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FEATURED INTERVIEW

Traumatic Brain Injury and Intimate Partner Violence: Awareness, Recognition, and Rehabilitation

Interview with Angela Colantonio, PhD, OT Reg. (Ont.), FCAHS, FACRM and Halina Haag, MSW, RSW, PhD(c)

Angela Colantonio, PhD

Dr. Colantonio is a Professor of Occupational Science and Occupational Therapy and Rehabilitation Sciences at the University of Toronto where she holds a Canada Research Chair on Traumatic Brain Injury in Underserved Populations. She is also a Senior Scientist at the KITE-Toronto Rehabilitation Institute-University Health Network, where she leads the Acquired Brain Injury and Society team.

Dr. Colantonio leads an internationally recognized program of research on acquired brain injury with diverse foci on women, sex and gender, work-related traumatic brain injury, and under-served populations. She is a Fellow of the Canadian Academy of Health Sciences, the American Congress of Rehabilitation Medicine and the American College of Epidemiology. She was the 2020 recipient of the Brain Injury Association of America William Fields Caveness Award, which recognizes research that has made outstanding contributions to bettering the lives of people with brain injury.

Halina Haag, PhD(c)

Halina (Lin) Haag is a Contract Faculty Member and PhD candidate in Social Work at Wilfrid Laurier University in Ontario, Canada. Her work focuses on the gendered experience of traumatic brain injury and the impact on mental health, return to work, and social integration encountered by brain injured women survivors of intimate partner violence. Lin is committed to improving outcomes through direct practice, innovative research, and professional education, believing that increased knowledge and understanding is key. As someone with lived experience of TBI, she has been a guest speaker addressing issues of dis-

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In This Issue

The focus of this issue is traumatic brain injury (TBI) in the context of intimate partner violence (IPV). Why is this interrelation important? TBI is a frequent result of IPV due to blows to the face and head, being thrown about against a wall or floor, and non-fatal strangulation. The outcome is particularly severe when TBI occurs repeatedly. Our interview is with Dr. Angela Colantonio, the Director of the Rehabilitation Sciences Institute at the University of Toronto, and Halina Haag, of the Wilfrid Laurier University in Waterloo, Ontario. The interview focuses on TBI and its impacts on mental health, return to work, and social integration of women survivors of IPV with brain injury. A separate article explains the gendered experience of TBI, and another gives basic information on the physical, psychological, and social impacts of TBI. Our statistics article focuses on odds ratios and confidence limits, measures that are often encountered in comparisons of populations, particularly regarding risks. Finally, we have identified websites of interest with resources for those who have sustained TBI and for their caregivers.

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A key message from survivors is that people need to ask more. There is still a stigma, there is still a silencing around IPV and around TBI.

ability, brain injury, and marginalization for a variety of international academic, professional, and community-based organizations.

Dr. Whalen: How did you become interested in interpersonal violence-related brain injury?

Dr. Colantonio: Early in my career I noticed the gap in terms of brain injury and intimate partner violence (IPV). Our lab at the the University of Toronto has had a long-standing focus on marginalized and underrepresented populations and addressing sex and gender with respect to traumatic brain injury (TBI). We have looked at the prevalence and extent of brain injury in persons in marginalized groups such as the homeless, those in the justice system, and persons injured due to violence. These are often overlapping populations.

We produced the first papers in Canada on brain injury and IPV looking at the gaps in knowledge regarding brain injury and front-line providers. We have addressed assault as a mechanism of injury looking at how intentional injury might differ from other mechanisms of injury in TBI. Also, we led the first international workshop on women and brain injury in collaboration with the American Congress of Rehabilitation Medicine.

We received funding from the Federal Department of Justice to help with the development of our web-based toolkit (Abused & Brain Injured) to draw attention to the intersection between IPV and brain injury. It is evolving to provide information, resources, research and practice recommendations for providing trauma-informed service delivery (*www.abitoolkit.ca*).

We received a large grant funded by the Ontario Ministry of Health and Long-Term Care focused on the integration of TBI, mental health, and addiction, again, working collaboratively with major stakeholders around these topics. It aimed to address brain injury in underserved populations such as homeless and persons in the justice system, and to include intimate partner violence (IPV) because there is so much overlap in these underrepresented populations. I should say too that I have been recently awarded a Canada Research Chair in Traumatic Brain Injury in Underserved Populations. The first term is seven years and includes a focus on IPV. We were fortunate to have Halina Haag, who has training in social work, join our lab and take on a leadership role in this work as a doctoral candidate.

Halina Haag: I came to work with Angela as I was drawn by her research interests and the opportunity to work with her in an interdisciplinary collaborative group. I had worked alongside of social workers who perform a lot of the frontline work in the IPV context and I knew that there is little conversation about TBI. I just thought, "This is something that really needs more attention." I felt very passionate about committing to this work.

Dr. Whalen: You touched upon critical gaps in TBI research. Would you elaborate on that topic?

Dr. Colantonio: I believe this field is in its infancy. There is a huge information gap. We do not have good prevalence numbers. Having national estimates that cover the full range of brain injury is very important. In addition, much of the data on TBI research on women with an IPV is based on a range of different types of samples and some studies that include shelter populations have found that the prevalence of TBI is high. The World Health Organization indicates that one out of three women are affected by IPV in their lifetime

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Information has a huge impact on the experience of a survivor. Literature suggests that shared experience, the understanding of what is happening to yourself in relation to what has happened or is happening with others, is helpful.

(https://www.who.int/news-room/fact-sheets/detail/violence-against-women). The most common sites of injury are the head, face, and neck, but our research shows that there has been minimal training in this area for frontline providers.

Some TBI screening instruments, like the HELPS (Picard, Scarisbrick, & Paluck R, 1991), have been published, but I do not believe there is one that has been validated to address IPV in this context. There need to be protocols for the screening. There are risks associated with being a brain injury survivor. It is important to remember to do no harm in the process of screening.

Halina Haag: A lot of people say "screening, screening, screening," but not how to do it in a manner that respects the dignity and the choice of the person. That needs to be worked out as well.

Dr. Colantonio: Another side to screening is the context where this may take place. One needs to make sure that your facility is accessible to people who may have some of the consequences of a brain injury. The facility needs to consider having a setting that can minimize distractions and sound, if needed. Some of these individuals also have sensitivity to light. They may need written instructions and reminders for appointments. There is also some good evidence for the success of communication partner training relevant to persons with TBI leading to positive changes in communication outcomes with community members like police (Togher, McDonald, Code, & Grant; Wiseman-Hakes et al., 2020). Training communication partners has the potential to improve conversation outcomes for persons with TBI and provide more accessible environments. These could be implemented universally so nobody has to self-identify as brain-injured or as a victim of IPV because the communication processes and strategies are incorporated into your everyday structure.

Women want information on the effects of TBI, to put a label on what they are feeling. They want to know that there is something biologically wrong and that it is not an issue of motivation or personal failings. There is something biological that might explain why things like appointments might be missed.

Halina Haag: Information has a huge impact on the experience of a survivor. Literature suggests that shared experience, the understanding of what is happening to yourself in relation to what has happened or is happening with others, is helpful. "I am not just losing my mind. There is a physiological underlying condition that has created this in me." That is a very common refrain from survivors of TBI. I have no reason to believe that this does not apply to the IPV context as well and, in many ways, is amplified, because they are getting messages of "You're stupid. You're useless. You're not valuable as a human being. You can't even make appointments. You cannot do your homework." They hear this from an abuser, but also frequently in their interactions with support structures. There is a disconnect between the understanding of a frontline worker and the behavior of a survivor. We are working hard to find the balance. How do we provide this for survivors and empower them through knowledge and understanding without putting them at further risk and, as Angela says, how do we do no harm?

Dr. Whalen: There are certainly risks associated with screening, but there are also risks for TBI not being identified and going untreated. What do frontline workers need to know about TBI?

Dr. Colantonio: Frontline workers absolutely need to know about brain injury. In the toolkit we have red flags that are pretty well-known and are part of standard concussion evaluation. Some examples are: headaches that worsen, neck pain, looking very drowsy, repeated vomiting, inability to recognize people or places, increasing confusion, weakness or numbness in arms or legs, unusual behavior change, increasing irritability, and loss of consciousness. You want people to know about these red flags and to know to call for immediate help.

Halina Haag: One of the challenges is that so many of the symptoms that Angela was describing can be misinterpreted as something else, as substance use or defiance, and may often be overlooked. There are layers of challenges in the sense that people will look at behaviors and attribute them to something completely different because there is a lack of recognition of the symptoms of TBI. When we look at a football player who doesn't get up right away and shakes his head a little bit, there is an immediate response of "Are we dealing with a concussion?" There are protocols in place for that. But we are still not thinking about underlying trauma to the brain when looking at women, even when

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I think we need to step aside, at least for the moment, from the idea of diagnosis for treatment and move towards a model of identification or awareness for accommodation and support.

there are physical signs of extreme violence to the head, face or neck.

For some women with TBI, it is extremely important that they receive immediate medical care. There can be significant medical implications when there are hits to the head, face, and neck. If you are looking at repeated exposure within a short period of time you could have "second impact syndrome". A minimal amount of basic information handed out to the front-line worker can aid them in making those critical observations and decisions. Then, how do we refer women out into our communities in such a way that they are safely able to access support?

I think we need to step aside, at least for the moment, from the idea of diagnosis for treatment and move towards a model of identification or awareness for accommodation and support. We do not need to put another label on somebody that potentially puts them at higher risk. We need to become aware of what we are seeing from a survivor's behavior compared to what we expect to see, and is there a disconnect between the two? There are low cost, easy-to-implement solutions that organizations can put in place. It is about letting them know what to look for. The tools that Angela mentioned are very helpful for the people who are talking to the survivors: "What do I need to know to make this assessment?" Are they looking at someone who has a chronic ongoing situation where they need some extra support in terms of memory tasks and organizational capacity and safety planning?

Dr. Colantonio: We have spoken about people in the justice system being a marginalized group. Rates of abuse are high prior to incarceration and often there are early life experiences of physical and sexual abuse, particularly for women. These settings are overwhelmingly focused on mental health and addiction, but TBI could be a factor in the treatment of victims in terms of consequences of a brain injury like impulsivity. Having an awareness of some underlying causes of these problems can enhance a more effective treatment response.

Halina Haag: I want to highlight some of the implications of marginalization in the groups we have described and to note that their experiences are different and complex. Intimate partner violence happens across a broad cross-section, but the more you layer marginalization on top of that, the harder it is for women to overcome their situation and escape. While it is massively overrepresented in women, it is important to remember that IPV with TBI does happen to all genders. TBI can also be a precursor to marginalizing conditions such as being homeless or incarcerated. Being exposed to IPV is much more likely for people who have a TBI. So, I think you have a bit of a chicken and an egg situation.

When someone sustains a TBI, often through some perfectly innocuous event, their judgment and decision-making may be impaired. They may experience substance use or other challenges and end up in the criminal justice system where they can experience more violence and there is a greater likelihood of further injury. It is really important to look at lifetime history of TBI and how that increases the risk of negative outcomes.

Dr. Colantonio: As written by Wayne Gordon, a leader in the field in New York (*https://www.brainline.org/article/tbi-research-review-unidentified-brain-injury)*, we are trying to prevent social failure through providing some support and rehabilitation after brain injury so we do not have some of these negative consequences.

Dr. Whalen: If we assume that the mental health paradigm will continue to dominate the field, say focusing on PTSD or depression, how would you recommend helping clinicians to prioritize treatment?

Dr. Colantonio: There has to be a tailored approach to the individual. We have guidelines that are comprehensive in terms of what should be examined. With brain injuries, one of the challenges is that no two brain injuries are alike. PTSD is an overlapping condition with brain injury, but some of the symptoms are different. These are important considerations in assessing PTSD.

Halina Haag: A lot of what we have called PTSD historically, may have a lot more to do with TBI than we previously understood. Equally, for what we think about in terms of mental health treatment for depression and anxiety. These conditions are very often-seen with TBI. Knowing that there is an underlying brain injury component can change how you want to intervene for the depression or anxiety.

Dr. Colantonio: It is important to have an appreciation for what all rehabilitation professionals can provide in terms of care and to keep a broad focus on that. Supporting survivors to engage in or return to employment through vocational rehabilitation and/or occupational therapy for instance, can be very empowering. Other

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providers of rehabilitation are speech-language pathologists who can address problems related to speech and social communication. Physical therapists can assist with therapeutic physical activity and psychologists and other providers can offer cognitive behavioral therapy and mindfulness-based approaches, for example.

Another area of interest is that of sleep and TBI. The importance of sleep to recovery has been very underappreciated.

Another area of interest is that of sleep and TBI. The importance of sleep to recovery has been very underappreciated. As part of a doctoral thesis, one of my students showed that when sleep was treated and targeted, persons with TBI show significant improvements in a variety of the outcomes. Some people have suffered with trauma-related sleep disorders for a very long time that were not being addressed. Again, some of the symptoms related to anxiety and depression may have been due to an underlying sleep disorder.

We should also note that perpetrators have been found to have a higher than expected lifetime brain injury. A lot of programs do not address the perpetrator side, but it is an important consideration. The problem may be bigger than just the woman being affected. We know, for example, that TBI can be associated with impulse control.

Halina Haag: Much of our work is about education, whether it is somebody who is throwing the punch or somebody who is receiving it. We are giving those who support these populations tools for their toolbox. It is not about telling them how to do their job. It is not about giving them another checklist that they need to go through at a very specific time and make a diagnosis. It is about an awareness and a sensitivity to issues that are prevalent on both sides of the fence, victim and perpetrator.

One of the things that we can do is to try not to be the ones who are leading the agenda. Rather, we can continually go back to our community partners and to our network to seek guidance. Over the past five years, we have built our Knowledge to Practice Network (K2P Network) with a significant number of members who have joined for the purpose of disseminating information and contributing to the work we are doing (Haag et al., 2019). If we need research partners or we are looking for stakeholders for a project, we go to the K2P Network. Before we sit down and start thinking up the next research project and looking for funding, I usually put in a couple of phone calls and say, "What are you experiencing? What are you seeing on the front lines? What do you think is the next step?" The people who have the best sense of what is happening are the people who are living with it every day, either in terms of a survivor perspective or a service provider. We have had contacts from police forces, nurses who are in emergency rooms, and shelter organizations in direct IPV service.

Dr. Whalen: There are other risks associated with a brain injury. Could this information be used by an abuser to get custody of children or to work against the person affected? Is there evidence that this kind of information has been used for custody battles or other legal proceedings?

Halina Haag: In terms of evidence, at this point it is largely anecdotal. We hear concerns from frontline workers, people in the IPV sector with legal backgrounds and from survivors themselves regarding their concerns and experiences. We do not have specific data on the relationship between a diagnosis in this context and outcome in a legal context because the field is in its infancy. But, we have raised the issue of risk and the need for consideration of whether we are potentially putting women at further risk of harm and for what gain in terms of what services are there to support them.

Dr. Whalen: What are some additional the topics on TBI and IPV that we should be talking about?

Dr. Colantonio. We have addressed how brain injury might be different in terms of sex and gender. We found that among ninety thousand concussions presenting in an emergency room, women are more likely to have comorbid neck injuries likely due to weaker neck musculature. This held true for a range of mechanisms of injury such as motor vehicle collisions, sports, as well as assault-related injury. It is important to create that awareness among practitioners. Also, from the sports injury literature, it seems to support that girls and women can have a longer recovery time after concussion.

Halina Haag: I would like to give you a final perspective from survivors. A key message from survivors is that people need to ask more. What we are hearing from survivors is that they are not being asked about IPV and TBI. There is still a stigma, there is still a silencing around IPV and around TBI.

Dr. Colantonio: Finally, some of our education materials are not meant for indigenous and

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BUILDING BRIDGES TO RESEARCH

Odds Ratios and Confidence Intervals

By James E. McCarroll, PhD, Ronald J. Whalen, PhD, Joshua C. Morganstein, MD, and Robert J. Ursano, MD

Multiple injuries were almost three times as likely to be reported by abused women compared to non-abused women.

What are the odds of…? This is a question we often ask ourselves, whether we are playing the game tables in Las Vegas or making some other important decision. In behavioral research, this question is often about whether there is a significant difference between two groups and, if so, how much of a difference. For example, the odds of a smoker developing lung cancer compared to a non-smoker is much greater for those who smoke cigarettes compared to those who do not smoke cigarettes.

An odds ratio can be a useful comparison of events in family violence. For example, differences between the reports of abused and non-abused women were compared in a study of 380 who reported a history of abuse and 358 reported never being abused. When the reports of injuries by abused women were compared to injuries reported by women who were not abused, multiple injuries were almost three times as likely to be reported by those who reported abuse (Anderson, Stockman, Sabri, Campbell, & Campbell, 2015). This result was based on the odds ratio of 2.75 with the 95% confidence interval (CI) of 1.58-3.57. A 95% CI means that there is 95% confidence that the interval defines a range of values that contains the odds ratio and the values are not due to chance. The range of the CI shows that there was a statistically significant difference between the two groups because the values of the lower (1.58) and upper boundaries (3.57) of the CI do not include 1.0. The interpretation of the boundaries of the CI indicate that the odds ratio could be from 58% higher (1.58) to as much as 257% greater (3.57) when abused women were compared to non-abused women.

The important points to remember from this example are (1) that an odds ratio greater than 1.0 indicates that the exposed group (abused women) has a higher likelihood of injuries than the comparison group (non-abused women); (2) the confidence interval does not include the value of 1.0 indicating that the difference in the two groups is significant; and (3) there is 95% certainty that these values are accurate.

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black women. They may need a completely different approach and more research needs to be done. In addition, the leadership should come from those underrepresented groups.

Halina Haag: One solution is not going to fit everybody and it needs to come from the communities that are experiencing them. We can support that, but I do not think we can be the driving force.

Dr. Colantonio: I also want to say that this work that we have described is not about one person. It is many people. We have many terrific collaborators, trainees, people like Halina, and supporters. We try to incorporate the end-user perspective in the work that we do. So, a lot of recognition goes to everyone who has contributed to our research program.

Dr. Whalen: Thank you both.

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What is a Traumatic Brain Injury?

By James E. McCarroll, PhD, Ronald J. Whalen, PhD, Joshua C. Morganstein, MD, and Robert J. Ursano, MD

Recovery from TBI is influenced by severity of injury, age, gender, prior concussion, health history, and the presence of comorbidities and vulnerabilities.

A traumatic brain injury (TBI) is one of two types of acquired brain injury (ABI). That is, an injury to the brain that has occurred after birth. ABI can be non-traumatic or traumatic. Non-traumatic brain injury can occur in a variety of ways such as from a stroke, tumor, or a cardiac arrest that deprives the brain of oxygen and results in brain damage. TBI occurs when a force to the head or body alters brain function. TBI can be focal or diffuse, intentional or unintentional.

Focal injuries occur from blows to the face or head that produce contusions, lacerations, and hemorrhage. In such incidents, there can also be a rapid acceleration and deceleration of the brain resulting in injury. Diffuse injuries can occur even when there may not be a direct blow to the head, but from being shaken or thrown about (McKee & Daneshvar, 2015). TBI can also occur from penetrating injuries such as gunshot wounds to the head. External forces resulting in TBI can also damage the spinal cord and neck (Pacheco, Mollayeva, Jacob, Colantonio, & Mollayeva, 2019). Females are at higher risk for concurrent neck injury compared to males likely due to necks that are weaker and have distinct anatomical features (Catenaccio et al., 2017; Sutton et al., 2019; Vasavada, Danaraj, & Siegmund, 2008).

In 2013, TBI accounted for 2.8 million emergency department (ED) visits, hospitalizations, and deaths in the U.S. TBI is undercounted when there is no hospital or other medical evaluation or treatment, when more severe injuries take priority in the ED, and comorbidities may mask or mimic, the effects of TBI. Definitions and criteria for diagnosis vary; there are no standardized processes for evaluating patients (McCrea, Nelson, & Guskiewicz, 2017). Additionally, refusal or inability to seek medical care and the lack of recognition of the signs and symptoms of TBI by both victims and providers may contribute to underdiagnoses. Approximately 87% of TBIs are mild (mTBI) and represent persons who were treated in and released from EDs (Centers for Disease Control and Prevention, 2015).

The terms mTBI and acute concussion are sometimes considered interchangeable, yet the definitions of both vary (McCrea et al., 2017). Central to the definition of mTBI/concussion is the rapid onset of impairment of neurologic function that can resolve in a short time frame — hours to weeks. Subconcussion, another form of mTBI, can occur when there is no clinical sign of a concussion and symptoms are minimal or non-existent. Subconcussion can be harmful when it is repeated causing long-term diverse and non-specific changes in cognition, mood, behavior, and motor functioning (Bailes, Petraglia, Omalu, Nauman, & Talavage, 2013; Mariani, Alosco, Mez, & Stern, 2020).

Clinical diagnosis of mTBI is based on the combination of injury mechanism and acute symptoms and signs. It can occur without loss of consciousness or measurable posttraumatic amnesia. There are varied injury characteristics that are physical (e.g., headache), cognitive (e.g., difficulty concentrating), emotional (e.g., irritable), and sleep disturbances (e.g., drowsiness). Some symptoms are nonspecific and can occur in the context of other health conditions (e.g., mood disorders, learning disabilities, other developmental cognitive disorders). The rate of recovery is influenced by severity of injury, age, gender, prior concussion, health history, and the presence of comorbidities and vulnerabilities. Many assessment tools have been developed including checklists, CTs and MRIs, and neuropsychological tests. However, there is much to be learned about the neuropathological and metabolic changes that occur in brain injury and how such changes affect recovery (Povlishock & Katz, 2006). In addition, recovery is affected by a variety of biological, psychological, and social factors and symptoms may not resolve in the anticipated time (Hou et al., 2012). This failure to meet expectations of recovery is not uncommon. The failure to meet expectations of recovery may be internalized by patients as a personal failure, particularly in instances of repetitive head trauma. In a study of 131 patients with mild concussion, 14.5% still had symptoms that did not resolve in one year (Rutherford, Merrett, & McDonald, 1979). Recovery is tailored to the patient's individual needs and progress (McCrea et al., 2017).

mTBI is not only a common concern in contact sports, but also a frequent result of intimate partner violence (IPV). There has been more research on mTBI in male athletes than on

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female victims of IPV even though the population of abused women with mTBI affects millions of women worldwide (Colantonio, 2020). IPV victims may not seek medical care due to stigmatization of admitting family violence or fear of retaliation by the abuser or their family (St Ivany et al., 2018). Despite the frequency of IPV-related TBIs, many health care providers are often unaware of the prevalence of TBI in IPV and many lack the understanding of how to respond to it (Haag et al., 2019).

A wide variety of research shows multiple effects of mTBI in contexts of IPV. A clinical study of 99 women residing in a shelter and community women found that almost 75% had experienced a TBI from an intimate partner and nearly half had been repeatedly victimized.

A wide variety of research shows multiple effects of mTBI in contexts of IPV. A clinical study of 99 women residing in a shelter and community women found that almost 75% had experienced a TBI from an intimate partner and nearly half had been repeatedly victimized (Valera & Berenbaum, 2003; Valera, Campbell, Gill, & Iverson, 2019). Women veterans also have been found to have a high level of IPV-related mTBI. Of 176 women veterans, 18.8% met the VA criteria for an IPV-related TBI history (Iverson & Pogoda, 2015). Similarly, of 224 who completed a web-based survey, 12.5% reported an IPV-related TBI history with current symptoms and 15.6% reported no symptoms (Iverson, Dardis, & Pogoda, 2017). The women with symptoms were almost six times more likely than women without symptoms to also report probable PTSD. A longitudinal study of 13 women veterans who reported persistent TBI symptoms (problems with memory, balance, dizziness, sensitivity to light, irritability, headaches, and sleep) that began or became worse immediately after the TBI were compared to 20 women without persistent symptoms. Follow-up at 18 months of those with persistent symptoms found significantly worse outcomes including insomnia, depression, and deteriorating physical health (Iverson, Dardis, Grillo, Galovski, & Pogoda, 2019). These studies show a high prevalence of TBI in which victims have a wide variety of acute and chronic symptoms and poor outcomes when it occurs in incidents of IPV.

In strangulation, several mechanisms can produce brain injury as well as immediate death: pressure of the carotid arteries preventing blood flow to the brain; pressure on the jugular veins preventing venous blood return from the brain and resulting in blood being backed up in the brain causing unconsciousness and depressed respiration; and pressure obstruction of the larynx cutting off air flow to the lungs and producing asphyxia (Hawley, McClane, & Strack, 2001). Non-fatal strangulation can cause brain injury through hypoxia or anoxia of the brain as well as injury to the neck and cervical spine (Sutton et al., 2019). Females are the predominant victims of non-fatal strangulation. In 586 ED and acute care visits for assault by strangulation, 70% were females and 58.7% were between the ages of 20-39 years (Jacob et al., 2020). In addition to the multiple physical injuries from non-fatal strangulation there are often multiple acute and long-term psychological symptoms including anxiety, depression, suicidal ideation, PTSD, nightmares and insomnia. Non-fatal strangulation is also under-reported. Focus groups and interviews of 17 women who had survived intimate partner strangulation found that 15 of the 17 had been strangled multiple times. Fewer than half had sought medical care and only one quarter of those disclosed strangulation (Joshi, Thomas, & Sorenson, 2012). Such lack of disclosure may be decreased when clinicians ask specific questions about strangulation and examining the victim's neck.

Much more needs to be learned about the effects of TBI (including mTBI and concussion) in the context of IPV such as how it relates to sex and gender (Colantonio, 2016; Colantonio, Harris, Ratcliff, Chase, & Ellis, 2010). Additional needs are for more neurorehabilitation as well as strategies that address victims' physical and social environments.

A further suggestion for improving practice and research is the need for increased education about the relationship of TBI to IPV among the service sectors for women's health, including frontline workers, legal officers and the courts, and the general public. Interventions are needed to provide and improve services for TBI victims such as shelters, rehabilitation for returning to work, parenting, reducing barriers to successful participation in legal and child protection systems, and procedures to promote long-term health (Haag et al., 2019). Underlying all these is the need for research.

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Sex and Gender in Traumatic Brain Injury

By James E. McCarroll, PhD, Ronald J. Whalen, PhD, Joshua C. Morganstein, MD, and Robert J. Ursano, MD

Males and females have differences in head and neck geometry, neck strength, and vertebrae. Females' necks are significantly weaker in flexion (32%) and extension (20%) than males' necks making females more prone to concussion, whiplash, and neck pain.

Traumatic brain injury (TBI) is defined as an alteration in brain function or other evidence of brain pathology, caused by an external force (Menon, Schwab, Wright, & Maas, 2010) such as direct blows to the head, neck, and face (Haag et al., 2019). Brain injury can also occur by strangulation resulting in decreased oxygen supply to the brain causing hypoxic or ischemic injury and death (Hlavaty & Sung, 2017; Mcquown et al., 2016).

Research on TBI in Dr. Colantonio's lab (University of Toronto and Toronto Rehabilitation Institute) has emphasized the roles of both sex and gender, complex and often misunderstood terms. Sex and gender are often used interchangeably, but there are marked differences that should be accounted for in research (Mollayeva, Mollayeva, & Colantonio, 2018). Sex refers to biological attributes of humans and animals, including physical features, chromosomes, gene expression, hormones and anatomy whereas gender refers to socially constructed roles, behaviors, expressions and identities of people, which are culturally- and historically-based, and constantly changing. Gender can refer to the socially prescribed dimensions of "masculinity" and "femininity" for example [author's quotes]. Colantonio recommends referring to sex/gender as a means of including the complexity of both when these concepts are hard to disentangle rather than relying solely on the terms sex and gender separately (Colantonio, 2016, 2020). However, these differentiations are overlapping and the interactions are influenced by other factors such as income, education, social environments, health practices, and culture (Mollayeva, El-Khechen-Richandi, & Colantonio, 2018). [Also see Government of Canada https://cihr-irsc.gc.ca/e/48642.html]

How does use of the sex/gender framework affect outcomes in rehabilitation research? This question is difficult to answer in that research studies of rehabilitation in general often either have not included females or the results are not stratified by sex (Mollayeva, Mollayeva, et al., 2018). A review of more than 200 studies of mild traumatic brain injury (mTBI) outcomes in children and adults, found that only 7% of them stratified their data by sex (Cancelliere, Donovan, & Cassidy, 2016). Examples of gender norms and role expectations have been reported in sports injuries. Men were found to have less knowledge about TBI and were less likely to seek medical care and outpatient rehabilitation care. Women were more likely to seek health care and treatment and were less likely to leave hospital care against medical advice.

The origins and effects of traumatic brain injury (TBI) differ for men and women. For men, different severity levels of TBI can be found in sports injuries, in high risk occupations (e.g., those that are physically demanding) and military service (Colantonio, 2016). Women are more likely than men to suffer TBI from intimate partner violence (IPV), and in occupations typically held by women such as health care. mTBI in sports is more frequent among women than men in both soccer and basketball injuries resulting in concussion (Giza et al., 2013). Physical damage to females can be worse than that for males based on differences in skeletal structures and musculature. Males and females have differences in head and neck geometry, neck strength, and vertebrae. Females' necks are significantly weaker in flexion (32%) and extension (20%) than males' making females more prone to concussion, whiplash, and neck pain (Sutton et al., 2019; Vasavada, Danaraj, & Siegmund, 2008).

Sex/gender effects are highly prevalent in IPV and TBI. Service providers of IPV support often have little awareness, knowledge, or understanding of TBI among women exposed to IPV. In addition, frontline workers and survivors themselves have been found to not recognize symptoms of TBI. These are significant practice deficits that require increased education about the effects of sex and gender on health and well-being as well as research to benefit survivors (Haag et al., 2019).

TBI is a major and escalating public health concern that has resulted in increased funding and legislation. However, research on differences in TBI by sex/gender is limited at the present time. Animal models, preclinical, and clinical studies have explored the role of vulnerability, nature and presentation of injury, responses to treatment, and outcome, all of which can vary

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Sex and Gender in TBI, *from page 10*

by the interaction of sex and gender (Mollayeva, Mollayeva, et al., 2018).

Research on TBI requires attempts to resolve many controversies. Among these are the effect of sex hormones on TBI outcome, whether men or women have greater impairment and disability after TBI, vulnerability due to personal, environmental, and injury-related factors, and negative stereotyping or stigmatization in women's health. The multitude of interacting processes affecting survival of TBI, including TBI from IPV, require the consideration of sex- linked factors at the biological level, and gender-linked factors including, and not limited to, health care utilization and interpersonal relationships (Mollayeva, Mollayeva, et al., 2018).

Research on TBI requires attempts to resolve many controversies. Among these are the effect of sex hormones on TBI outcome, whether men or women have greater impairment and disability after TBI, vulnerability due to personal, environmental, and injury-related factors, and negative stereotyping or stigmatization in women's health.

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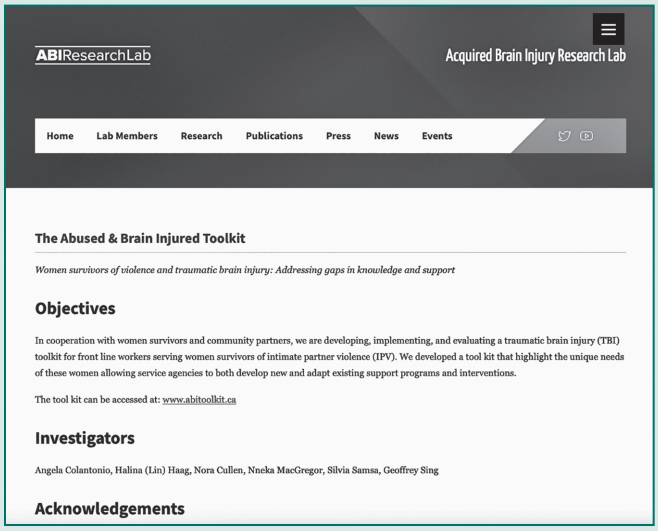
Interview with Angela Colantonio and Halina Haag, *from page 6*

Wiseman-Hakes, C., Ryu, H., Lightfoot, D., Kukreja, G., Colantonio, A., & Matheson, F. I. (2020). Examining the efficacy of communication partner training for improving communication interactions and outcomes for individuals with traumatic brain injury: A systematic review. Archives of Rehabilitation Research and Clinical Translation, 2(1), doi:10.1016/j.arrct.2019.100036.

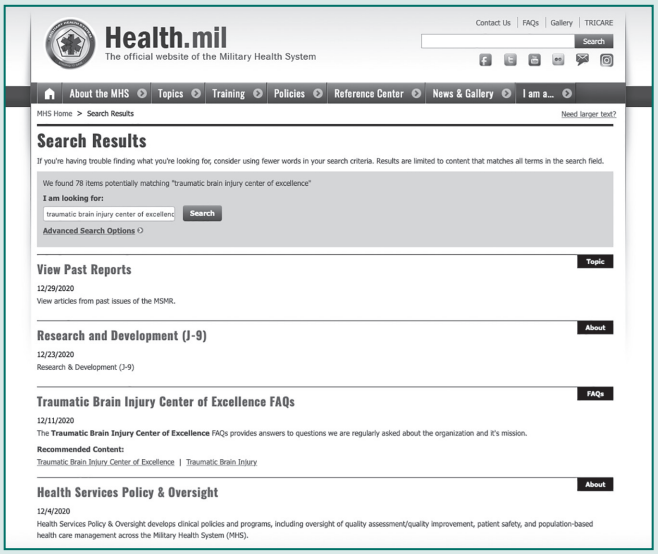
Websites of Interest

As noted in the interview with Dr. Colantonio and Halina Haag, the Acquired Brain Injury Research Laboratory, University of Toronto (***https://abiresearch.utoronto.ca/research/tbi-intimate-partner-violence/***), received funding for the development of an educational toolkit for frontline workers serving women survivors of intimate partner violence (IPV) as well as survivors and their families and friends (see ***www.abitoolkit.ca***). This website provides a variety of resources including a description of brain injury, care guidelines, service provision, and many others.



Dr. Colantonio is the Primary Investigator on a project sponsored by the Ontario Neurotrauma Foundation (onf.org) to provide information about the intersection between TBI and IPV, and its implications for women's mental health and employment, in order to develop and implement knowledge materials that are intended to support women survivors of IPV. (Search "Supporting Employment in Brain Injured Women Survivors of Intimate Partner Violence" at ***onf.org*** to learn the objectives of this project)

In the U.S., the Department Defense has many resources for evaluation and management of traumatic brain injuries (TBI) including military acute concussions (***https://health.mil/Search-Results?query=traumatic%20brain%20injury%20center%20of%20excellence&refSrc=1***). This website has basic information on brain injury, current statistics on worldwide TBI, current research, and stories by caregivers in supporting recovery.



VA's Polytrauma System of Care (PSC) (***https://www.polytrauma.va.gov/index.asp***) is an integrated network of specialized rehabilitation programs dedicated to serving Veterans and Service Members with both combat and civilian related traumatic brain injury (TBI) and polytrauma. Services available through PCS include: interdisciplinary evaluation and treatment, development of a comprehensive plan of care, case management, patient and family education and training, psychosocial support, and application of advanced rehabilitation treatments and prosthetic technologies.