivera: drafting/revision of the manuscript for content, including medical writing for content; major role in the acquisition of data; study concept or design; analysis or interpretation of data. G. Pagnotta: drafting/revision of the manuscript for content, including medical writing for content; major role in the acquisition of data; study concept or design; analysis or interpretation of data. M. Sproul: drafting/revision of the manuscript for content, including medical writing for content. L. Phillips: drafting/revision of the manuscript for content, including medical writing for content. N. Syed: drafting/revision of the manuscript for content, including medical writing for content. J.D. Drattell: drafting/revision of the manuscript for content, including medical writing for content. M.V.C. Juanito: drafting/revision of the manuscript for content, including medical writing for content. J. Fay: drafting/revision of the manuscript for content, including medical writing for content. T.V. Denham: drafting/revision of the manuscript for content, including medical writing for content. L. Serrano: drafting/revision of the manuscript for content, including medical writing for content. J. Zhao: drafting/revision of the manuscript for content, including medical writing for content. C.A. Parkin: drafting/revision of the manuscript for content, including medical writing for content. S. Datta: drafting/revision of the manuscript for content, including medical writing for content. B.S. Im: drafting/revision of the manuscript for content, including medical writing for content. D. Cardone: drafting/revision of the manuscript for content, including medical writing for content. B. Hainline: drafting/revision of the manuscript for content, including medical writing for content. S. Flanagan: drafting/revision of the manuscript for content, including medical writing for content. S.L. Galetta: drafting/revision of the manuscript for content, including medical writing for content. L.J. Balcer: drafting/revision of the manuscript for content, including medical writing for content. H. Arciniega: drafting/revision of the manuscript for content, including medical writing for content; major role in the acquisition of data; study concept or design; analysis or interpretation of data.

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