**Clinician Burnout: Effects on the Brain and the Healthcare Industry**

Dr. Tammie Chang had just gotten off a busy day of work as a pediatric oncologist. As she drove on the road that leads to home, she felt her exhaustion finally catching up to her. She hadn’t slept in several days, and couldn’t remember the last time she had a proper meal. Just earlier, she had a conversation with a young boy’s parents who decided to stop his treatment. The conversation lingered in her head, and a plethora of negative thoughts began to spill into her head, to stop the pain that this was causing her, to find a way that ended the unending cycle of suffering. Fortunately, she catches herself, but a chill still runs down her spine. Finally, she admits one thing to herself:

*I need to ask for help* [1]*.*

This is a case of burnout. Burnout is typically defined as a response to chronic job stresses [2]. It is more than just a psychological issue–it bears tangible physiological effects. Healthcare workers like Dr. Chang are constantly overworked and overstressed, often with no way for others to know, as it could disrupt patient-provider trust. However, this issue has been gaining increasing amounts of attention. Over the last three years, the COVID-19 pandemic has pushed healthcare workers to their limits. Swarmed by the influx of infected patients, many are barely keeping their head above water. In a recent large-scale study of over 2000 clinicians, 68% of participants reported at least one instance of feeling burnt out in 2021, almost 30% higher than in 2020 when the pandemic had just begun [3]. The neuroscientific mechanisms of burnout are complex, but are nevertheless integral to understanding what it means to experience burnout neurologically and how that affects clinicians in their workplace.

**Defining and Identifying Burnout**

Unlike clinical depression or post-traumatic stress disorder, burnout is not an official mental illness classified in either the APA manual or the DSM, which are the standardized guides for mental disability diagnosis in the United States. Commonly reported symptoms of burnout are headaches, chronic fatigue, sleep disturbances, and high blood pressure [2], which all also happen to be symptoms of a variety of other mental disabilities. Since there is no formal list of symptoms that doctors know well, it is often a challenge to get an accurate diagnosis and can often be misdiagnosed as something else.

Currently, the most common way of identifying burnout is the Maslach Burnout Inventory, otherwise known as the MBI [4]. The MBI is a seven-point survey that asks questions primarily pertaining to mood disturbances brought on by burnout. It distinguishes burnout as a three-step process: cynicism, detachment, and “attitudes of inefficacy”. These three dimensions are thought to be a product of exhaustion from excessive workload as well as other work-related stresses such as an excessive workload or job ambiguity, culminating into attitudes of inefficacy, where feelings of low personal accomplishment begin to manifest [2]. However, the MBI is not a one-size-fits-all identification of burnout––there are specialized versions of the test made for different groups of people, such as the MBI-ES for educators and the MBI-HSS (MP) for medical personnel. These surveys are made almost exclusively for research as opposed to clinical diagnoses, and while there is a strong correlation of MBI scores with observed burnout conditions [4], critiques of the test include its private ownership and the difficulty of putting its results into practice [5].

The prevalence of burnout also differs between medical fields or specialties. Generally, healthcare workers with more patient-facing roles are more susceptible to burnout. Beyond frontline positions, the physician specialties that have the highest reported rate of burnout are urology, neurology, and nephrology, with 50% of physicians in these disciplines reporting burnout in 2020 [6]. Since every clinician has a different threshold of tolerance before becoming burnt out, studies and inventory methods should not generalize the effects of burnout on all clinicians.

**Investigating the Physiology of Burnout**

When we tell ourselves that we feel stressed, our bodies create and moderate several stress systems throughout the body. Just like how chronic stress comes from outside of the workplace, burnout comes about when these systems in our bodies are unable to keep up with the stressors that pile on seemingly without an end. While multiple body systems contribute to the physical experience of burnout, one of the biggest players is the hypothalamus-pituitary-adrenal (HPA) axis [7].

The HPA axis consists of three parts of the neuroendocrine system: the hypothalamus, the pituitary gland, and the adrenal gland. Each of these areas are responsible for releasing their own hormone in one aspect of the stress response. First, in response to stress, the hypothalamus releases corticotropin-releasing factors (CRFs), which serve as the principal stress hormone that directs other subsequent responses and bodily processes. Then, through blood vessels, CRFs travel to the pituitary gland, which in turn releases adrenocorticotropic hormones (ACTH). These hormones circulate throughout the bloodstream, ultimately activating the adrenal gland and promoting cortisol secretion. When cortisol levels reach a high amount, they signal to the hypothalamus to stop releasing CRFs, functioning as a feedback loop. Normally, this feedback loop keeps a steady chemical balance by releasing CRFs when needed, creating a hormonal balance in the body. However, this balance is disturbed with repeated activations of the HPA axis, such as in periods of high stress that lead to burnout [7]. A part of the feedback loop for CRFs is cortisol, a steroid stress hormone regulated through the hypothalamus-pituitary-adrenal (HPA) axis. In this type of feedback loop, higher levels of cortisol secretion over time is directly correlated with lower levels of total CRFs released, meaning that the hypothalamus and other subsequent parts of the HPA axis become less active in the process [8]. However, when this system is disrupted, such as during burnout, cortisol levels reach so high that lowering CRFs isn't enough to regain balance, establishing a new, raised normal for the body.

Many burnout studies lean on measuring cortisol levels. It is regarded as the closest to a gold standard for measuring the body’s stress response [9]. According to the FDA, cortisol is a good biomarker, a characteristic of the body that researchers can easily measure [10]. Through non-invasive means such as sampling saliva and hair, cortisol is a popular choice for researchers to use as a biomarker for the body’s stress response [9]. For example, in a study done at a Brazilian hospital, researchers measured hair cortisol levels from a variety of healthcare professionals, ranging from physicians and nurses to roles such as administrators and lab technicians, during the onset of the COVID-19 pandemic. In the study, hair from the front of a participant’s head was cut, measured, weighed, and subsequently used in a biochemical test to determine its cortisol levels [11]. Another similar study chose to measure cortisol levels through saliva, which was collected by participants in small, labeled vials throughout several designated times of the day [12]. In both of these studies, cortisol secretion levels correlated with perceived burnout. Combined with other research on the pathways in which cortisol is secreted, researchers were able to identify that unusually high levels of cortisol released by those with burnout is likely related to the HPA axis’ feedback system.

In addition to the HPA axis, the functions and controls of the prefrontal cortex (PFC) are also heavily impacted by occupational burnout [13]. The prefrontal cortex is located in the front of the brain and is responsible for complex processes such as planning, decision-making and problem-solving, which are all crucial to the clinician’s day-to-day work [14]. When these neural circuits are constantly overloaded, they also activate nearby areas of the brain through interacting with other neural connections, weakening the PFC’s regulating ability. One such nearby region is the amygdala, a region of the brain primarily concerned with regulating responses to fearful stimuli and reacting to physical stressors and dangers [15]. Activating the amygdala leads to much more reactive rather than thoughtful responses [16]. While this can help temporarily alleviate the stress on the prefrontal cortex, prolonged stress constantly activates PFC wiring, eventually establishing a new threshold for stress regulators to activate [17]. This leads to the constant activation of PFC connections, further contributing to feelings of irritability and frustration.

Apart from experiencing physical exhaustion, exposure to uncontrollable workplace stress, such as overwhelming mental demand on physicians, causes structural changes to the brain. The exact biological remnants of these functional changes, however, are difficult to deduce without the help of brain imaging techniques.

**Understanding Burnout Through Brain Imaging Techniques**

Brain imaging methods have been crucial to understanding the physical mechanisms of burnout. By using different methods, researchers can begin to understand the mechanisms of how burnout functions, as well as the lasting effects it might have on the brain.

Magnetic Resonance Imaging (MRI) has been an integral imaging method to understanding burnout. MRI helps create internal images of the body using large magnets and radio waves. In terms of usefulness to studying burnout, MRI assists researchers in distinguishing structural characteristics of the brain. In one MRI-based study, researchers found the amygdala was larger in stressed participants, compared to non-stressed ones, further corroborating that the amygdala is likely involved in the stress response to burnout [13].

Another method researchers use is electroencephalography (EEG). In EEG, small metal discs called electrodes are placed on a person’s scalp. These electrodes pick up the electric signals that neurons in the brain use to communicate with each other. Specialized software can then transcribe these signals for people to understand [18]. A study that observed EEG brain patterns of healthcare professionals during the COVID-19 pandemic, researchers identified that the electrical signals in the central region of the brain and the right hemisphere of the brain, were significantly different compared to that of a person not experiencing burnout [19]. Knowing this information allows researchers to begin narrowing down where key structures related to burnout are located. Studies such as this one further strengthen the hypothesis that major regulatory structures are changed with burnout, such as the hypothalamus, pituitary gland, and amygdala, all of which are affected as well as involved with burnout.

Through interpreting and reading experimental data generated by these imaging methods, researchers can begin deducing the pathway of how burnout functions, and the impacts it has on brain activity.

**Effects on Patient Care and Physician Well-being**

Work-related stressors continue to be an issue in many workplaces, the issue is an especially rising concern for clinicians and physicians. In a large outcome study done at an Ohio public hospital system, overall burnout was highly correlated with physicians leaving their specific organization. In addition, higher amounts of time spent communicating with patients correlated with increased burnout and rates of leaving the profession [20]. When clinicians devote so much of their time to their patients’ well-being, this can leave them with little time to care about their own well-being.

Another study done on nurses and healthcare workers on a similar level found that while depressive symptoms did not have significant correlation with information processing, there is a high correlation between occupational exhaustion and slowed information processing speed. In this study, reaction time was used as a proxy for information processing as this represents the foundation of higher-order cognitive processes. The researchers found that nurses who reported feeling symptoms of burnout exhibited a slower reaction time, compared to their coworkers who did not, and were less able to switch tasks effectively [21]. Another study shows that physicians with burnout have higher levels of self-perceived medical errors [22], likely related to deteriorating information processing abilities which could harm patients in the long run. These errors can compound onto themselves and cause serious harm. Medical errors are one of the top causes of death in the United States, and physicians that have made actions leading to either a real or perceived medical error are more likely to feel anger, guilt, and incompetence. This may lead to other destructive behaviors such as not reporting any subsequent medical errors or unhealthy coping mechanisms, ultimately perpetuating a cycle of continued medical errors, worsening its effects on both provider and patient [23].

Mishaps on patient health are drastic not only for the patient receiving erroneous care, but also for the healthcare provider themselves. If left alone, they can develop into patterns and worsen the cycle of both patient and provider dissatisfaction, leading to a hostile clinical culture that further wears on physician mental health. However, this can be alleviated by focusing on clinician well-being.

**Caring for Physicians**

Combating physician burnout begins by treating healthcare as more than just a work setting—it starts with treating healthcare workers as individuals and more than just corporate hospital tools.

One of the most effective ways of doing so is to improve communication between medical staff. In a study done on primary care physicians, increasing interpersonal staff interactions, both personally as friends and functionally as colleagues, significantly decreased rates of burnout and subsequently increased job satisfaction. One method identified by the study was scheduling biweekly meetings focusing on issues both in and out of work, as well as providing a space for clinicians to write down their concerns through an informal survey. Discussions of burnout management with clinical higher-ups was also another intervention that significantly decreased clinician burnout in primary care. In the study, these discussions took the form of presenting data and related research to leading members of a particular clinical department as well as having one-on-one meetings with clinical staff specifically about work schedules and personal concerns [24].

Another way to reduce clinician workplace burnout is to make other parts of a clinician’s work more easy to navigate. In a survey, over 70% of practicing physicians reported finding it difficult to navigate and use their clinic’s health information technology (HIT) systems, such as patient-accessible electronic health records and electronic prescriptions. While most agreed that these systems improve efficiency of clinical payments and staff-to-staff communication, many also experienced frustrations directly related to these systems, adding unnecessary frustration to pre-existing levels of stress in their daily practice [25]. An explored way to alleviate this issue is the use of medical scribes, supporting professionals that transcribe patient visits in real time. Scribe usage decreases the time that physicians are interacting with their HIT systems both in and outside the clinic, increasing efficiency of their care without sacrificing record-keeping [26].

Dr. Tammie Chang, who has since recovered from her burnout, recommends doctors to “give yourself the grace and compassion that you strive to give to your patients.” This grace and compassion, however, needs to come from more than just clinicians themselves. Hospital administrators and other stakeholders need to extend the same kind of empathy and compassion to make changes that improve the lives of their employees. With effective workplace systems and structural overhauls within the healthcare industry, hospitals can retain happy physicians with the energy to give their best for their patients and the health of their communities.

References

[1] Chang, T. (2022). Retrieved from https://hbr.org/2022/03/my-burnout-nearly-cost-me-everything-now-i-help-other-physicians-overcome-it

[2] Maslach, C., & Leiter, M. P. (2016). Understanding the burnout experience: Recent research and its implications for psychiatry. *World Psychiatry*, *15*(2), 103–111. doi:10.1002/wps.20311

[3] Shanafelt, T. D., West, C. P., Dyrbye, L. N., Trockel, M., Tutty, M., Wang, H., … Sinsky, C. (2022). Changes in burnout and satisfaction with work-life integration in physicians during the first 2 years of the COVID-19 pandemic. *Mayo Clinic Proceedings*, *97*(12), 2248–2258. doi:10.1016/j.mayocp.2022.09.002

[4] West, C. P., Dyrbye, L. N., Satele, D. V., Sloan, J. A., & Shanafelt, T. D. (2012). Concurrent validity of single-item measures of emotional exhaustion and depersonalization in Burnout Assessment. *Journal of General Internal Medicine*, *27*(11), 1445–1452. doi:10.1007/s11606-012-2015-7

[5] Williamson, K., Lank, P. M., Cheema, N., Hartman, N., & Lovell, E. O. (2018). Comparing the Maslach Burnout Inventory to other well-being instruments in emergency medicine residents. *Journal of Graduate Medical Education*, *10*(5), 532–536. doi:10.4300/jgme-d-18-00155.1

[6] De Hert, S. (2020). Burnout in healthcare workers: Prevalence, impact and preventative strategies. *Local and Regional Anesthesia*, *Volume 13*, 171–183. doi:10.2147/lra.s240564

[7] Kageyama, K., Iwasaki, Y., & Daimon, M. (2021). Hypothalamic regulation of corticotropin-releasing factor under stress and stress resilience. *International Journal of Molecular Sciences*, *22*(22), 12242. doi:10.3390/ijms222212242

[8] DeMorrow, S. (2018). Role of the hypothalamic–pituitary–adrenal axis in health and disease. *International Journal of Molecular Sciences*, *19*(4), 986. doi:10.3390/ijms19040986

[9] Lee, D. Y., Kim, E., & Choi, M. H. (2015). Technical and clinical aspects of cortisol as a biochemical marker of chronic stress. *BMB Reports*, *48*(4), 209–216. doi:10.5483/bmbrep.2015.48.4.275

[10] Center for Drug Evaluation and Research. (2017). Retrieved from https://www.fda.gov/drugs/biomarker-qualification-program/what-are-biomarkers-and-why-are-they-important-transcript

[11] Ibar, C., Fortuna, F., Gonzalez, D., Jamardo, J., Jacobsen, D., Pugliese, L., … Fabre, B. (2021). Evaluation of stress, Burnout and hair cortisol levels in health workers at a University Hospital during COVID-19 pandemic. *Psychoneuroendocrinology*, *128*, 105213. doi:10.1016/j.psyneuen.2021.105213

[12] Karlamangla, A. S., Friedman, E. M., Seeman, T. E., Stawksi, R. S., & Almeida, D. M. (2013). Daytime trajectories of cortisol: Demographic and socioeconomic differences—findings from the National Study of Daily Experiences. *Psychoneuroendocrinology*, *38*(11), 2585–2597. doi:10.1016/j.psyneuen.2013.06.010

[13] Savic, I. (2013). Structural changes of the brain in relation to occupational stress. *Cerebral Cortex*, *25*(6), 1554–1564. doi:10.1093/cercor/bht348

[14] Chini, M., & Hanganu-Opatz, I. L. (2021). Prefrontal cortex development in health and disease: Lessons from rodents and humans. *Trends in Neurosciences*, *44*(3), 227–240. doi:10.1016/j.tins.2020.10.017

[15] Likhtik, E., Stujenske, J. M., A Topiwala, M., Harris, A. Z., & Gordon, J. A. (2013). Prefrontal entrainment of amygdala activity signals safety in learned fear and innate anxiety. *Nature Neuroscience*, *17*(1), 106–113. doi:10.1038/nn.3582

[16] Woo, E., Sansing, L. H., Arnsten, A. F., & Datta, D. (2021). Chronic stress weakens connectivity in the prefrontal cortex: Architectural and molecular changes. *Chronic Stress*, *5*, 247054702110292. doi:10.1177/24705470211029254

[17] Liu, W.-Z., Zhang, W.-H., Zheng, Z.-H., Zou, J.-X., Liu, X.-X., Huang, S.-H., … Pan, B.-X. (2020). Identification of a prefrontal cortex-to-amygdala pathway for chronic stress-induced anxiety. *Nature Communications*, *11*(1). doi:10.1038/s41467-020-15920-7

[18] K., S. L. E., Frey, L. C., & Britton, J. W. (2016). *Electroencephalography (EEG): An introductory text and Atlas of Normal and abnormal findings in adults, children, and infants*. Chicago, IL: American Epilepsy Society.

[19] LoMauro, A., Molisso, M. T., Mameli, F., Ruggiero, F., Ferrucci, R., Dellarosa, C., … Vergari, M. (2022). EEG evaluation of stress exposure on healthcare workers during COVID-19 emergency: Not just an impression. *Frontiers in Systems Neuroscience*, *16*. doi:10.3389/fnsys.2022.923576

[20] Windover, A. K., Martinez, K., Mercer, M. B., Neuendorf, K., Boissy, A., & Rothberg, M. B. (2018). Correlates and outcomes of physician burnout within a large academic medical center. *JAMA Internal Medicine*, *178*(6), 856. doi:10.1001/jamainternmed.2018.0019

[21] Potter, G., Hatch, D., Hagy, H., Radüntz, T., Gajewski, P., Falkenstein, M., & Freude, G. (2021). Slower information processing speed is associated with persistent burnout symptoms but not depression symptoms in nursing workers. *Journal of Clinical and Experimental Neuropsychology*, *43*(1), 33–45. doi:10.1080/13803395.2020.1863340

[22] Tawfik, D. S., Scheid, A., Profit, J., Shanafelt, T., Trockel, M., Adair, K. C., … Ioannidis, J. P. A. (2019). Evidence relating health care provider burnout and quality of care: a systematic review and meta-analysis. *Annals of Internal Medicine*, *171*(8), 555. doi:10.7326/m19-1152

[23] Rodziewicz, T. L., Hipskind, J. E., & Houseman, B. (2023). *Medical Error Reduction and Prevention*. Treasure Island, FL: StatPearls Publishing.

[24] Linzer, M., Poplau, S., Grossman, E., Varkey, A., Yale, S., Williams, E., … Barbouche, M. (2015). A cluster randomized trial of interventions to improve work conditions and clinician burnout in primary care: Results from the Healthy Work Place (HWP) study. *Journal of General Internal Medicine*, *30*(8), 1105–1111. doi:10.1007/s11606-015-3235-4

[25] Gardner, R. L., Cooper, E., Haskell, J., Harris, D. A., Poplau, S., Kroth, P. J., & Linzer, M. (2018). Physician stress and burnout: The impact of health information technology. *Journal of the American Medical Informatics Association*, *26*(2), 106–114. doi:10.1093/jamia/ocy145

[26] Mishra, P., Kiang, J. C., & Grant, R. W. (2018). Association of Medical Scribes in primary care with physician workflow and patient experience. *JAMA Internal Medicine*, *178*(11), 1467. doi:10.1001/jamainternmed.2018.3956