LESSONS LEARNED FROM

THE DEBRIEF

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LOW-LEVEL BLAST EXPOSURE AND TRAUMATIC BRAIN INJURIES: IT IS TIME TO START PAYING ATTENTION

PART TWO

In part one of this series, we looked at the growing data that connects repetitive low-level blast effects (RLLBE) to a constellation of symptoms and effects. As we stated, the most effective approach to managing mTBI and RLLBE injury is never to let it occur. While tactical officers unavoidably will be exposed to a certain amount of RLLBE throughout their career, there is certainly enough data available at this point to demonstrate that reduction of unnecessary exposure is prudent, if not essential, and that recovery after injury is crucial.

In this article, we will discuss how a three-pronged approach to *reduce* the frequency of exposure, *mitigate* the effects of exposure and *recover* from exposure prior to repetition is prudent based on available data. We also will consider commonsense steps your team can take to accomplish these three things. Returning to the smoking analogy from part one, we will be looking at how to smoke fewer cigarettes (reduce), smoke filtered cigarettes (mitigate) and allow your lungs to heal before and after you smoke (recover).

Context for this article

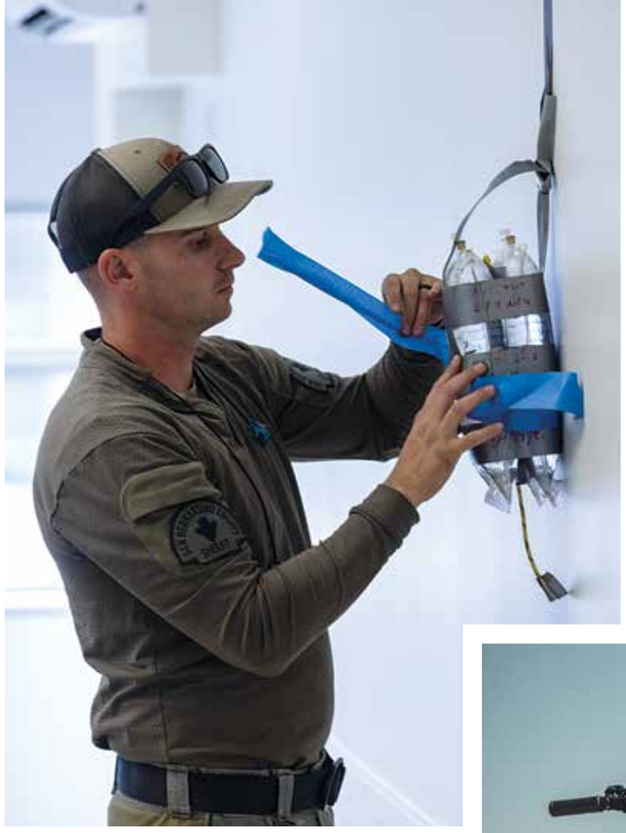
A word of qualification is appropriate before diving into the approaches. This is, by no means, an exhaustive list of strategies to prevent injury. Nor are they guaranteed to prevent injury or intended as a prescription that must be followed completely. The spirit in which they are offered is that of ideas for open discussions within your team about how you want to prevent injury.

There is a fine balance between safety and operational effectiveness in tactical units. This balance is different for every team. That said, we believe that this "starter list" is worth a discussion within your team and that it is essential that teams take appropriate action now to prevent unnecessary harm. With this in mind, we will dive right into the discussion of techniques.

Reducing exposure

The first approach to limiting injury and the potential for harm is to reduce overall exposure to blast events. One of the biggest challenges with low-level blast exposure is that we do not truly understand what levels or frequencies of exposure are safe. While breaching schools have traditionally used a 3-4 psi overpressure as a basis for training, and DOD uses 4 psi, this threshold is not yet supported by sufficient data to ensure it is "completely safe." The problem is more complicated than establishing a "safe overpressure" would seem to convey.

At this point, we do not understand the true mechanisms for injury, safe thresholds, safe frequencies of exposures and appropriate recovery intervals required after exposure. Additionally, no models exist to predict or measure exactly what



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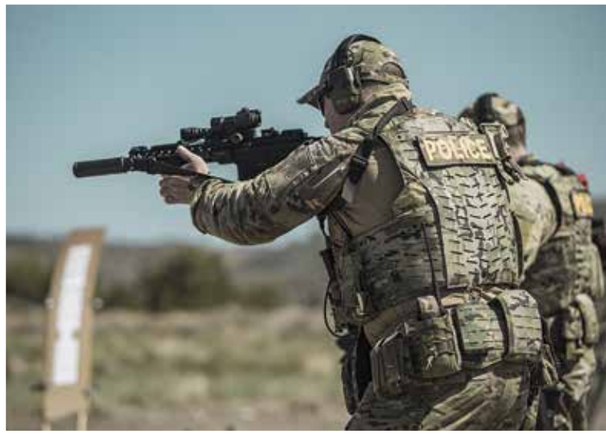

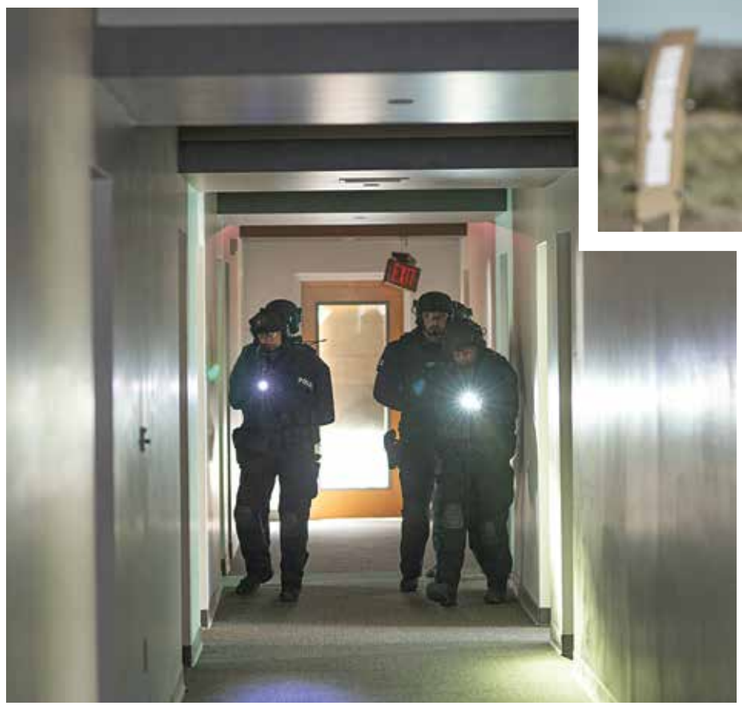

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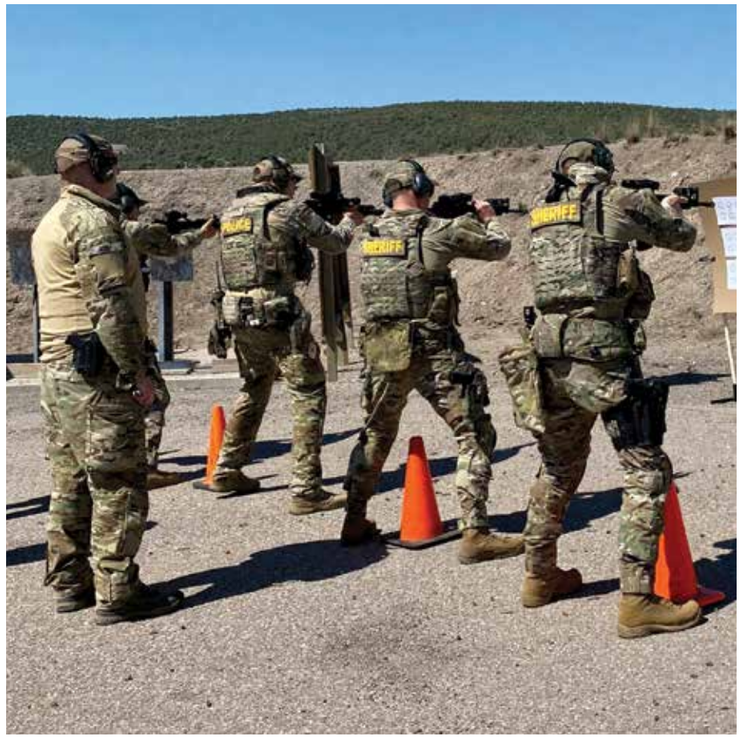
an individual's threshold for injury may be. Like so many things in health science, each of us arrives with an entire life history of prior damage, different physiological attributes than the person next to us, and different levels of hydration, sleep, fitness, etc. As a result, predicting the effects of a blast event is impossible. Does this mean we need to stop using these devices? Of course not! These are essential lifesaving technologies that are necessary for public safety. However, it does mean that we should not allow ourselves to be exposed unnecessarily to the effects of RLLBE. More specifically, it means that whenever possible, we should eliminate unnecessary exposure (e.g., smoke fewer cigarettes). There are several recommended ways to accomplish this.

Establish rules to prevent overexposure

On Nov. 4, 2022, DOD implemented interim guidance in a memo that set minimum standoff distances for weapon systems known to produce RLLBE. As noted by Lopez in DOD News, "For such systems, one example of BOP mitigation includes defining an appropriate standoff distance from the blast source — how far away an individual such as instructors or range safety officers must stand in order to minimize their exposures to BOP."[1] DOD also has implemented guidelines on the number of exposures an individual may have to a given weapon system in a day of training. Both guidelines adjust their numbers based on the blast effects of the individual weapon system. These guidelines can form the basis for an initial discussion of individual exposure limits for your team.

Rotate training cadres

There is no one on a team that has a higher level of exposure to RLLBE than the training cadre, instructors and range safety officers. While each element of a team may receive a few exposures during explosive breaching, flashbang or sniper rifle training, the training cadre often is present for all the events and, therefore, receives exposure to every event. The cumulative exposure of an instructor may, therefore, be five to 10 times that of the other team members, and worse yet, these exposures may occur with little to no recovery time between events. In fact, "To provide some perspective on the level of exposure some service members have, one study found that up to 32 percent of blasts experienced by breaching instructors exceeded the recommended exposure limit."[2] Moreover, the United States Marine Corps looked at the exposure of grenade instructors as a potential worst-case scenario for RLLBE exposure. In part, this research revealed that: "The cumulative effect of repeated low-level blast exposure in such environments can cause symptoms similar to TBI."[3] As a result, it is best practice that training cadre are rotated constantly to keep them away from overexposure and not allowed to accumulate dramatically more exposure than other team members. This is, of course, true for all team members. Watching another squad's training (for example from a catwalk) or acting as an opposing force for training units will double or even triple exposure.



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Consider using training devices

One of the most common sources of RLLBE exposure is light sound diversionary devices (LSDD) which create sound pressure levels around 175 dB and produce both a substantial blast wave and a significant acoustic signature. Anyone who has spent a day throwing flashbangs has experienced the effects of this exposure. Whether it be headaches, brain fog, dizziness or difficulty sleeping, these effects can and should be avoided to the greatest degree possible. Yet most teams will do repeated runs with live flashbangs when practicing CQB/CQC or HRT tactics. This repeated exposure is certainly less than ideal and, in many cases, is avoidable with the simple adoption of training flashbangs, which have a much lower 147 dB level. This drop in dB levels takes the overpressure from 1.6 psi for a 175 dB flashbang down to .065 for a 147 dB training flashbang.

Mitigation strategies

The second group of approaches to reducing the risk of mTBI caused by low-level blasts are mitigation strategies. These strategies are rooted in the idea that since there is really no amount of blast overpressure that is good for you, it is wise to avoid any exposure that can be mitigated by protective equipment or by changing behavior. Mitigation strategies focus on things that can be done to limit the amount of blast wave exposure when training or operating. It is important to note there are a wide variety of ways to do this, but the ones included below can be done with little to no effect on operational effectiveness.

Utilize suppressors for long guns

One of the easiest and most effective strategies to reduce blast exposure is to utilize suppressors on all long guns. Suppressors not only reduce the amount of sound from weapons, but they also reduce the blast signature and help to direct it away from the shooter. In reflective environments (like concrete ranges or shoot houses) this also reduces reflected wave exposure for everyone in the area. This topic area has previously been explored well in *The Tactical Edge* and other publications. In the Fall 2018 issue of *The Tactical Edge,* Kamimori et al. looked at the effects of .50 cal rifle blast effects, concluding suppressors provided "a 92 percent reduction in pressure readings as compared to no muzzle device, a 120 percent reduction in measured pressure as compared to the 45-degree muzzle brake, and a 49 percent reduction as compared to a flash hider."[4] Although this was with an admittedly small data set, these types of reductions will make a huge difference to the long-term risk posed by training. As noted in a subsequent article, "The blast, or the forces that result from firing the .50-caliber rifle, strikes the operator with enough energy to warrant implementing strategies that minimize shooter risks that may result from exposure."[5] In the Summer 2020 issue of *The Tactical Edge,* Kamimori, et al wrote: "Suppressors were effective on all weapons systems/action types evaluated, suggesting that regardless of which tool is used in conjunction with a suppressor, benefits will be apparent, even if variable."[6] As Land et al. noted, "When resources and operational parameters allow, suppressors are recommended, as are positions that move the shooter farther from reflective surfaces (standing preferred) to reduce blast exposure effectively."[7]

Consider range conditions when training

Along the same lines, it is important to consider the conditions of training locations with an eye specifically toward reducing blast exposure, both direct and reflected. The typical training site architecture like concrete walls and floors, metal roofs, narrow hallways and of course narrow spacing of shooters all can expose those training to reflect RLLBE. The closer the trainees are to the origin sources of the RLLBE or to reflective surfaces, the greater the effects and the more likely they are to be exposed to a mach stem, which will significantly increase the potential for damage. This is especially true when standing on a catwalk above RLLBE events or when shooting prone. As the Marine Corps Force Preservation Directorate noted in 2019, "Positions closer to the ground experience higher blast overpressure and impulse due to blast reflection from surfaces."[8] A holistic approach that considers the effects of reflective surfaces, the spacing of shooters from one another, the density of surfaces when shooting prone, etc. would seem prudent. Small changes to the training environment like installing rubber floor mats in ranges, spacing shooters out, shooting over grass rather than concrete, etc. will reduce the potential for injury.

Establish training safety distances (TSDs)

Utilizing minimum safe distances (MSD) for energetic breaching has long been an accepted practice. The idea of an MSD is to provide a clear and effective rule of thumb for the minimum distance team members should stand from the breaching charge based on the size of the charge. This long-standing practice attempts to balance the risk of being too close to a charge, thereby risking injury against the time lost by standing at a greater distance and delaying entry. While MSD remains the gold standard for operations, more and more teams have begun to establish a training safety distance (TSD), which shifts the balance toward exposure prevention and tries to mitigate or even eliminate the effects of training on the operators. While MSD may attempt to hold blast exposure under 3-4 psi, TSD attempts to hold it down to 1-2 psi or, ideally, zero. Depending on charge size and training site, this may mean extending the MSD by a few feet or even doubling it. It may also include ensuring a 90-degree corner between the team and the blast. Because of the exponential relationship between distance and blast pressure, these small changes can make a huge difference in exposure to blast effects, thereby significantly improving team safety.

Recovery — preventing repetitive injuries

By most accounts, the absence of healing prior injuries is a likely trigger for lasting damage from mTBI caused by RLLBE. For this reason, it is essential to prevent recurring injuries and to provide healing time after exposure. Several of the experts we spoke with analogized inflicting recurring blast injury to scraping the scab off a healing cut. By reinjuring the brain, you prevent it from beginning its natural healing process. If you do that often enough, the body will work around the normal healing process and create a scar to close the wound.

As a result, the objective seems to be allowing for complete healing after each exposure and not re-inflicting injury before healing occurs. This can be accomplished in three ways: allowing greater recovery time between events, intentionally separating high-impact events, and most importantly, paying attention to symptoms and taking them seriously.

Allow greater recovery time between training events

As discussed previously, it's not just the exposure that causes harm, it's also the absence of recovery time after the exposure and repeated exposures to RLLBE. As a result, allowing time between training iterations that involve exposure to RLLBE events allows the body to repair damage prior to additional exposures. Knowing this, it would make sense to plan training evolutions to create separation between RLLBE exposures whenever possible. For example, if the team is planning a solid week of training, placing the explosive breaching refresher and HRT or CQC evolutions at opposite ends of the week may reduce damage.

Within a monthly training schedule, allowing weeks to pass between these iterations will likely decrease damage and allow for healing. Additionally, separating an hour block of flashbang training into two blocks of four hours on separate days may make sense to reduce the duration and frequency of consecutive exposures. Simply put, training in breaching and HRT on the same day or even subsequent days may not be the best decision. When possible, create separation and allow time for recovery. One of the experts we talked to recommended allowing 72 hours between significant exposures, including avoiding fighting and combative sports, to ensure the brain is not reinjured.

Pay attention to symptomology and take it seriously

The expression "listen to your body" has been around forever. But in a community like this one, where pain is a frequent companion, durability is essential and motivation is high, saying this is not enough. RLLBE injury has a collection of very clear and often consistent symptoms. Headaches, difficulty focusing, brain fog, difficulty sleeping, irritability and poor impulse control are signs that something is wrong. You *must* take them seriously. This is true not only as an individual but also as a team. The best way to address this issue at a prevention level is to establish a team culture that takes injuries seriously. In the same way that a teammate with a broken ankle would be expected to rest, a teammate who is experiencing "breacher's brain" or RLLBE symptomology must be expected to recover before further exposure. Damage to the brain and nervous system is insidious. Its symptoms are subtle and easily confused with other ailments. But anytime you have symptoms following exposure to RLLBE it is critical to take it seriously and give the body time to repair.

Conclusion

The ultimate solution for this problem will be a four-pronged approach that includes the ability to detect and monitor exposure, track damage and recovery using blood-based biomarkers, treat the damage created through clinical approaches, and prevent and mitigate the effects through training and equipment practices. To this end there are numerous well-funded research efforts taking place in each area that will yield greater understanding and hopefully a cure. However, until we understand more, it seems essential to make concerted efforts to reduce, mitigate and recover from the effects of low-level blast. Establishing a team culture that focuses on avoiding unnecessary injury would seem essential as well as continuing to monitor developments in this area.

To return to our smoking analogy from part one of this series, you may have to smoke for your mission, but please don't smoke more than you must, smoke the most filtered cigarettes possible, and give your body as much time as possible to heal between cigarettes. Moreover, take any symptoms you may experience very seriously. The long-term health, cognitive function, and happiness of you and your teammates are worth protecting. REDUCE, MITIGATE and RECOVER!

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Endnotes

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3. Ibid.

4. Mark Lang, Gary H. Kamimori, Jude Braun, and Michael J. Egnoto, "Minimizing .50-Caliber Rifle Blast to Police Snipers: Suggestions for Training and Deployment," *The Tactical Edge,* Fall 2018.

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7. Michael J. Egnoto, PhD and William McQuiggan, An Expansion on Suppressor Usage for Weapon Systems: Combining Evaluations of Auditory Insult to Blast Overpressure Assessment, *The Tactical Edge,* Summer 2020.

8. Headquarters Marine Corps Force Preservation Directorate (MCDAPO), Overpressure Study Report 20191025 (Washington, DC: United States Marine Corps, 2019).