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INTRODUCTION

A couple of years ago, the first author of this volume had knee surgery, one of many that was a consequence of a lifetime of playing soccer. This time the surgery involved a microfracture procedure that was a little more involved than previous surgeries and included a long period of physical therapy and rehabilitation. Fortunately, everything went well, and he is now back playing soccer, surfing, hiking, and other physical activities. However, what was interesting about this is the diagnosis that led to the surgery. The diagnosis was a 2-centimeter full-thickness tear in the articular cartilage in the medial compartment of the right knee. As a result of this diagnosis and the subsequent failure of conservative, nonsurgical treatments, an orthopedic surgeon who specializes in knee surgeries recommended the microfracture procedure.

This was a very specific diagnosis of a particular type of knee injury. The orthopedic surgeon did not simply diagnose a "knee injury." Instead, he

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diagnosed a subtype ("articular cartilage tear") of knee injury with specific features and characteristics ("2 cm full-thickness . . . medial compartment"). Other diagnoses (e.g., meniscal tear, anterior cruciate ligament tear, dislocation, osteoarthritis, patellar tendon tear) would have resulted in different clinical conceptualization and treatment approaches.

This clinical approach is in stark contrast to the most common approach to diagnosing and conceptualizing a concussion, which is much more homogenous. A homogenous perspective assumes that all concussions are alike and can be treated using a one-size-fits-all approach. But if we have many different types of knee injuries, why would we expect to have one type of concussion? After all, and with no disrespect to knees intended, the brain is infinitely more complex than the knee, yet clinicians and researchers typically rely on a single diagnosis of "concussion."

Unfortunately, current conceptual approaches to assessing and treating concussion continue to revolve around this faulty homogenous perspective. This homogenous perspective is, in part, to blame for the numerous failed clinical trials for treating concussion (Z. Zhang, Larner, Kobeissy, Hayes, & Wang, 2010). In each of these trials, the researchers have conceptualized concussion from a homogenous perspective involving symptoms and perhaps cognitive or balance impairment. The key assumption in these studies is that a specific pharmacological therapy will improve symptoms and impairment of *all* patients with a concussion in the same manner. However, as evident in the failure of these trials, the reality is that these therapies are likely improving symptoms and impairment in a small subsample of patients. This subsample might have in common specific symptoms, impairment, risk factors, or other characteristics, thereby resulting in a successful outcome following therapy. In contrast, patients with different symptoms, impairment, and other characteristics may experience no benefit or an adverse response to the same therapy, and thus, the trials fail.

Similarly, in the growing literature in concussion, the majority of empirical studies include one or more of the following outcome variables: total symptoms or symptom severity, cognitive, or balance impairment. As a result of this generalized approach (from which all concussions are measured the same way) the effect sizes or magnitude of changes reported that are related to the effects of concussion are often minimized. Again, the issue is that not all patients have the same symptoms and impairments. It was not until recently that researchers began to expand the outcomes assessed following concussion to include vestibular (e.g., Mucha et al., 2014), oculomotor (e.g., Pearce, Sufrinko, et al., 2015), psychological (e.g., Kontos, Covassin, Elbin, & Parker, 2012), and other outcomes. However, the majority of researchers continue to select the same outcomes in their studies, leading to less robust findings and potentially missing the true effects associated with this injury.

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Although concussions may share some underlying biomechanical and pathophysiological characteristics, even these similar underpinnings may lead to different outcomes. These different outcomes may result from a variety of risk factors, and these differences cannot be boiled down to a total symptom score or only balance impairment. We typically measure more than 20 different symptoms associated with this injury that range from dizziness, headache, and nausea to trouble concentrating and sleep problems. Symptom presentation alone provides compelling evidence that concussion is a highly individualized injury that demands a conceptual framework that goes beyond the current one-size-fits-all approach.

DEFINING CONCUSSION

In developing our own definition of concussion, we began by considering a typical definition representative of the field: "a traumatic brain injury induced by biomechanical forces" (P. McCrory et al., 2017, p. 2). The definition goes on to describe concussion as involving direct and impulsive (i.e., indirect) forces to the head, short-lived impairment, evolving initial signs and symptoms, functional versus structural injury, and a range of clinical signs and symptoms. Although the initial portion of this definition is succinct and provides a conceptual framework for this injury, it lacks operational or practical application and does not reflect our evolving understanding of this injury. We thus propose to extend the above definition as follows:

> a complex pathophysiological process affecting the brain, induced by biomechanical forces, *which may involve different symptoms, impairment, clinical profiles or subtypes, and recovery trajectories that are influenced by a variety of risk factors*.

We believe that this definition of concussion represents a more accurate and practical reflection of the current thinking regarding this injury. We address concussion terminology in more detail in Chapter 2.

GOALS AND ROADMAP OF THIS BOOK

The primary objective of this book is to present and discuss an evidence-based, targeted, and comprehensive approach to concussion assessment and care that accounts for the heterogeneous nature of the injury. This approach incorporates a comprehensive assessment, an interdisciplinary approach, and targeted, active treatments. It is based on our 30 plus years of collective experience in concussion clinical care and research.

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Because the approach relies on a health care team with diverse specialties, this book is intended for any professional who might be involved in concussion care, including athletic trainers, clinical/counseling psychologists, neuropsychologists, neurologists, neurosurgeons, optometrists, physical therapists, and primary care physicians. We realize that in many instances, it is not feasible or possible (for reasons of geography, access to health care, or financial constraints) to assemble a comprehensive team of interdisciplinary health professionals. In fact, it is more common that a single health care provider is responsible for all aspects of concussions clinical care rather than an integrated, interdisciplinary team. However, through the cultivation of proper referral networks and the growing field of telemedicine, these barriers can be overcome. Regardless of whether a patient is treated by a team or an individual, the information in this book provides a guide to better understand, conceptualize, and treat this injury from an interdisciplinary perspective.

We hope that this book acts as a catalyst to advance the discussion about concussion such that more comprehensive, active, and targeted approaches to assessing and treating concussion become the standard of care moving forward. In short, we believe concussion is a treatable injury and that when it is managed properly and in a timely fashion, a positive outcome can result.

We have organized this book in a progressive manner with a focus on understanding this injury. The first few chapters help conceptualize concussion. We begin with an overview of our model, emphasizing the six clinical profiles (Chapter 1). We then provide a broader review of how concussion functions, including underlying mechanics and pathophysiology, as well as common signs and symptoms. We refer to this review as "Concussion 101," and it reinforces the approach we propose in this book (Chapter 2). We then review the psychological issues related to concussion (Chapter 3). Next, we apply this understanding to clinical practice. We provide a comprehensive approach to assessment (Chapter 4) and targeted, active treatment and rehabilitation strategies (Chapter 5). We also present and discuss case examples that represent the various clinical profiles to better illustrate the model in action (Chapter 6). Finally, we examine more closely specific at-risk groups and issues related to concussion (Chapter 7) and consider where the field is heading (Chapter 8).