Margaret A. Naeser,[1,2] Ross Zafonte,[3,4] Maxine H. Krengel,[1,2] Paula I. Martin,[1,2] Judith Frazier,[3] Michael R. Hamblin,[5] Jeffrey A. Knight,[6] William P. Meehan III,[7] and Errol H. Baker[1]

[1]VA Boston Healthcare System, Boston, Massachusetts.

[2]Department of Neurology, Boston University School of Medicine, Boston, Massachusetts.

[3]Department of Physical Medicine and Rehabilitation, Spaulding Rehabilitation Hospital, Charlestown, Massachusetts.

[4]Massachusetts General Hospital, Brigham and Women's Hospital, Red Sox/MGH Home Base Program, Department of Physical Medicine and Rehabilitation, Harvard Medical School, Boston, Massachusetts.

[5]Wellman Center for Photomedicine, Massachusetts General Hospital, Department of Dermatology, Harvard Medical School, Harvard-MIT Division of Health Science and Technology, Cambridge, Massachusetts.

[6]National Center for PTSD, VA Boston Healthcare System, Boston, Massachusetts.

[7]Micheli Center for Sports Injury Prevention, Waltham, Massachusetts and Sports Concussion Clinic, Boston Children's Hospital, Harvard Medical School, Boston, Massachusetts.

This pilot, open-protocol study examined whether scalp application of red and near-infrared (NIR) light-emitting diodes (LED) could improve cognition in patients with chronic, mild traumatic brain injury (mTBI). Application of red/NIR light improves mitochondrial function (especially in hypoxic/compromised cells) promoting increased adenosine triphosphate (ATP) important for cellular metabolism. Nitric oxide is released locally, increasing regional cerebral blood flow. LED therapy is noninvasive, painless, and non-thermal (cleared by the United States Food and Drug Administration [FDA], an insignificant risk device). Eleven chronic, mTBI participants (26–62 years of age, 6 males) with nonpenetrating brain injury and persistent cognitive dysfunction were treated for 18 outpatient sessions (Monday, Wednesday, Friday, for 6 weeks), starting at 10 months to 8 years post- mTBI (motor vehicle accident [MVA] or sports-related; and one participant, improvised explosive device [IED] blast injury). Four had a history of multiple concussions. Each LED cluster head (5.35 cm diameter, 500 mW, 22.2 mW/cm^2) was applied for 10 min to each of 11 scalp placements (13 J/cm^2). LEDs were placed on the midline from front-to-back hairline; and bilaterally on frontal, parietal, and temporal areas. Neuropsychological testing was performed pre-LED, and at 1 week, and 1 and 2 months after the 18th treatment. A significant linear trend was observed for the effect of LED treatment over time for the Stroop test for Executive Function, Trial 3 inhibition (p=0.004); Stroop, Trial 4 inhibition switching (p=0.003); California Verbal Learning Test (CVLT)-II, Total Trials 1–5 (p=0.003); and CVLT-II, Long Delay Free Recall (p=0.006). Participants reported improved sleep, and fewer post-traumatic stress disorder (PTSD) symptoms, if present. Participants and family reported better ability to perform social, interpersonal, and occupational functions. These open-protocol data suggest that placebo-controlled studies are warranted.