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REVIEW

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CORNELL HEALTHCARE REVIEW

Dear Readers,

I would like to start off by thanking the rest of our wonderful E-board, writers, editors, and artists for their hard work, dedication, and patience as I navigated my first semester as Co-President. Since I joined in the fall of 2022, I have seen our publication grow and transform in various ways, but have always been inspired by our consistent pursuit to share our passion for healthcare, innovation, and health equity.

In addition to our publication this year, we have hosted multiple speaker series events, featuring presentations from physicians at Weill Cornell Medicine and other speakers dedicated to promoting health equity.

Finally, I want to extend my deepest appreciation and gratitude to Christian Bertomo and Flavia Scott, who previously served as co-presidents and who are graduating this spring. Both the publication and I could not be where we are today without their support and trust, and I have learned so much under their guidance in this organization and beyond. I am confident that their dedication to healthcare, medicine, equity, as well as their overwhelming kindness and compassion will lead to incredible achievements. With that, we are delighted to share with you our Spring 2024 edition.

Happy reading!

Allison Kwon on behalf of the Cornell Healthcare Review E-Board

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Untold Stories: Storytelling in Modern Medicine

By Josephine Kelly, BME '27

Artwork by Sabrina Chen

Imagine you are in the emergency room awaiting a doctor. When the doctor finally approaches you after several hours, they rattle off some questions ("How are you today?"), write down a few notes, and deliver orders to nurses. They then leave, and you are left alone once again for hours, unsure of what to do and your story untold.

Experiences like this are more than common in clinical settings and often end in patient dissatisfaction. Imagine another scenario: consider if the doctor had taken the time to listen to your concerns. Wouldn't you feel much more satisfied with the personalized care? Narrative medicine is defined as the ability or potential to reflect on, connect with, and identify a patient's suffering [1]. This can seem like common sense: Doctors should be forming personal and caring relationships with their patients. Despite the rapid advancements in technology and how narrative medicine is being integrated into them, narrative medicine's place in medical education is cloudy. Medical students should be explicitly taught how to combine humanities comprehension with their biomedical backgrounds.

Narrative medicine is a format of medicine meant to tie together patient care and storytelling. This level of shared reflection can grant patients a means of catharsis in addition to granting medical students growth in imagination, empathy, and reasoning skills. The relationship between patient and doctor is one of the most important relationships during the healing process; that human connection allows for much more than it is granted for all parties. In one study, medical students were asked to try narrative medicine in its three stages: attention, representation, and affiliation. Attention involves being present in patient interactions; representation involves finding importance in those interactions; affiliation involves the emotional connection with patients and their friends or family [1]. Some of these details seem to be concepts that should already be present in everyday clinical practice. The study focused on the effect that narrative medicine had on the medical students, and the results were resoundingly positive. Students felt a much stronger sense of belonging and self-fulfillment; they felt more confident in their ability as doctors. They also enjoyed the fresh perspectives they experienced when talking to patients and gained a better concept of their professional values and morality [1]. The cultivation of a narrative competence can also benefit overall competence in medical areas since symptoms are viewed as a story rather than a path to diagnosis [2]. Furthermore, knowing a patient's thought processes and daily decisions can be valuable to preventing a repeat of certain medical issues or explaining present ones in case problems arose due to the patient's daily practices or choices [3]. If narrative medicine benefits both the healthcare providers and the patients, why should it not be used in practice?

A critique of narrative medicine mentions the folly of narration with its added flourishes or lacking details. Patients may not know exactly what to share or how to explain certain information. How can the doctor be sure they are receiving all the most relevant details on top of the narrative nuances? People often present themselves as they want to be seen when given the opportunity. What stops a patient from constructing a new narrative? Furthermore, patients may not want the pressure of presenting all the necessary details on their own with little prompting. It may feel as though they are given the job of concluding their own diagnosis, which is certainly not something a patient is prepared to do. Moreover, much of the evidence used to support the usage of narrative medicine is empirical and qualitative and, as such, highly prone to manipulation whether due to placebo or personal biases [4].

On the contrary, narrative medicine is not as "patient-led" as it may seem. It more heavily leans on the doctor's ability to practice empathy in doctor-patient interactions and truly listen to what the patient has to say. Conversations should be guided by the doctor with questions that echo evidence-based medicine but are then followed up with deeper personal questions. The goal is not to have the patient diagnose themselves but rather have the doctor listen to their story, maybe comprehending some contextual problems along the way [3]. Upon the point of circumstantial evidence due to bias, medical students participating in narrative medicine studies may be providing skewed perceptions of how well the practice of integrating humanities is actually affecting their mental state [5]. However, these skewed perceptions of how they are gaining skills in practicing empathy and connecting with their patients are what will grant them the confidence to genuinely develop such skills. Narrative medicine is a newer practice that has yet to be deeply explored, but with its strong bonuses to the patient and doctor psyche collectively, it has the potential to benefit many.

Narrative medicine not only calls for doctors to ask "How are you today?" but also "What are your concerns?" Narrative medicine should be taught to medical students to prevent the stonewalling that many patients experience and give more interactive care involving the patient's input. Narrative medicine has been proven beneficial in multiple case studies spanning very different medical focuses as well as in the mental states of both healthcare providers and patients. Patients' untold stories deserve to be brought to light.

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The Crippling Battle Between Health & Productivity

by Maya Gowda, Global Development '27

People in India do not often think twice about the hardships and tears that go into growing the ingredients for their favorite foods. Indian agricultural workers face many difficulties when trying to provide nutritious food for their families and communities. Exposure to pesticides also affects the efficiency of workers on their farms and may lead to crop failure over time. This makes it difficult for farmers to pay off their debts and can cause mental health issues. The unregulated use of pesticides by farmers imposes a gender and health burden on farming households in India.

For many years, the Indian government has overlooked farming households that are grappling with the negative effects of unregulated pesticide use. The capitalist mindset of pesticide companies has created a power imbalance and poor relationship between pesticide companies and farmers. Dr. Vandana Shiva, an Indian scholar and environmental activist, mentions that the Green Revolution was driven by malicious chemical industries in an attempt to profit from vulnerable farmers [1]. In "Toxic Tears," the farmers mention that unregulated pesticide use is similar to an unhealthy drug which is driving farmers into a systemic cycle of continuously hurting their health in hopes of successfully growing crops. Pesticides may contain carcinogens that can promote cancerous cell development [2]. Farmers often feel unsupported due to the lack of governmental regulation regarding pesticide use which is preventing them from receiving loans. [1]. The inability to pay off their debts often makes farmers feel embarrassed as well as unmotivated to continue their work. Such negative feelings can start to accumulate and lead farmers' mental health to deteriorate, causing some to commit suicide [1]. Dr. Shiva explains that an increasing rate of suicides from male farmers is directly causing a decline in the birth rate on farms. This decrease in agriculture workers may severely impact food security across India.

Not only may farmers prioritize work over health, but also over their family members. Additionally, continuous exposure to pesticides contributes significantly to many family members developing cancer. Saini states that there will be a 50% increase in cancer rates due to agrochemical usage on farms [3]. In fact about 830 million people residing in agricultural areas are being affected by pesticides [3]. Research has shown that cancers of the prostate, brain, and blood are exceedingly common in areas that use agricultural pesticides [4]. The narrative of the Kumar family captivates attention. Living on a farm saturated with pesticides, the wife of farmer Rakesh Kumar found herself battling breast cancer. Despite his desire to support her, he was constrained by the demands of maintaining their farm. The financial debt further compounded their hardship, making it difficult to afford the costly cancer treatments needed. This could worsen disparities in cancer outcomes, particularly for agricultural workers or individuals from lower socioeconomic backgrounds who may struggle to afford cancer treatments or reside in areas with less pollution [5]. Coping with health issues, both personally and within their families, is a common challenge experienced by Indian agricultural workers and many others globally.

Indian farmers are often battling with the question of "Should I prioritize my health or my work?' Does the Indian government need to witness more suicides before implementing policies that truly benefit agricultural workers' health? Will the deteriorating mental health of farmers always be irrelevant? How many more lives must be lost due to the hardships of Indian agriculture before meaningful change is made?

Artwork by Joyce Wang

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Mindful Medicine: Breaking the Healthcare Provider Burnout Cycle

by Rma Lara Polce, Biology & Society 2026

Five hours of sleep, thirteen-hour shifts, and copious caffeine consumption are hallmarks of many healthcare workers. From a lack of resources to inefficient utility management, many of our physicians are facing the highest levels of burnout in the last century, with as many as 68% reporting symptoms of burnout in 2021 [1]. Yet, the problem applies to providers at all levels of clinical teams. For example, in 2023, one study found as many as 91.1% of nurses reported feeling a high level of burnout [2]. These strenuous conditions translate into worsened patient care, too, as the vacancy and turnover rates grow, with RN vacancy rates around 15% in 60% of hospitals nationally [3]. With all these negative projections for the healthcare field, the real question we need to address is: what can be done?

The solution on paper seems very clear: increase mental health resources for medical staff and regulate shift lengths. The problem with these simple solutions is that they are not enough. In 2021, one out of every ten physicians reported they had considered or attempted suicide, and 24% of doctors reported having clinical depression [4]. So what can we do to help those who have dedicated their lives to aiding others?

Sixteen minutes and fourteen seconds – the average time a physician spends using an electronic health record system for each patient [5]. As the patient load increases, the time doctors and healthcare professionals spend on non-clinical tasks continues to rise, leading to lower engagement levels for doctors with their work, which in turn results in burnout [8]. The easiest way to combat this is to delegate these tasks to other healthcare team members, such as scribes. This solution proves sufficient, as one study found that increased use of scribes in plastic surgery practices decreased physician workload and costs while improving efficiency [6]. However, this solution comes with complications, as only 55% of scribes are trained by the practices they work for [7]. The lack of investment in these clinical team members is counterproductive; healthcare professionals at all levels must realize that in order to reap the benefits of delegation, proper training is needed. To combat healthcare burnout, the medical team has to commit to growth and improved efficiency *together*.

Artwork by Carla Hu

There are many ways to foster positive work environments that increase the dialogue between clinical team members. For example, multiple studies have found that solid mentorship and leadership improve the opinions healthcare workers hold about their workplaces, which in turn increases job satisfaction [6, 9-10]. This increase in positive associations with the workplace can act as a preventative measure of physician burnout [8]. Additionally, introducing social events such as celebrations and team-building exercises can increase the sense of community within the healthcare workforce and has been shown to decrease burnout in physicians [6]. For example, exercises like frequent conversations between resident physicians and senior surgeons to discuss case studies and interpersonal skills have been demonstrated to help protect against burnout in plastic surgery residents [11].

These simple workplace improvements of increased training and intra-office dialogue go a long way to foster a more cohesive and engaging environment, protecting our healthcare workers from burnout.

Despite potential preventative measures, it is still essential to address what can be done to resolve those already experiencing burnout. The first possible solution is to encourage the extensive use of clinical team resources. For example, at the University of California San Francisco Medical Center, managers who oversee phone calls and online communications are provided with "triage playbooks," which include basic information about various medical specialties [12]. These documents enable the nonphysician members of the clinical team to effectively and efficiently handle common questions and concerns [12]. This allowance will provide physicians and nurses with more time to allocate to treating patients and dealing with the patient volume on hand instead of answering basic inquiries.

Another solution is to promote widespread mindfulness and education programs for nurses and other clinical members. When struggling with mental health and burnout, it is common for providers to feel alone; the inclusion of widespread support systems allows staff to seek support without feeling singled out. Also, professionals, like nurse educators, are trained to provide nurses with stress-coping strategies that can help alleviate the negative work-related emotions they feel [13]. Furthermore, primary care physicians subjected to mindfulness training demonstrated improvements in well-being and patient-centered care in the short and long term[14], underscoring the importance of teaching these practices to healthcare workers.

Stopping burnout in healthcare workers means starting at the source. Without proper training, communication, and resource management, it’s easy for burnout to set in; however, there are preventative and retroactive measures healthcare workplaces can take to ameliorate the conditions of providers across the country. Coming off of a global pandemic, continued research in this field is extremely important to protect those who protect us.

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Could Pets Provide Cognitive Benefits for Elderly Individuals?

by Carla Hu, Human Biology, Health, and Society '26

Do you love your pets? Your answer, if you have pets, should hopefully be yes. Animal companions have been found to be able to provide emotional and physical support to their owners [1]. Beyond yourself, have you ever wondered if pets could help people, such as elderly individuals, in maintaining or even preventing cognitive decline? This question is the focus of this article. Cognition is defined by the ability of individuals to be functionally independent [2]. For example, individuals should be able to manage their own finances, travel safely, and take their prescribed medication. As we age, our cognitive abilities decline, and this can be accelerated by dementia and neurodegenerative diseases [2]. A common illness that affects elderly individuals is Mild Cognitive Impairment (MCI), often a precursor to dementia and Alzheimer's disease [3]. According to researchers, approximately 10 - 20% of individuals over 65 years old with MCI develop dementia over a one-year period [3]. The population of Americans over the age of 65 is expected to more than double over the next 40 years, so there is growing necessity to develop preventative measures to protect against MCI [4]. Currently, the most common preventative measures against MCI include sleep, improving diet, and increasing exercise. While these measures are supported by various studies, few current studies consider the effects of pet ownership on MCI [5]. The novel studies on animal companionship as a therapeutic strategy for MCI have recently gained recognition as they reveal pets may be the next step to maintaining and improving cognitive function.

A recent study published at the end of 2023 based on the Baltimore Longitudinal Study of Aging (BLSA) found that cognitive decline is slower in older adults who had pets [6]. The BLSA is the longest running study for human aging in America funded by the National Institute on Aging [7]. In order to understand the cognitive benefits of having a pet, the study looked at how support from a pet can benefit the lifestyles of elderly individuals within the social, biological, and psychological realms. According to data from the Health ABC Study and the Health and Retirement Study (HRS), it was found that individuals with pet ownership exercised more than non-owners and had less visits to healthcare professionals [8]. In order for elderly individuals to care for pets, they have to maintain a lifestyle that provides positive benefits such as increased physical activity and companionship [8]. Much of the pet ownership lifestyle relates to the common preventative measures against MCI, and in animal therapy, pet interactions decrease agitation while increasing social behaviors in cognitively impaired elderly individuals [8]. However, these benefits from pet ownership relies on the physical and mental ability of elderly individuals, and individuals living in extended care facilities may struggle to access opportunities to own or care for pets.

Artwork by Laurel Whidden

TIn many extended care facilities, allowing short term pet visits as therapeutic animals is a common practice to improve stress levels and positive feelings of elderly individuals [8]. However, for individuals living alone or suffering from dementia and Alzheimer's disease, it is often more challenging for them to take advantage of pet companionship opportunities without outside assistance. The issue reported most often by elderly individuals in a study looking at potential limitations of pet ownership for the elderly was being able to access pet care items [9]. The solution for this problem has been found in using technology to imitate the effects of pets: a seal shaped robotic pet that could fit in an individual's lap is known as PARO® [10]. This robotic pet specifically targets individuals with dementia who are unable to own a pet. Studies using the PARO® robot technology found decreased stress and anxiety in patients, and even lower reliance on medications, revealing multifaceted ways for technology to improve the health of elderly individuals [10]. Currently, there is limited research on the long-term benefits or preventative abilities of robotic therapeutic devices such as PARO®, but it reveals a viable nontraditional option for MCI prevention or improvement [10]. The implementation of these forms of elderly healthcare devices could give elderly individuals who are often the most vulnerable and isolated the opportunity to bond socially, physically, and psychologically with a pet companion without the health risks and physical limitations.

Ultimately, while recent longitudinal studies such as the BLSA reveal that we should consider alternative measures for preventing MCI, we should also be aware of complexities which come with providing these opportunities for elderly individuals. Pet ownership has many benefits for cognitive function physically and psychologically, but individuals living alone or requiring specialized care could potentially benefit from robotic versions of pet companionship, in addition to recognizing the long-term benefits of pet therapy. The recognition of pet ownership as beneficial to healthy aging can create a mutually beneficial environment where patients may engage with more preventative or treating measures relating to MCI, in addition to the recommended medical treatments from health professionals. By implementing more pet ownership opportunities for our elderly individuals, we are able to provide a unique form of care which many elderly individuals currently are unable to access, but we must continue down this path to address further improvements in elderly healthcare in order to provide adequate MCI treatments and prevention for our future.

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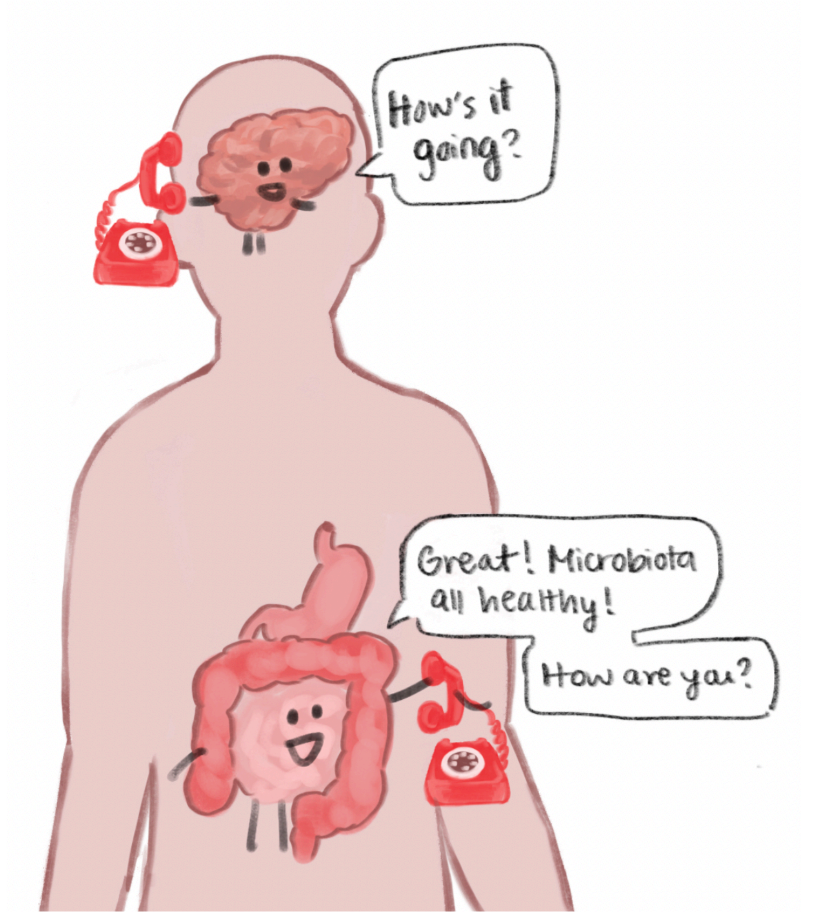
The Gut-Brain Axis: The Role of Microbiota in Psychiatric Conditions

by Anna Nanas

The relationship between the gut and the brain has garnered increasing attention in recent years. Referred to as the gut-brain axis, this relationship represents bidirectional communication between the central nervous system and the digestive system. To facilitate this communication, the gut-brain axis utilizes various pathways, including the vagus nerve (which manages communication between the brain, heart, and digestive system), and the humoral pathway (through the secretion of peptides or the production of antibodies). Current scientific research from microbiologists and psychiatrists still seeks to explore the extent to which the gut-brain axis is a factor in psychiatric conditions.

Many recent studies have shown that these intricate pathways connecting our brain and gut actually do play an integral role in the manifestation of psychiatric conditions [1]. One argument for the fact that these conditions are impacted by the gut-brain axis is that individuals with conditions such as generalized anxiety disorder and major depressive disorder often present with gastrointestinal issues such as stomach upset or bowel movement changes [2]. Through the release of microbial metabolites and neurotransmitters, the gut microbiome can influence central nervous system function, and conversely, neuropsychological stressors can change the composition of gut flora and epithelial permeability [3]. As a result, generalized anxiety disorder and major depressive disorder are often comorbid with irritable bowel syndrome or inflammatory bowel disease [4].

The development of gastrointestinal symptoms may not be the only aspect of psychiatric diseases in which the gut-brain axis is involved. The composition of the gut microbiome may make a person more susceptible to the development of psychiatric conditions such as depression or anxiety. The signaling pathways of different microorganisms interact with the brain and stress responses differently; some microbiota may have a positive effect on mood whereas others can activate stress responses and negatively impact mood [5]. As the composition of the gut microbiome can be controlled in various ways, such as through fecal microbiome transplant or supplementation with psychobiotics, the notion that gut microbiome composition can impact psychiatric conditions opens up new possibilities for treatment [5].



Artwork by Julia Chen

The aforementioned treatments involve different mechanisms. A fecal microbiome transplant involves transplanting stool from a healthy individual into the affected individual to transfer the microbiota from the healthy stool into the recipient's microbiome. Psychobiotics refer to prebiotics and probiotics that can impact psychiatric well-being. Prebiotics contain growth factors for microbiota and can be given as a supplement to a patient in order to strengthen their microbiome. Probiotics can also be given as a supplement, but they differ from prebiotics in that they contain live microbiota. An alternative to taking these supplements is adjusting diet to increase consumption of fermented foods, which naturally contain prebiotics and probiotics [6]. Despite its proven effectiveness, the modulation of the microbiome as a treatment for psychiatric conditions is relatively uncommon. Nevertheless, it is undeniably a potential option in treating treatment-resistant psychiatric conditions [7]. Furthermore, incorporating microbiome profiling by tailoring microbiome modulation towards individual needs may allow for the formulation of more effective psychiatric treatments.

Thus, the gut microbiome serves as both a consequence of and a contributing factor to psychiatric conditions, influencing the pathophysiology and pathogenesis of such conditions. As such, microbiota-based interventions hold promise as novel therapeutic modalities for treating psychiatric conditions. Emerging evidence that microbiota-based interventions can impact psychiatric well-being warrants further research into both the molecular mechanisms underlying the neuroendocrine interactions between the gut and the brain and microbiota-based interventions for treating psychiatric conditions.

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Melanoma In Its Darkest Form: Why Darker Skin Suffers

by Sarah Ayusa, Biology & Society '25

"The imminent death..."
"A life of hospitalization..."
"The biggest threat to medicine..."

It is ubiquitous knowledge that the diagnosis of cancer is a difficult and undesired reality. Cancer has always been synonymous with death. But for Black and Brown people, cancer, especially skin cancer, is an even harsher reality than people may think.

Skin cancer is the fifth commonly diagnosed cancer in 2024, just after breast, lung, colorectal, and prostate cancer. [1] The most serious form of skin cancer, malignant melanoma, affects the melanocytes in your skin which are responsible for producing the melanin pigment. Melanoma occurs when DNA is damaged as a result of exposure to ultraviolet (UV) radiation, as it triggers melanocytes to produce more melanin and allow the likelihood for DNA mutations to occur and ultimately result in uncontrollable cell growth. Thus, a major cause and factor which increases risk of melanoma is unprotected exposure to UV radiation, either from the sun or tanning beds. [2]

Eumelanin serves as the body's natural defense against the damage done by UV radiation, which leads Non-Hispanic White people to experience the highest incidences of melanoma. However, despite experiencing a lower incidence in cases, Black and Brown people tend to suffer metastasis (the spreading of cancer growth beyond the primary site) and are more likely to die from it. When detected early, melanoma can have a 94.1 % 5-year survival rate. [2] However, because non-Hispanic Black patients are more likely to be diagnosed much later, they suffer the lowest 5-year survival rate of any other racial demographic at just 52%, while non-Hispanic White patients see the highest survival rate at around 75%. Because male mortality rate more than doubles that of females in melanoma, Black men especially suffer the lowest survival rates. [3]

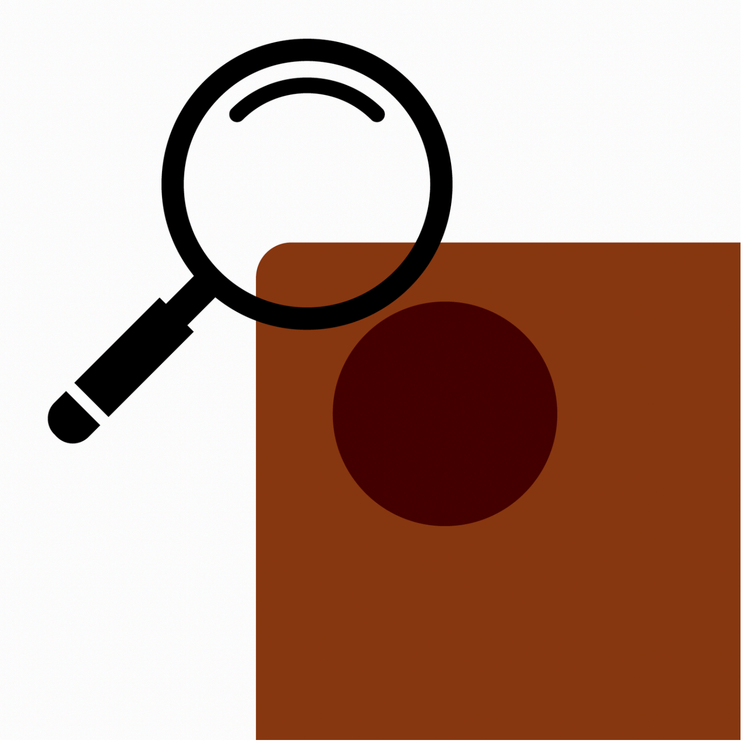
Why do these statistics look so bleak for Black and Brown people?

The most common melanoma subtypes reported by Black patients are acral lentiginous melanoma, which affects the hands and feet, and subungual melanoma, which appears as stripes of dark lines under the nails. These uncommon areas are lower extremities which can easily go unchecked, and this—in tandem with the black or brown coloring of melanoma tumors—makes misdiagnosis and prolonging of diagnosis a lot more common for these cancers.

Another barrier is introduced when medical professionals are not taught how to diagnose skin cancer in darker skin. The skin noted in the pictures and diagrams of dermatological textbooks commonly show people with fairer skin. Brown and Black skin, categorized as types V and VI on the Fitzpatrick scale, are virtually nonexistent in the realm of medical education. [4] To worsen things, ethnic differences in the prevalence of certain conditions and symptoms are not even mentioned in textbooks. This produces generations of specialized medical providers who are ironically not educated enough to support their Black and Brown patients. Without proper medical training on the dermatological care of minority patients, the disparity in health outcomes will only continue to exacerbate.

The issue of skin color discrepancies in dermatological education are beginning to gain more recognition by U.S. medical schools, and some of them are taking action. The American Academy of Dermatology (AAD) established a new skin of color curriculum in March 2022. [5] Medical students have begun to take action on their own, as well. Malone Mukwende, a medical student at St. George's University of London, has authored a clinical handbook titled Mind The Gap which details the signs and symptoms specific to Black and Brown skin. [6] Alongside this, efforts must be done to increase access to quality healthcare for low-income patients. Low-income individuals, who tend to be Black, are less likely to afford treatment for further developed cancer, which even further heightens the mortality rate.

As we live in a time where global warming only continues to get more aggressive, the risk of cancer, especially skin cancer, only proliferates. It is integral that once the summer sun blasts and the tropical vacations commence, everyone (including people with dark skin) is protecting themselves from future complications through sunscreen and avoiding sun exposure in excessive amounts of time.



Artwork by Janice Indajang

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Eye Care Disparities: Mend the Social Gaps First

by Olivia Qin, Biological Sciences ‘27

“One better or two better?” An all-too-familiar question at an annual eye examination. You answer, “Two.” The doctor scribbles down some numbers. A week later, you pick up a new pair of glasses and your vision is as good as new. The process is straightforward. Regardless of your race, sexual orientation, and socioeconomic status, blurry vision is blurry vision and a prescription is a prescription. But as you age, diagnostic complications arise with increasing risks for complex diseases.

When discussing biomedical and clinical research, the rapid advancement of screening technology and surgical techniques may be the first thought that comes to mind. However, this curtain of progress veils layers of cost concerns, accessibility barriers, and inaccurate diagnoses. Although there has been an abundance of research on several scientific aspects of healthcare, the need for awareness toward the social determinants of health remains unfulfilled. Researchers and medical practitioners have overlooked epidemiology factors such as racial distribution, population density, wealth gaps, education quality, and health literacy in clinical practice, leading to false medical labeling, unnecessary testing, disregarded risk factors, and poor health maintenance. In the field of ophthalmology, this unintended negligence has significantly reduced the reliability of eye care services.

Demographic analysis of the populations most affected by cases of cataracts, the clouding of the natural intraocular crystalline lens in the eye, demonstrates the consequences of this negligence. As the leading cause of blindness worldwide, the elderly population experiences this condition to a notable extent. According to population studies, the prevalence of cataracts is disproportionately elevated in minority populations including those of African, Hispanic, and Chinese Americans. Cataract removal surgery, first invented by French surgeon Jacques Daviel in the eighteenth century, is also more complex for these minorities in comparison to Caucasians. For example, postoperative patients of African descent experience worse outcomes of visual acuity and a greater frequency of complications, such as anterior uveitis1 [1]. The artificial intraocular lens that surgeons transplant into the eye is tailored to the preferences and prescription of each individual and the anatomical measurements of their eyes. However, the surgical procedure is nearly identical for every patient regardless of race or ethnicity. Yet, the variance in postoperative complications demonstrates that the current method produces the most desirable results for Caucasian patients. This finding reveals the likelihood that researchers tested the effectiveness of cataract surgery and optimized the procedure for a historically privileged population.

Diabetic retinopathy2 cases serve as another indicator of eye care disparities due to social determinants. As the prevalence of diabetes mellitus increases, African and Hispanic Americans continue to experience a greater severity in disease burden yet receive lower rates of recommended screenings and eye examinations [1]. Severe cases often occur from inattention toward risk factors for these demographic groups. In addition, diabetic retinopathy has become more common in rural communities than in urban environments, even following accessibility adjustments. Patients in rural regions have reported cost hurdles, lack of insurance, and transportation barriers [1]. These obstacles prevent patients from keeping up with follow-up appointments and annual examinations, which become increasingly important with age. Furthermore, greater prevalence of retinopathies among patients with lower income and educational attainment is attributable to a lack of knowledge of preventative measures and limited access to eye care services due to the amplified wealth gap between affluent and under-resourced individuals. Low health literacy is another contributing factor to deficient knowledge of ophthalmic diseases. For instance, although a large percentage of the population is aware of common eye diseases and disorders, most are unaware that the onset of these diseases may come without early warning signs [2]. Thus, the contrast between a wide distribution of eye care services and inadequate medical awareness also limits the ability of different demographic groups to maintain their ocular health.

The epitome of eye care disparities resides in cases of glaucoma3, the leading cause of irreversible blindness. The cup-to-disc ratio is a measurement taken from the optic nerve at the back of the eye and reflects a major risk of developing glaucoma. Patients with a cup-to-disc ratio of 0.6 or greater are flagged as glaucoma suspects, subjecting them to frequent appointments [3]. It is not a coincidence that Asians and Africans, who have naturally larger cup-to-disc ratios than Caucasians, are over-labeled as glaucoma suspects. After all, the accepted normal range for cup-to-disc ratios of 0.2-0.3 derives from statistical data of ophthalmic features in Caucasian males [4]. This standardization must adjust to acknowledge differences in ocular anatomy between different races and genders. Furthermore, similar to cataract surgery cases, patients of African descent experience higher rates of surgical failure for glaucoma than Caucasians [5]. The lack of research regarding different surgical procedures for optimal results in each racial and ethnic category explains this observation. Recent studies reveal that minor modifications in minimally invasive surgeries yield better outcomes for African and African-American patients, further demonstrating the value of researching variations for standard surgical procedures and their potential to offer greater benefits to different populations.

Artwork by Julia Chen

In the face of exciting innovations, it is easy to neglect the multifaceted social determinants of eye care and overlook or mislabel signs of risk. While it is important to continue expanding the horizons of medical knowledge, it is even more fundamental that clinicians, researchers, and health policy-makers merge their expertise to provide holistic and individualized eye care services and treatments for everyone.

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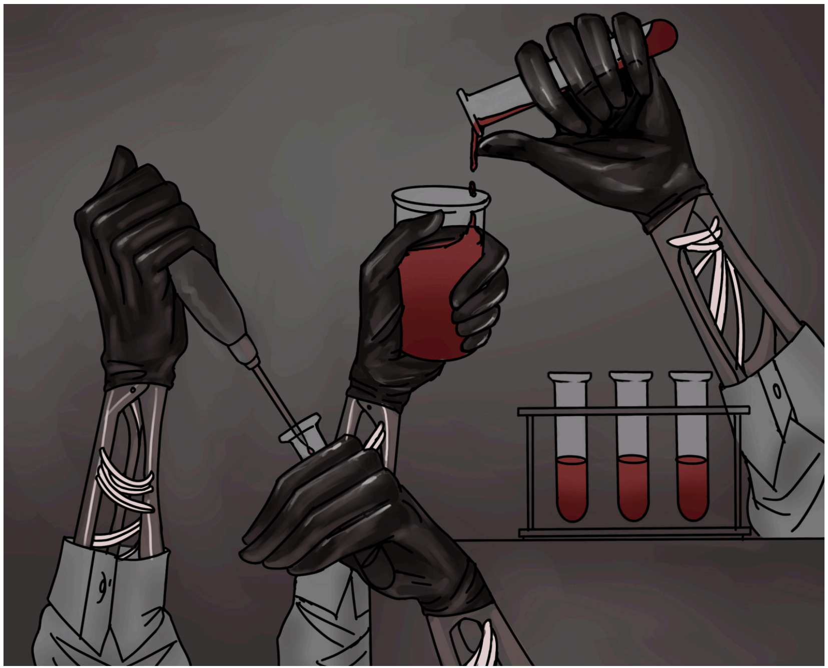
AI-driven Healthcare: Bridging Gaps or Widening Disparities?

by Emily Zhang, Human Biology, Health and Society '27

Medical racism is not an issue of the past. Despite efforts to combat race-based medicine, racism continues to be deeply ingrained within the US healthcare system both implicitly and explicitly [1]. Racialized biases in healthcare are highly consequential especially for the minority population, leading to poorer health outcomes and quality of life. Now, as the healthcare industry becomes increasingly digitized, a new and pressing threat to health equity emerges: artificial intelligence.

Artificial intelligence (AI) is at the forefront of the digital healthcare revolution. Through its diagnostic potential, ability to perform administrative tasks, and potential in creating life-saving drugs, there is no doubt that AI is well underway in addressing healthcare challenges worldwide. But despite its massive potential, research suggests that these systems can perpetuate long-standing racial disparities and biases [2]. *But, how exactly can these automated systems harbor bias?*



Artwork by Jenny Li

The answer lies within the datasets that these AI are trained with. AI relies on machine learning, which is a technique that trains algorithms to identify patterns within data to create accurate associations and predictions [2]. The success of machine learning is dependent on high-volume and high-quality data. However, the data used to train AI systems can be flawed by lacking diversity, whether by sex, race, or other factors. As Mattie of Harvard University explains, "bias can creep into the process anywhere in creating algorithms: from the very beginning with study design and data collection, data entry and cleaning, algorithm and model choice, and implementation and dissemination of the results" [3].

Algorithmic bias also stems from the fact that racialized minorities have been historically excluded from medical research. Whether it be due to a fear of exploitation, distrust of the medical professionals, or lack of time or resources, participants of color are not equally represented in clinical trials [4]. When trained on these datasets that are not representative of the full population, AI can harm these underrepresented groups predominantly those of color. "When you learn from the past, you replicate the past. You further entrench the past," says Dr. Mark Sendak, a lead data scientist at the Duke Institute for Health Innovation [5].

The implications of AI bias are direct and harmful. In a landmark study published by *Science* in 2019, Obermeyer et al. found that a widely used algorithm that affects 100 million patients has significant bias. In this model, health risk was predicted using past healthcare spending. Due to Black patients having unequal access to care, they often spend less on healthcare despite their actual health conditions. Therefore, this model consistently underestimated the health needs of Black patients [6]. Another study published in *JAMA Dermatology Network* identifies disparities in how skin cancer is diagnosed across different skin colors as most models are trained with light-skinned subjects [7]. While developers of these algorithms hadn't intended to include these biases, these flaws can translate to lesser quality of care by affecting the diagnoses and recommendations physicians provide.

As of 2024, the first drugs designed with AI begin to reach clinical trials [8]. AI-driven technologies have also been shown to be capable of tackling administrative tasks and interpreting images— radiographs, histology, and optic fundi [9]. It has even been shown that two large language models including Chat GPT can pass the USMLE, the three-step exam for medical licensure [10]. While AI won't necessarily replace the need for physicians, there is no question that its presence in healthcare will continue to rapidly expand. However, the implementation of AI requires multidisciplinary efforts from data scientists, physicians, and legal professionals to make combating bias a priority. Leveraging the capabilities of AI in the right ways is crucial, ultimately seeking to promote greater equity instead of worsening divides.

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The Insulin Injustice

by Muqadas Jawad, Biologicl Science '27

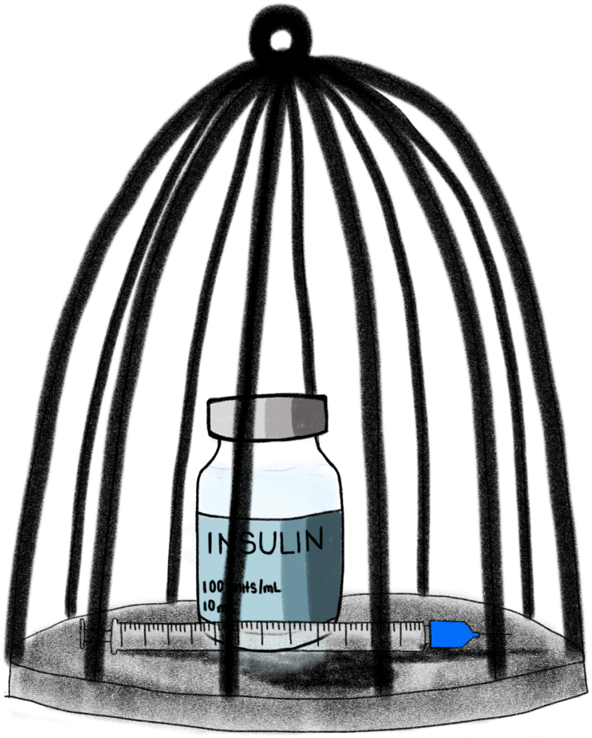
S On May 3, 1922, a physician and scientist made a discovery that had the potential to change the lives of many people who suffered from type 1 and type 2 diabetes. That discovery was of insulin. The significance of insulin as a treatment became evident when Leonard Thompson, a type 1 diabetic, received his first insulin injection. His blood sugar dropped just 24 hours after injection. In 1923, Sir Frederick G. Banting, the recipient of the patents on insulin, declared "Insulin does not belong to me, it belongs to the world" [1]. Banting advocated for equal access to insulin. Yet, 102 years later, there exists a pressing concern to address why some diabetics still struggle to afford insulin.

According to the New England Journal of Medicine, in 2019, 100 units of insulin cost $18 for uninsured persons. To put this statistic into perspective, for a person weighing 70 kg and requiring one unit per kilogram daily, 100 units would last only two days [1]. This amounts to a monthly expenditure of $270 solely on insulin. Moreover, the CDC reports that the total annual cost of diabetes stands at $327 billion, where $237 billion allocated to "direct medical costs." Individually, Medicare beneficiaries who have type 2 diabetes spend approximately $5,876 per year annually for diabetes management [2]. Otherwise, those with diagnosed diabetes spend about $9,600 per year in relation to their diabetes, with potential expenditures amounting to $16,750 annually for additional medical expenses [3]. According to research from the Yale School of Medicine, "insulin is seven to 10 times more expensive in the U.S. compared with other countries around the world." A vial of insulin that was priced at $21 in 1996 could now cost up to $250, despite estimates suggesting it only costs up to $4 to produce one vial [4]. The insulin production process involves profit extraction at every step, resulting in unreasonably high prices for one vial of insulin.

The affordability of insulin is especially problematic for "low-income, uninsured, and underinsured populations," who are more likely to face challenges in purchasing a vial of insulin in an economy where income is decreasing while the cost of living is increasing. This demographic, which disproportionately consists of minority racial and ethnic groups, are also at a hightened risk of being unable to afford medication that could be vital to their lives. Alarmingly, "one in four Americans who take insulin report reducing their dose or stopping it altogether because of cost" [5]. This can present many health complications for diabetics. Moreover, racial minorities are also typically more likely to have some form of diabetes. Therefore, the limited accessibility of insulin for these minority groups exacerbate existing racial healthcare disparities.

Recent legislation, such as the Insulin Affordability and Inflation Reduction Act, attempts to address the soaring costs of insulin [6]. It is commendable that there are efforts being made to address the high cost of insulin, especially considering that 30% of the population with type 2 diabetes and all individuals with type 1 diabetes require insulin [5]. However, it is crucial to note that an act like this only provides provisions for those covered by Medicare. Additional support is imperative for the uninsured, underinsured, and low-income individuals in accessing a necessity for a condition that is fatal when left untreated.

After enduring years of unreasonable and unjust barriers to insulin, it is time that we begin to shift healthcare in a way that insulin can be made affordable to all – to those with Medicare or other forms of insurance, and to those who are underinsured or do not have insurance. Given that insulin has the potential of being one's only solution for diabetes management, we cannot delay action much longer. For something as vital as insulin we must take immediate steps in order to make this treatment fully accessible and affordable to all individuals in need.



Artwork by Michelle Choi

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Medications Can Cause Harm? An Analysis of Polypharmacy in the Perspective of Geriatrics

by Minjae Shin, Design Environmental Analysis '27

Have sleeping issues? Take melatonin. Have diabetes? Take drugs that promote insulin secretion. People often approach prescriptions in a disease-centered perspective, as if they are simple one-to-one instantaneous solutions to certain diseases. In fact, the current healthcare systems generally have a single-disease focus. However, the conditions are more complicated than we think, especially for elders who commonly suffer from multimorbidity, the co-occurrence of two or more chronic conditions [1]. Prescribing multiple medications is often clinically required to deal with multimorbidity, but excessive prescriptions can lead to threatful health outcomes due to adverse, often unexpected, interactions between drugs. This condition, often referred to as polypharmacy, is even more detrimental to the health-related quality of life of elders due to their vulnerability [2]. With the increasing significance of the multimorbidity of geriatric patients, the threat of polypharmacy must be addressed and improved within the healthcare field.

Significance of Polypharmacy and The Potential Impacts on Individual Patients

Polypharmacy, the prescription of multiple (usually five or more) medications to a patient at the same time, has emerged as a significant health issue due to the increase in the elderly population. According to the National Health & Nutrition Examination Survey held in the United States, the proportion of polypharmacy among adults aged 65 or older tripled from 12.8% to 39.0% between 1988 and 2010 [3]. 46% of the hospitalized elderly patients in Korea have experienced polypharmacy [4]. The threats of polypharmacy due to drug-drug interactions, drug-disease interactions, and medication errors are often more detrimental to the elderly because of metabolic changes and reduced drug clearance associated with aging [5].

Prior studies put emphasis not only on the direct metabolic effect on each individual but also on the indirect consequences that appear in the process of caregiving and handling medications after consuming the medications. Polypharmacy is linked to increased risks of disability and cognitive decline; it also reveals a correlation with prolonged hospitalization, which is associated with increases in healthcare costs and the onset of disuse syndrome [6][7]. The physical decline due to a decreased lack of physical activity as a side effect of a longer hospitalization period leads to frailty, another predominant chronic disease associated with aging. The inability of physical activity due to muscle loss (sarcopenia) significantly impacts elders' physical and psychological health, developing as a public health problem [8]. Since polypharmacy frequently initiates additional health issues, it sets off a positive feedback loop where more medications are needed by the patient, thus even more exacerbating the negative effects of polypharmacy.

The costs of polypharmacy are not limited to health but also extended to the patients' economic conditions and quality of life. Although the prevalence of polypharmacy itself does not show evident differences between populations of different poverty levels [9], costs of recovering from the same threats may impact more heavily on underprivileged patients, for reasons such as aggravation of costs for medication and caregivers or aftereffects of long term deviation from work due to hospitalization. Combination of these health and personal costs emphasizes the necessity of patient-centered care that may alleviate the problem of polypharmacy.

Current Solutions to Polypharmacy

The problem of polypharmacy, unfortunately, cannot be alleviated merely by decreasing the number of prescriptions in elders because the conditions derived from polypharmacy are often demented with normal aging signs, such as tiredness, sleepiness, or decreased alertness [5]. The symptoms are consequently often disregarded as another new health issue that should need a prescription, instead of the side effects of medications already prescribed, leading to a negative feedback loop of even more medications being consumed by the patients. Thus, the complexity of diagnosis and prescription indicates a need to view a patient's condition from multiple perspectives and emphasizes the importance of collaboration and communication between healthcare providers about decision-making that best fits individual patients' unique needs [10]. The complexity also sheds more light on the analysis of adverse health outcomes due to multi-drug combinations that should be monitored and expanded by healthcare professionals.

Artwork by Amelia Wildermuth

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The Most Common Cardiac Procedure: But Is It Safe for Women?

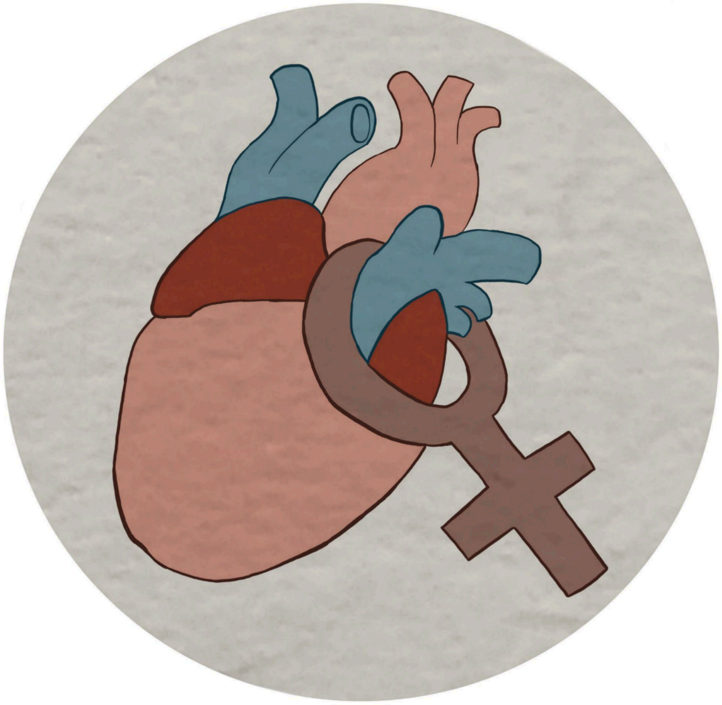
By Natalia Collins, Undecided Major '27

"I'm still struggling with the fear it will happen again," writes Susan Leary, after an incomplete vascularization during coronary artery bypass surgery required a second bypass procedure [1]. Known as the most common cardiac procedure, over 370,000 patients undergo coronary artery bypass surgery in a given year in the United States. However, women face over a 22.9% risk for postoperative mortality and morbidity after bypass surgery, compared to a 16.7% risk for men [2]. Coronary artery bypass surgery (CABG) is a well-understood procedure, but differences in the pathology of CABG between men and women are not well-studied, as clinical studies on CABG are performed primarily on men. The underrepresentation of women in studies on procedures like CABG points to critical gender disparities in clinical trials and in its informing of patient treatments.

For Susan Leary, a retired New York City teacher, her CABG procedure was expected to be routine. But after an incomplete vascularization, she now has to undergo another bypass surgery [1]. Ms. Learly, a few years prior, had a procedure to shrink her varicose veins in her leg and had inadequate vessels for coronary grafting. Unknown to her doctors that she would need these veins for a cardiac procedure in the future, she had to undergo a stent procedure for her third artery after a double bypass was performed as opposed to the necessary triple bypass. Women often require CABG at later ages as opposed to men, and ill preparation can lead to cardiac readmissions and additional procedures. For Ms. Learly, the postoperative complications have caused depression and anxiety out of fear of further complications [1].

To address these gender discrepancies, a 2023 study in the Journal of American Medical Association investigated the postoperative outcomes of women undergoing CABG, as compared to men. Through examination of complications and mortality rates for women over a 9-year period, the study found an increased risk of a number of major complications, including myocardial infarction, kidney failure, sternal wound infections and stroke [2]. Adverse complications lead to greater rates of cardiac readmission, prolonged ventilator use, and long-term cardiac treatments [3]. Observed mortality rates following CABG had significant differences between genders: women face a 2.8% mortality rate, while men face a 1.7% mortality rate [2]. Despite these drastic variations in postoperative effects, the procedure selection and revascularization strategy remains uniform for both men and women, and treatment evaluation does not consider physiological differences across genders [4].

Anatomical and physiological differences between men and women are understudied, especially as they relate to treatments for CABG, causing postoperative complications unique to female patients. Women have smaller coronary arteries, along with a greater risk of heart failure from preserved ejection fraction caused by higher pressure in the left ventricle [3]. Hormonal differences in women are under examined, and estrogen withdrawal post-menopause may increase postsurgical complication rates [4]. Comorbidity factors like diabetes, obesity, smoking, and chronic kidney disease are more common among women undergoing CABG and can increase the risk of complications like myocardial infarction [4]. An understanding of the variations in pathophysiology between men and women undergoing CABG is required to create diagnostic and treatment procedures properly tailored to gender-based differences.



Artwork by Fiona Reilly

Given the variations in physiology between genders, Doctor Mario Gaudino of Weill Cornell Medicine, with a team of researchers, is examining the discrepancies in postoperative outcomes of CABG [5]. The clinical trial compares the operative outcomes of multiple arterial grafting to single arterial grafting in an examination of female-only trial patients, Ms. Leary being one of 2000 women participating in the trial. By investigating the occurrence of adverse cardiac events, including death, stroke, myocardial infarction and revascularization, researchers hope to determine the CABG treatment best suited to female physiology. [6]. Dr. Gaudino emphasizes the importance of performing trials exclusive to female patients to adjust for differences in age and other gender-related health factors in CABG procedures [5].

Increased rates of postoperative morbidity in women point to a broader underrepresentation that exists in clinical trials and surgical techniques. Generalized treatments for both men and women create disparities in operative outcomes. Procedures must be tailored to account for gender-related physiological differences. For patients like Ms. Leary, the lack of consideration for variations in operative outcomes poses significant risks for both physical and mental well-being. Advancements in surgical procedures must consider essential differences that exist among underrepresented populations, and future work must be done to account for these differences and strive for equity in the healthcare space.

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Putting the Brakes on Deadly Driving in America

by Kylie Huber, Human Biology Health and Society '25

When behind the wheel, many of us find a brief escape. Tinted windows endow a sense of anonymity in a place where we can immerse ourselves in air conditioning and the blare of our favorite songs. Yet, despite the comfort and luxury, the modern car can still facilitate deadly driving. And more deadly than ever before. Though we can feel safe in the veneer of anonymity that the car gives, the unprecedented death tolls seen on American roads unveil a great deal about our behavior and our coping mechanisms with the increasingly stressful events of our world.

The American Automobile Association (AAA) revealed that in 2023, more than half of American drivers took part in dangerous behavior, including speeding, distracted driving, aggressive driving, and combinations of each [1]. Looking back at data from 2020 to 2021, when COVID held the country in lockdown, there was a 16 percent increase in car crashes, resulting in nearly 6 million crashes over the course of one year and nearly 43,000 deaths [2]. These figures easily categorize reckless driving as a severe public health crisis. Yet, we are so used to it that it is invisible. While the car can often offer a sense of invincibility in the anonymity it offers, the uptick in car-related deaths indicates its status as a public health threat as severe as gun violence [2].

For United States teenagers, motor accidents are the leading cause of death [3]. Young people are especially prone to multitasking behind the wheel, aggressive behavior, and speeding [2]. Additionally, when analyzing the behavior of young drivers who engaged in driving on drugs, a study found that these drivers were less likely to have "relatedness" to others that would support them not driving after taking drugs [4]. This statistic indicates that the fostering of positive, healthy relationships, particularly by facilitating policies that would prevent adverse childhood experiences, is more important now than ever before.

Additionally, the same study found that drug-using drivers recognized that they have a choice not to drive while high, and were more likely to plan for alternative transportation methods compared to non-drug using counterparts [4]. This data demonstrates that the strengthening of widespread public transportation can play a critical role in health outcomes. It also reveals that relationships with peers and family members that are positive rather than stress-inducing are crucial to encouraging the pursuit of alternative, safe transportation methods.

Beyond the behaviors of young people, an entire nation has become unprecedentedly burdened while driving. Even worse, we are not properly paying attention to its severity, and it may be too late when we give it the awareness it deserves. This perspective is reflected in much of Americans' perceptions of their mental and physical health. In a study from the American Psychological Association, 81 percent of respondents stated that they believe their physical health has improved, but 66 percent of those same participants said their healthcare provider diagnosed them with a stress-related chronic illness [5]. Similar self-evaluation deviations are shown when it comes to mental health as well. 81 percent of participants said their mental health has improved, but 37 percent of them have received a diagnosis for a mental health condition.

Furthermore, in the same way that we almost expect to encounter reckless driving each time we get on the road, approximately three in five Americans are expected by the people in their lives to merely 'get over' their stress [5]. The data supports the phenomenon that we, as a country, are undergoing collective trauma, and it is seen in our driving. When events that make us feel powerless seem never-ending, our stress levels manifest while driving: a time when we think nobody's looking.

In a near perfect world, asking a whole country to take self-accountability and regulate their stress responses may be feasible, but we also know that surroundings greatly influence a person's behavior [6]. Transportation data reveals how this phenomenon can be considered for our safety. For example, technologies like cameras at

Artwork by Joyce Wang

red lights and speed cameras have proven effective in France. When widespread speeding cameras were implemented there, the first decade of the program saw a significant decline in car-related injuries and fatalities, as well as speeding [2].

Arguments against these technologies include perspectives on technology's infringement on individual civil liberties. Data privacy and security are rapidly becoming issues at the forefront of policy, and certainly should not be ignored. Still, when a person is identified in a split-second snapshot to receive speeding punishments that are often quite minor, it begs the question of what cost we'd be undertaking to prioritize the privacy of a few drivers. We still need to protect citizens' personal liberties to drive on safe roads and highways. In the long run, road enforcement policies would work to dissipate our stress and social policies can work to improve public transport and the safety of interpersonal relationships from a young age, but we can all be reminded that we have lives in our hands each time we're on the road. Day by day, driving can eventually be an opportunity for all of us to slow down when so much feels out of our control, rather than unintentionally making it a harmful vessel of our frustrations.

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The Vital Role of Pediatric EDs in Child Abuse Detection

by Gina Lombardo, Healthcare Policy '24

Pediatric emergency departments across the globe play a vital role in detecting cases of child neglect and abuse. Each year, approximately 1 in 7 children in the United States experience some form of neglect or abuse at the hands of someone they know [1]. However, thousands of children suffer in silence as countless cases go unreported each year. Child abuse encompasses various forms of maltreatment, including physical, sexual, and emotional abuse, often accompanied by instances of neglect. It can have profound and long-lasting effects on children's physical and emotional well-being, making early detection crucial to mitigate harm. Pediatric emergency medicine practitioners are uniquely positioned to recognize signs of abuse and intervene effectively to ensure the safety and well-being of their patients.

Pediatric emergency departments are often the first point of care a child victim comes into contact with when entering the healthcare system. For this reason, nurses and doctors are trained to recognize signs of child abuse and neglect to flag down high-risk patients before it's too late. One of the largest and nationally ranked pediatric acute care hospitals, Nationwide Children's in Columbus, OH, says that there are both subtle and overt signs to look out for when evaluating each child for neglect or abuse [2]. Oftentimes, child victims have trouble maintaining eye contact with their providers during visits, in addition to displaying extreme emotional behaviors or a complete lack thereof. Sudden changes in behavior are also telling, as children will become more tense or fearful with their parents than without. On a physical level, they may appear malnourished and have noticeable bruising or untreated prior injuries — both of which can later stunt growth and development. Often, victims continue to suffer even after they escape their abusers, as children who experience neglect or abuse have statistically lower outcomes as well [3]. According to the American Society of Positive Care for Children, 30% of abused and neglected children will later abuse their own children, failing to break the horrific cycle. In addition to this, they are more likely to engage in sexual risk-taking behaviors, which results in 25% of abused children becoming parents when they are just teens [4]. Overall, the outcomes for children who survive neglect and abuse are daunting, but they shed light on the importance of healthcare providers who double as protectors. Not only do they physically care for their patients, but they play a huge role in mitigating any future harm by catching cases early and often, leading to better outcomes overall.

However, with great responsibility comes great pressure. Doctors admittedly struggle having to watch out for signs of abuse but recognize how important it is to detect them as early as possible. Nkeiruka Orajiaka, a board-certified pediatric emergency medicine doctor, details that this [observing for signs of abuse] is the hardest, yet most rewarding aspect of her career. Her expertise in pediatric medicine, and other specialists alike, allow her to conduct thorough medical evaluations to differentiate between accidental injuries and those caused by abuse. Dr. Orajiaka asserts that "dealing with children who have been sexually or physically abused before they can even read or write makes her wish she could erase her memory", but bringing them justice is what keeps her going. However, she highlights how prevalent cases of neglect and abuse have become, especially since the COVID-19 pandemic. "Evaluating 3 to 4 cases of neglect or abuse per day has become the norm" stated Dr. Orajiaka, which is a major public health concern for children across the country. She urges that there is a continued need to train pediatric healthcare professionals in screening for neglect and abuse as the issue continues to persist [5].

Artwork by Flavia Scott

Pediatric emergency medicine providers play a critical role in recognizing signs of child abuse and advocating for the welfare of vulnerable children. Their training, compassion, and commitment to child wellbeing are essential in addressing the complex needs of victims to set them on a path of recovery and healing. Pediatric EDs act as the eyes and ears of children in danger, which gives them a voice to receive the care and protection they deserve.

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Cutting and Correcting: Curing Brittle Bones With CRISPR-Cas9

by Lauren Wilkes, Biological Sciences '27

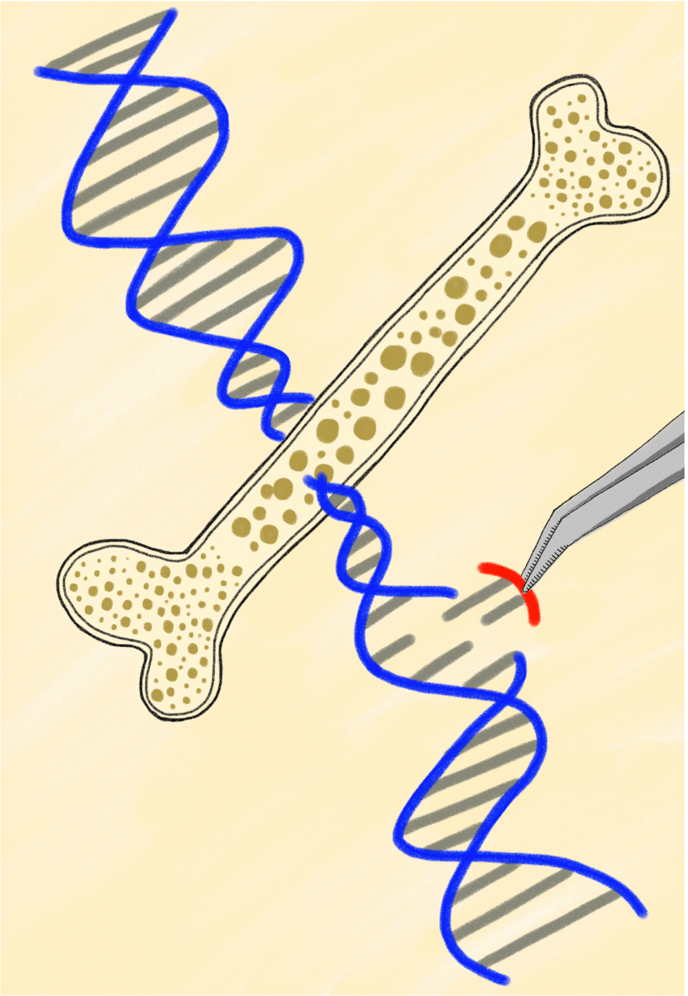
Brittle Bones Disease, as its name suggests, may seem like an arthritis-related problem easily resolved with some physical therapy or painkillers. However, Brittle Bones Disease, scientifically referred to as ***Osteogenesis imperfecta*** (OI), is generally classified as an incurable genetic disease. Despite innovations in biomedical technology, one may wonder why genetic cures on the cellular level for Brittle Bones Disease have not been developed yet. A quick Google search, however, will reveal that active research is being conducted to explore the potential for using CRISPR, a gene-editing technology, to help "fix" the mutated gene causing Brittle Bones Disease.

Osteogenesis imperfecta is a genetic disease in which bones are more susceptible to breaking easily [1]. The disease can result in numerous complications, from minimal hairline fractures to detrimental breakages [1]. In unaffected individuals, normal bone strength comes from and is maintained via collagen; the production of which is controlled by a specific gene, called COL1A1. Brittle Bones Disease has been traced back to a genetic mutation in this gene in humans, leading to either an absence of or impaired collagen production. The mutation prevents COL1A1 from producing the same amount of collagen as is necessary to maintain high bone mineral density to prevent easy breakages [2]. The lack of collagen production, therefore, leads to weaker bones that are more susceptible to fractures. Because this has been identified as a genetic mutation, active research is underway to investigate the potential for using the gene-editing technology CRISPR-Cas9 to edit and splice out the mutated genome, thereby correcting it [3].

CRISPR, short for "Clustered Regularly Interspaced Short Palindromic Repeats," is a gene editing technology that has proven useful in recent years in correcting errors in genetic sequences [4]. The functionality of the CRISPR complex works in stages including the recognition, cleavage, and repairing stages, respectively. CRISPR uses an enzyme, Cas9, which is the driving force behind the ability for CRISPR to actually cut, splice, and correct these erroneous sequences. Cas9 is a protein that has the ability to recognize a specific binding side on a DNA sequence [5]. Upon binding to that sequence, the enzyme executes the cleavage stage by splicing out a piece of the genome. The repair stage is then executed through Cas9 either inserting a new piece of a sequence, or repairing the broken sequence to complete the newly edited DNA strand [6]. CRISPR-Cas9 has opened up a myriad of opportunities for curing previously incurable genetic diseases, particularly due to the fact that it has demonstrated its efficacy in mammalian organisms [6]. In the recent past, in May 2017, for instance, researchers at Temple University successfully demonstrated that CRISPR could be utilized to excise the genome of the HIV-1 virus to completely shut down the replication of the HIV virus in animals [6]. In this way, the efficacy of CRISPR has been demonstrated on occasions in the recent past and thus provides us with insight into its efficacy in humans. However, one of the reasons for research regarding CRISPR's application for treating genetic diseases like OI is the need to confirm its efficacy and safety for use on humans.

In the case of correcting the COL1A1 mutation in OI patients, the pathway would proceed as follows: since the COL1A1 collagen-producing gene is dominant, it will have a higher likelihood of being passed on from generation to generation. Furthermore, the COL1A1 mutation that causes ***Osteogenesis imperfecta*** presents itself as a switch to a different protein that causes abnormal collagen to be distributed to bones, reducing bone strength. To correct this, CRISPR-Cas9 will cut and delete the mutated gene, changing the frame of the COL1A1 sequence to produce the normal protein which allows for normal collagen production to resume [7].

Given that COL1A1 is a dominant gene, this procedure would have especially vital implications for ***Osteogenesis Imperfecta*** patients in that the *corrected* gene would be the one most likely passed on to the next generation due to its dominance. If, ultimately, after conducting research to verify the safety to the surrounding cellular environment in addition to the targeted cells, using CRISPR-Cas9 as a curative measure is determined to be safe and effective, CRISPR-edited and corrected COL1A1



Artwork by Michelle Choi

would be placed in pluripotent stem cells, or cells that “have the ability to undergo self-renewal and to give rise to all cells of the tissues of the body,” to then be given to Brittle Bones Disease patients [8].

CRISPR falls into that vast and highly debated category of gene editing, making CRISPR a novel yet controversial technique due to bioethical concerns surrounding our lack of knowledge on its effects in humans, as it has been mainly researched in model mammalian organisms. However, when applicable and efficacious for curing the incurable, it is more than worth a shot [9].

Although it is estimated that only around one in every 10,000 individuals is affected by Brittle Bones Disease, its incurable and more importantly, hereditary nature makes it more than worth furthering our exploration of this genetics-based cure [10]. Individuals affected by Osteogenesis imperfecta would have a chance now to re-engineer the problem that is inevitably already engineered against them and their bodies. Thus, not only would CRISPR play an instrumental role in curing OI for the currently affected patients, but the many future generations that would have been affected.

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Buying Babies Abroad: New Era of Reproductive Methods

by Samuel Notch, Human Biology, Health, and Society '26

The emergence of life can be seen as a beautiful thing. Watching what begins as a simple cell develop into a walking and breathing person is a priceless experience cherished by many people globally. Despite pregnancy being a seemingly easy or accidental undertaking for some, many struggle for years when trying to start their own family. For certain individuals, infertility hinders the dream of having a child. For non-heterosexual couples, anatomical barriers render pregnancy impossible [1].

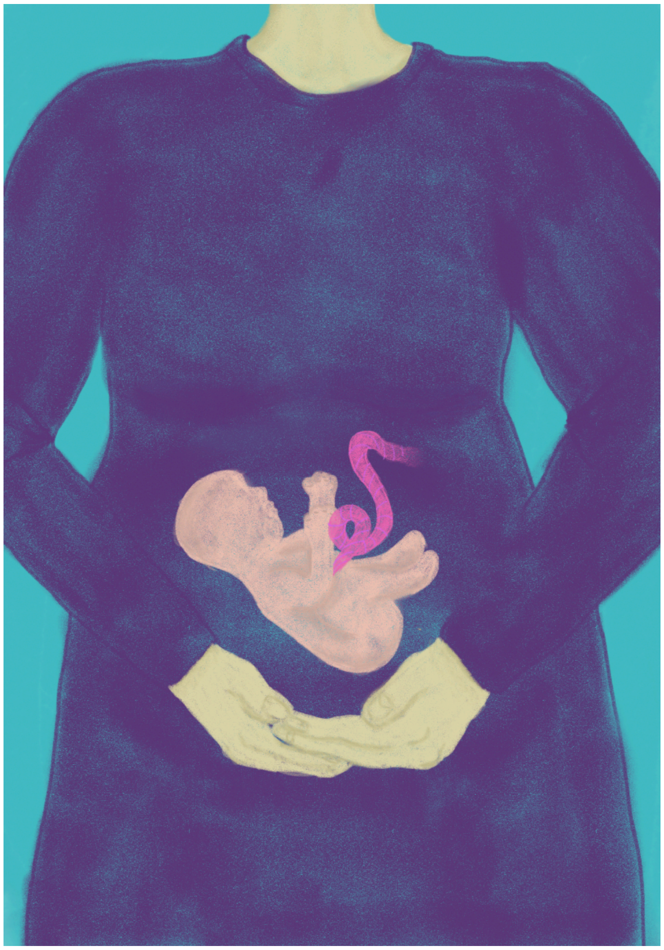
To address this issue, the practice of surrogacy was founded hundreds of years ago, originally for women who were unable to bear children for their husbands. Today, surrogate motherhood has evolved into a multimillion-dollar industry, connecting people from all over the world [2]. With changing social norms that have destigmatized non-traditional families, and higher rates of infertility due to changing biological factors, surrogates are in higher demand than ever before [3]. The transformation of this practice into an international business provides an amazing opportunity for hopeful parents, but raises ethical concerns.

Within America, couples often spend hundreds of thousands of dollars for their surrogate. Since this budget is unattainable for many people, an international market has been made, enabling Americans to find surrogates abroad who are willing to have their child in exchange for money. Areas that are particularly targeted by the industry, referred to as "reprohubs," include countries such as India, Mexico, Thailand, and Ukraine [4]. Reprohubs can be beneficial; bringing surrogacy to a community also introduces the need for pharmaceuticals, new technologies, and healthcare workers. This improves the well-being of everyone within these communities and better connects them to the rest of the world. However, reprohubs are also extremely controversial due to their exploitation of surrogates.

Despite the potential economic and health advantages, the practice of surrogacy frequently takes advantage of women within reprohubs. Women from lower socioeconomic backgrounds often become targeted and coerced into surrogacy arrangements as a means of self-sustenance. They are not provided with sufficient information from American couples to make the fully voluntary choice to enter surrogacy agreements, and thereby lack knowledge of the medical and legal consequences of the contract. This allows the surrogates to be underpaid, leading to vast disparities between the payments that surrogates receive in America relative to developing countries. In India, for example, surrogates receive between $2,000 and $10,000 for their services, compared to $20,000 to $30,000 in America [5]. Though this amount of money is small, it is necessary if a woman desires to leave the reprohub, which causes them to choose surrogate motherhood.

In a small number of cases, working as a surrogate provides women with the financial means to pursue higher education. However, in the majority of cases, surrogates receive minimal amounts of reimbursement to pay off existing debts. They are provided with costs to cover their food, healthcare, and travel for the benefit of the child, but are left with little after the process. International surrogates are thereby influenced to continue with surrogacy, ultimately living in reprohubs in a cycle poverty. So, what should be done to prevent this exploitation, while keeping or enhancing the benefits that some reprohubs reap? The answer lies in the way that the market is structured. Currently, the market for surrogates is private, meaning that there are no price ceilings or price floors. Due to the lack of price ceilings, Americans are unable to afford surrogates domestically and defer to foreign reprohubs for surrogates [6]. Additionally, the lack of price floors in reprohubs permits surrogacy companies to underpay women and reinforces traditional societal roles within these regions. Through government regulation and international negotiations to set price ceilings and price floors, reprohubs may be improved to allow women to benefit from working as surrogates by earning fair salaries.

Ultimately, it is important to educate people globally about the issue of surrogacy and to begin straying away from the current private market. While a private market fosters efficiency when trading foods and products, it is different when human lives and reproductive freedoms are at stake. Ensuring that both the surrogate and the parents are treated fairly is necessary so that people can continue



Artwork by Michelle Choi

benefiting from the astounding scientific advances that have made it possible. This can be done by mandating that staff working abroad have strong communication skills, and maximising the understanding of what surrogacy requires for both sides of the party. By working together with national and international governments to design these regulations, this can be achieved.

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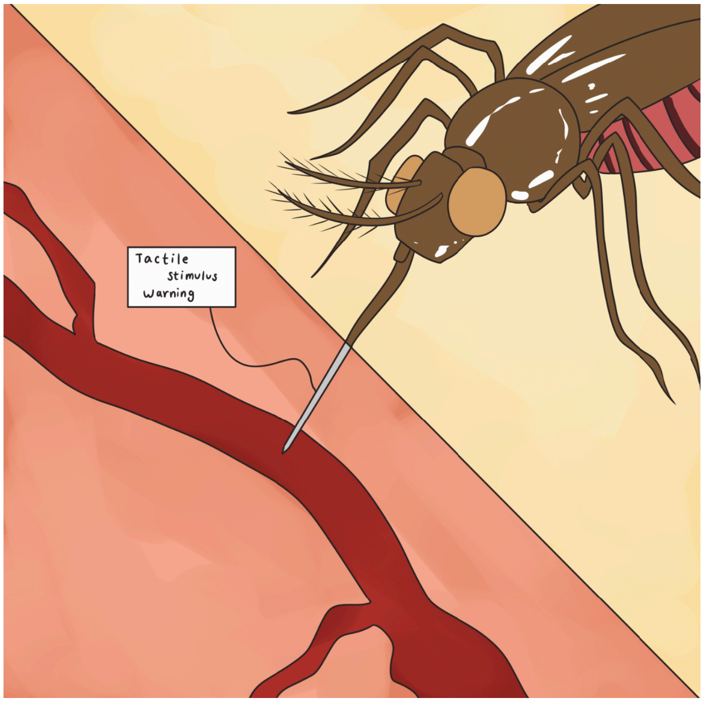
Following Nature's Example in Neurotechnology

by Bhavya Anoop, Chemical Engineering '27



Artwork by Sabrina Chen

Biomimicry, or the emulation of models in nature, has recently become a cornerstone of biomedical research within neurotechnology. Biomimicry has a few different levels, varying from mimicking natural forms and functions to natural processes or systems, the former being the most common approach in medical research [1]. Numerous novel and innovative solutions have been developed in the field by studying and utilizing natural patterns found in the world.

One fundamental principle of nature, for instance, is Murray's law, which, in biophysical fluid dynamics, details the relationship between the radii of parent and daughter vessels. In context, the law describes the decreasing sizes of pores across different scales, which researchers recently analyzed in plant systems to guide studies in the performance of lithium-ion battery electrodes, which are essential to many neural devices and implants [2]. Using this law, researchers could also develop artificial nerves with pores fit for neuroprosthetics. This is just one example of how a basic underlying principle of nature has been harnessed by scientists to improve the performance of many neurological devices.

Beyond just serving as broad inspiration, biomimicry can provide precise design blueprints and ideas for engineers. This close mimicking of natural components has been seen prominently in neural electrodes, which are small devices that can detect electrical signals produced by neurons once inserted into the brain. This allows scientists to interface the brain more efficiently while also allowing for studies into neurological disorders, such as epilepsy and Alzheimer's disease. Roberto Portillo-Lara in the Department of Bioengineering at Imperial College London notes that this adaptive biomimetic approach can bridge the gap between synthetic and biological systems, allowing for better implantable technologies [3].

A recent issue in this realm was the inability of such neural probes to distinguish between different tissue types during implantation in surgery. To address this deficiency, researchers began studying the blood-sucking process of mosquitos, as well as the structure of their mouthparts. When hunting blood, mosquitoes face similar issues in terms of uneven surface terrain and thick surface tissue. To combat this, their mothparts overtime evolved to be flexible and multilayered. These qualities were then mimicked in a neuroprobe system with high-sensitivity sensors and a flexible electrode array [4]. Additionally, based on the lower lip structure of mosquitos, a probe track was designed to stabilize implantation [5]. Not only does this biomimetic solve the issue of minimally invasive implantation, but it also inspires similar innovations in the future.

Another unexpected source of inspiration in biomedical engineering has recently been North American porcupines, which are known for their quills. These quills feature microscopic deployable barbs that enable easy, lighter penetration yet high tissue adhesion [6]. These porcupine quills are part of a large family of thin-walled conical shell structures found in nature, including plant stems, feather shafts, and hedgehog spines [7]. These structures, because of their unique combination of compression and bending, have been said to have great potential in many biomedical applications, allowing for lighter and more mechanically efficient innovations. One proposed mechanism following this structure was in the drug delivery field: an intestinal microneedle robot that would absorb intestinal fluids and inject drugs into the intestinal wall [8]. Adapting this technique to implanting electrodes and other devices in the brain is ongoing [6].

Following the structures and patterns in nature offers much more room for further inspiration and innovation. Whether analyzing the flexibility of gecko feet, stingers in wasps or simply studying water flow patterns, the answers to countless healthcare issues have been readily available since the beginning of time. Collaboration should occur not only between engineers, medical professionals, and scientists but also with nature itself.

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Grandma's Formula: Alleviating Menstrual Pain

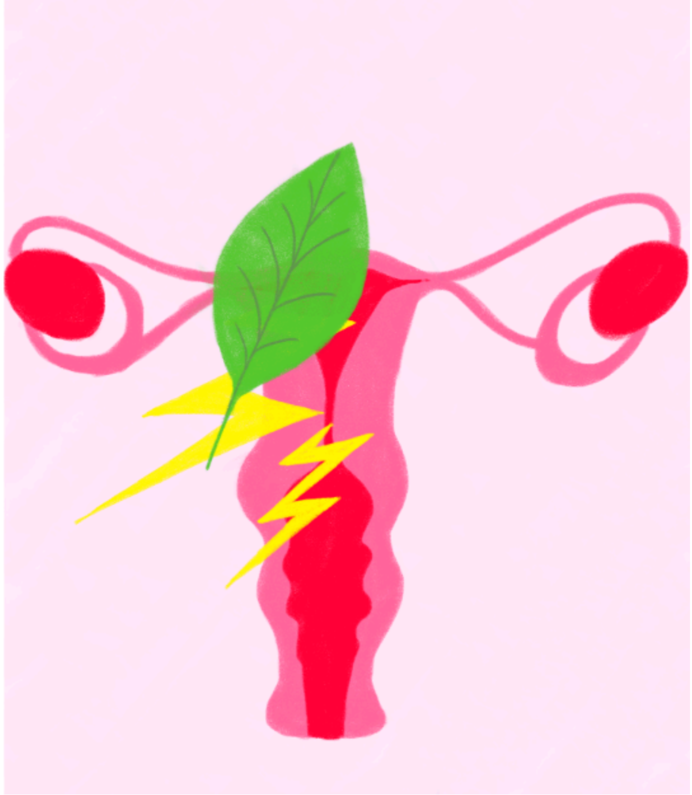
By Kiran Ganga, Human Biology, Health, and Society '24

In the journey of managing period cramps and primary dysmenorrhea (PD), many women have turned to the wisdom passed down through generations within their families. While modern medicine offers solutions, there's a timeless allure to the natural remedies cherished by our ancestors. Passed down through generations, these recipes carry not just ingredients but also stories and traditions.

Primary dysmenorrhea (PD) refers to pelvic discomfort arising from the uterus during menstruation that lacks discernible cause. It stands as the most prevalent gynecologic issue among women of reproductive age [1]. Despite its widespread occurrence, PD often remains undertreated [2]. The cause of this discomfort lies in the overproduction of prostaglandins, leading to the heightened levels that result in intense uterine contractions. Moreover, the process of menstruation involves shedding the uterine lining, which can lead to a decrease in oxygen levels in the surrounding tissues. As a result, cells may switch to anaerobic metabolism, producing byproducts such as lactate and hydrogen ions [3]. These anaerobic metabolites can accumulate, contributing to tissue irritation and inflammation within the uterus. Additionally, the increased uterine contractions during menstruation can cause temporary reductions in blood flow, resulting in uterine ischemia—a condition where the uterine tissues experience insufficient oxygen supply. Both the presence of anaerobic metabolites and uterine ischemia can sensitize pain receptors, known as nociceptors, making them more responsive to stimuli [3]. Consequently, this heightened sensitivity of pain receptors exacerbates the perception of menstrual cramps, amplifying the discomfort experienced during menstruation. Various factors, such as high-stress levels, familial predisposition, age, parity, and oral contraceptive usage, can influence the risk of PD [4]. The connection between PD and other modifiable social factors like smoking, substance use, and dietary habits necessitates continued exploration.

Management of PD primarily revolves around mitigating pain through pharmacological and lifestyle interventions. Non-steroidal anti-inflammatory drugs (NSAIDs) stand as the frontline treatment, functioning by inhibiting cyclooxygenase (COX) to diminish prostaglandin synthesis and inflammation [5]. However, NSAIDs may yield adverse effects such as nausea, vomiting, hepatotoxicity, ulcers, and fluid retention, which warrants consideration. Some individuals use hormonal contraceptives, which impede ovulation and endometrial thickening to halt prostaglandin production and menstrual pain [3,5]. However, this also presents concerns; one survey found that 40% of women turned down birth control due to side effects such as weight gain, irregular bleeding, mood swings, and cramping [6]. Non-pharmacological interventions, such as heating pads, topical creams, and massage therapies, offer alternative avenues for relief, but they often require menstruating to disrupt their daily lives.

For many women, including myself, my grandmother and aunts' recipe for cramp relief has been a comforting ritual during times of menstrual discomfort. The mixture of roasted flour, dates, dry fruits, nuts, and ghee embodies the holistic approach to wellness that resonates deeply with our cultural heritage. We would take one a day and our cramps would significantly decrease. This is similarly found in Iranian cuisine, and Aunt Flo's Kitchen, a startup at Cornell, sells Iranian period snacks that aim to alleviate period pain. While the recipe is a traditional recipe from founder Armita Jamshidi's grandmother, the ingredients –from tahini to cinnamon to cardamom to dates and much more –have been scientifically proven to have analgesic and antispasmodic impacts. The product comes in three flavors: rose, pistachio, and sesame, and is currently sold at multiple locations around Ithaca [7].



Artwork by Michelle Choi

While my and Armita's grandmothers' recipes remain a beloved tradition, many women have also embraced modern adaptations of natural remedies for period cramps. Herbal teas infused with ingredients like ginger, chamomile, or raspberry leaf offer soothing relief; they have often been used in many cultures to treat chronic pain generally. One study finds that rose tea in female adolescents causes a perceived decrease in pain, distress, and anxiety [8]. This can likely be attributed to an increase in glycine, known for its ability to calm muscle spasms, as well as the general facilitation of fatigue relief and the promotion of increased energy levels [9]. Additionally, essential oils like lavender or peppermint can be applied topically for targeted comfort [10]. Many of these oils are abundant with terpenes shown to have analgesic effects [11]. Additionally, mind-body practices such as yoga and meditation continue to gain popularity for their ability to ease menstrual discomfort by promoting relaxation and reducing stress [8]. Positive affect, self-compassion, inhibition of the posterior hypothalamus, and reduced salivary cortisol levels were all demonstrated to act as mediators in the relationship between yoga and stress alleviation [12].

Beyond their therapeutic benefits, natural remedies for period cramps foster a sense of connection—to our bodies, our heritage, and the natural world. By honoring the wisdom passed down through our families, we not only find relief from physical discomfort but also reaffirm our cultural identities and strengthen familial bonds. In sharing these remedies with future generations, we ensure that the legacy of healing endures, enriching our lives in ways that extend far beyond mere symptom relief.

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Navigating the Ethical Landscape of Artificial Womb Technology

By Lexi Waite, Biology '26

Imagine being a mother in a quiet hospital room, when the doctor breaks the terrifying news: "Your baby is going to be born prematurely". Sadly, this is the fate for many parents with 1 in 10 babies being born preterm in the United States. In 2021, 14.8% of infant deaths were due to premature births, but with advancing medicine this can be changed [1]. Newly developed Artificial womb technology (AWT) allows babies that were born prematurely to be placed into a device filled with artificial amniotic fluid creating an environment for further gestation. While this technology has multiple potential benefits, ethical and moral questions need to be considered before AWT human trials.

When evaluating the ethics of AWT, it is essential to understand its potential risks and benefits.. While an overarching benefit would be to allow for further development for premature babies, AWT also allows the fetus to engage in "social interaction" and "experience the benefits of connection with other human beings" [2]. Though the child itself will be placed in the artificial womb, it will be able to form connections with those around it, continuing the bonds that were developed in utero. This could be beneficial as these bonds can allow for the child to connect with its mother and foster a sense of safety even out of the womb.

Although there are benefits for the child and parents, there are also risks that could harm the fetus while in the artificial womb. The artificial womb requires an "anticoagulant coating t[hat] mitigate[s] the high risk of blood clots." [3]. While these preventative measures are beneficial, when using AWT there is still a significant risk of blood clots for the fetus. In addition to a high risk of clotting, it was also found in previous trials with fetal lambs there was the potential for sepsis which required screening for infections [3]. Infection could pose a serious complication that needs to be taken into account when understanding the potential risks that could come to a fetus that is being placed in the artificial womb. Before the implementation of AWT, further research needs to be conducted to understand the likelihood of these harms and how successful trials could be before experimenting with human babies. Physicians could also play a vital role in using their expertise to assess the safety of the new technology before human trials. Along with these physical risks and benefits, additional ethical questions that need to be answered.

One ethical question that remains unanswered focuses on who has the right to determine if a fetus should be placed in an artificial womb. The predominant opinion suggests that the mother should determine the outcome: "her will should be respected regardless of whether the trial could be beneficial for the fetus" [4]. This idea is supported and expanded on with the idea that using AWT is initially the mothers decision, but "once the fetonate is being supported by AWT, decision making would become a shared parental responsibility" [5]. While consent from the mother is crucial, there are alternative viewpoints that suggest "informed consent of both parents must be obtained," but if the use of AWT were to also benefit the mother, then "consent of only the pregnant person is required" [6]. It is thought that if a mother were at severe risk of continuing a pregnancy, her consent may be the only one needed to begin using AWT. Certainly, there will be differing viewpoints on this topic, but the ethics of consent is vital to decide prior to the birth of a premature fetus.

Artwork by Angela Yuan

The question of consent needs to be discussed further when evaluating who can give informed consent while ensuring parents understand the potential risks. Informed consent regarding AWT should require the parents to be "counseled about the options regarding not enrolling in the study and the potential harms and benefits of enrolling" [6]. This true sense of consent may be difficult to obtain as the "painful decisions and the details of the process will be especially hard for parents when the time is limited" making them feel "pressured by a sense of emergency" [6]. The circumstances under which parents would have to decide to utilize AWT would not allow for parents to rationally think through and understand all consequences making informed consent nearly impossible. One way to combat this barrier would be for physicians to identify potential premature pregnancies and facilitate these conversations about

AWT before this heightened emotional state. This role could be crucial as physicians can guide and support parents through the risks and benefits of AWT and provide information as to what the journey using AWT could look like. This difficulty, along with the other ethical considerations, demonstrates the multiple conversations that need to be had before using AWT on humans. While this technology can change neonatal medicine, it is crucial for all parties, patients and physicians, to understand the dynamics and limitations of working with AWT.

In conclusion, the emergence of artificial womb technology has begun to raise ethical considerations surrounding informed consent and the potential benefits and risks to the fetus. As this technology continues into human trials it is important for parents to understand the limitations that AWT could still have. Looking forward, it is important for physicians to understand their role such as informing parents and advocating for the safety of AWT before its use on human fetuses.

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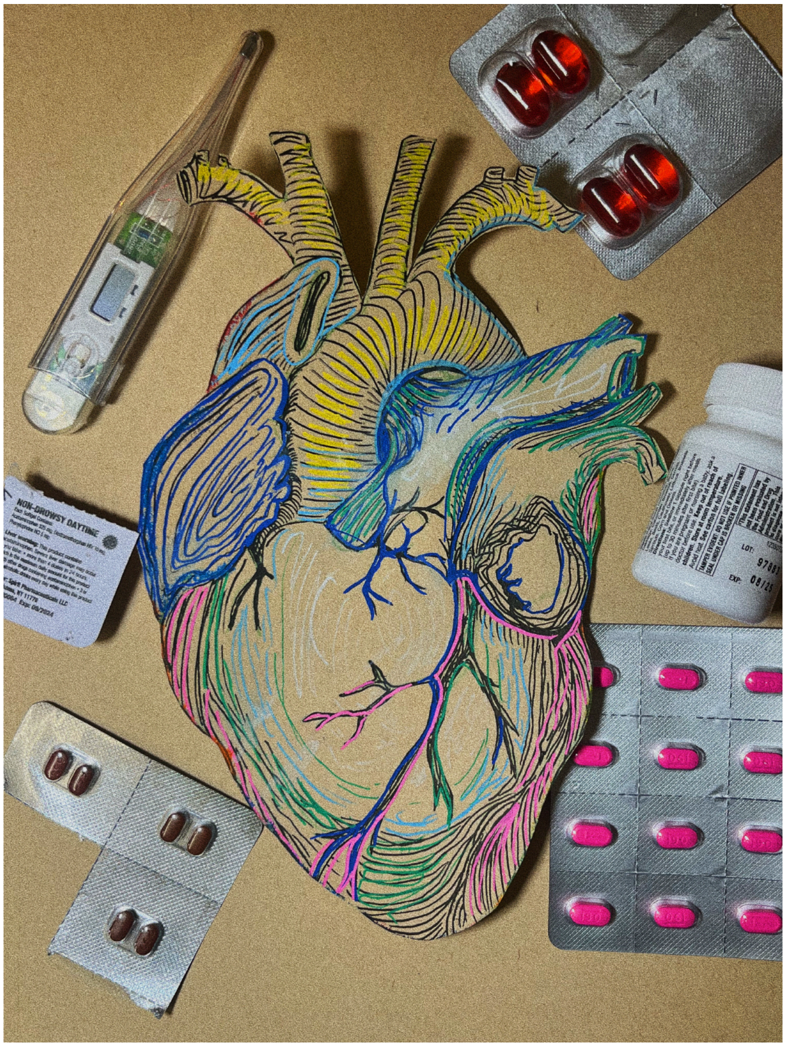
The Art of Biomedicine

by Laurel Whidden, Global and Public Health Sciences '26



Artwork by Laurel Whidden

Recent studies have shown that the dynamic intersection of art and biomedicine has the foundation to redefine healing. The traditional biomedical model emphasizes disease-specific causes of death, encompassing experimental, clinical, and epidemiological research [1]. Current investigations and scientific inquiry have called for the possibility of the humanities discipline to be integrated within biomedical research in the form of art. Derived from this educational shift, a new framework has come to light: arts-based research (ABR).

ABR is a type of qualitative research that utilizes participatory arts, such as visual, auditory, or performance, as a way to obtain additional information that may have been inaccessible otherwise, to understand and represent human action and experience [2]. There is growing evidence that participative arts can have a positive impact on health, as art-based interventions promoting well-being play an important role in recovery from mental illnesses such as anxiety disorders, depression, neurodevelopmental disorders, and PTSD [3]. To illustrate, the most widely used art therapy practice for post-traumatic stress disorder is the creation of a visual trauma narrative. The narrative can facilitate new insight, as well as help patients reconstruct their concept of self, others, and the world, and is hypothesized to reduce emotional numbing and avoidance [4]. Other arts-based research practices have employed art journaling as a catalyst for alleviating clinical depression, where the product (the participant's art journal) is used to facilitate conversations around mental illness [2]. Researchers from various disciplines employ ABR practices as a collection of methodological tools throughout all stages of research, encompassing data generation, analysis, interpretation, and representation [2]. These methods involve a holistic and engaged integration of theory and practice, specifically in healthcare settings. Engaging in the visual arts serves as a form of non-verbal communication, often helping patients organize and comprehend complex emotions [3]. By facilitating catharsis, artwork not only serves as an outlet but also provides a means to monitor an individual's emotional and developmental progress [5,6]. The arts can be profoundly captivating, primarily because they evoke emotions and have the potential to prompt patients to perceive or think differently [7].

The arts can also be harnessed to teach, fostering a depth of understanding that goes beyond "information" [2]. The emerging field of neuroaesthetics considers how our brains make sense of visual art, as Nobel laureate Eric Kandel (2012) explains that visual art activates many distinct and at times conflicting emotional signals in the brain, which in turn causes deep memories [8]. The use of visual art forms such as paintings and film in medical school curricula has been shown to build visual literacy. Broadly referred to as the "medical humanities", fine art can enhance the skills of medical professionals in training, such as the role of visual arts in the formation of a neurosurgeon [9]. Research has indicated that drawing abilities and stereovision, imagery, and thinking three-dimensionally are crucial in neurosurgery, and the surgical profession generally. This indicates that the arts influence our knowledge-building and transmission practices in the research communities and allow the ability to "see" and produce knowledge in different shapes [2]. The Association of American Medical Colleges (AAMC) advocates for integrating arts and humanities education into medical training to enhance physician skills. Embedding visual arts-based training in the curriculum has demonstrated improvements in observational skills, empathy, introspection, and reduced burnout among medical students. Furthermore, physician empathy serves as a predictor of patient-perceived treatment outcomes [10].

Arts-based interventions include not only visual forms of art but also auditory forms, as research has documented music's efficacy in notably boosting salivary immunoglobulin A (IgA), an antibody that is the first line in the defense against bacterial and viral infections [11]. Studies have revealed that IgA is not only a reliable indicator of the functional status of the entire mucosal immune system but is particularly responsive to music, increasing following exposure to a range of musical genres including both relaxing and stimulating music [12].

Of all the arts disciplines, the performing arts such as drama and theater have been remarkably effective in knowledge building and have been used successfully in medical education. This has been seen in Dwight Conquergood's arts-based public health intervention at a Hmong refugee camp in Ban Vinai, where he helped design and direct a health education campaign based on native beliefs and values and communicated in culturally appropriate forms. Alongside community leaders, he started a refugee performance company that produces skits and scenarios drawing on Hmong folklore and traditional communicative forms, such as proverbs, storytelling, and folk singing, to develop critical awareness about the health problems in Ban Vinai. This intervention embodied not only preventative public health education, but a holistic, cultural, and humanities-based transmission of information [13]. Similarly, theater-based interventions in the U.S. have been used as a viable prevention strategy for changing sexual health knowledge, attitudes, and behaviors related to HIV prevention [14].

As our understanding of human cognition deepens, it becomes increasingly evident that narratives, stories, and the arts can significantly contribute to the teaching of diverse subjects and connect with individuals on deeper levels. In another sense, art can be a healing process, as seen in the recent integration of arts in healthcare. As Patricia Leavy, PhD., a best-selling novelist and internationally recognized leader in arts-based research explained, "[the arts] can connect us with those who are similar and dissimilar, open up new ways of seeing and experiencing, and illuminate that which otherwise remains in darkness."

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Modern-Day Xenotransplantation: A Potentially Revolutionary Medical Practice

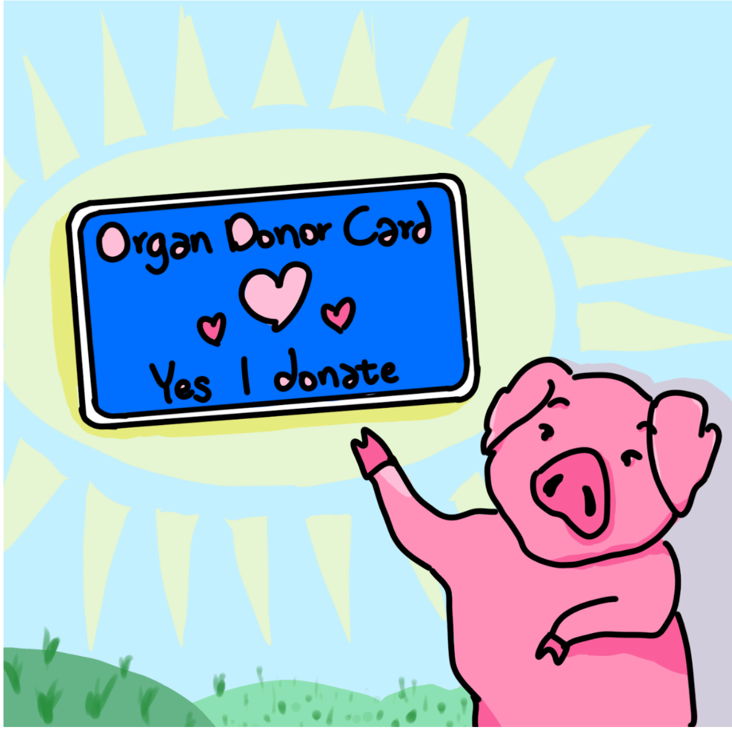
by Emma Robinson, Biological Sciences and English '27

Animal-to-human organ transplantation, otherwise known as xenotransplantation, could revolutionize transplant medicine and save millions of lives. In the 17th and 18th centuries, blood transfusions from various organisms into humans were attempted as a method of blood replacement. In the 19th century, skin grafts, especially using frog skin, were utilized experimentally. In the 1900s, chimpanzee kidney and heart transplants were also attempted without successful outcomes [1]. Current transplant medicine focuses on transplantation of organs grown in pigs as chimpanzees have become endangered. Pig organs are a promising option as they are quite similar to those of humans and they are easy to genetically modify [2].

The experimental use of pig tissues in human medicine has been ongoing for over half a century. Pig tissue has been used to replace heart valves since the 1960s. They are often a great option for older patients who are at lower risk for the structural valve deterioration associated with long-term use. This structural valve deterioration is likely due to immune rejection of the tissue [3]. Skin grafts from pigs are also currently used on a short term basis on burn victims while they wait for the availability of other grafts, but are not long term options because of immune rejection [4].

The current focus of xenotransplantation is the transplant of whole organs. Before transplanting solid pig organs directly into humans, transplant trials were performed in non-human primates. [5]. There were several pig-derived kidney transplants into chimpanzees and baboons that proved to be successful for even up to a year. However, the differing immune systems of non-human primates mean these transplants offer limited insights into xenotransplantation success in humans[5]. In 2022, three pig-to-human kidney transplants were completed. These surgeries were performed on brain-dead patients with family consent for the benefit of medical science, not life extension, resulting in short-term experiments. Two of the experiments lasted 54 hours and the third lasted 77 hours. In all three cases, the kidneys functioned properly for the entire planned experiment time [5]. However, this was not enough time to tell how the transplants would fare long-term. Another kidney xenotransplant was performed on a brain-dead patient in 2023, lasting a total of 61 days. This team was able to better understand the immune response to the kidney and did note rejection that required increasing immunosuppression medication. This observation was completed on September 13, 2023 and the doctors continue to evaluate their findings [6].

Finally, several transplants have been completed in patients in attempts to extend life. Within the past two years, two heart transplants from pigs to humans have had limited success. The first recipient, a man named David Bennet Sr., was able to live two months with the transplanted heart. Doctors gained new insights from this transplantation despite Bennet going into cardiac failure at the end of the two months. Bennet was never a candidate for a traditional transplant because he was in end stage heart failure along with other health complications [7]. The main issue the team found in this xenotransplantation was immune rejection. This was likely worsened by Mr. Bennet's immunocompromised state before surgery which prevented the use of proper anti-rejection measures. The team found that an antibody-containing drug administered to the patient after surgery might have contributed to the aggressive immune response [7]. There is also some evidence that a virus called porcine cytomegalovirus may have laid dormant and later impacted the health of the transplanted organ [8]. However, it was an important finding that the organ was not initially rejected during the first seven weeks after the transplant [7]. The second recipient was able to live for six weeks with a xenotransplanted heart. This patient was also in end-stage heart failure at the time of transplant. The final paper has not been published on this trial, but earlier articles indicate that the donor pig had undergone 10 gene mutations to alleviate negative immune responses [9]. The most recent development in the field of xenotransplantation was a pig kidney to viable 62-year-old human recipient in renal failure on March 16, 2024. The pig underwent a record total of 69 genomic edits to decrease the risk of rejection by the patient. Current updates state the transplant has been successful thus far [10].



Artwork by Joan Rong

The moderate success of xenotransplantation opens up a new life saving treatment for patients in need of organ replacement. However, there are technological and ethical challenges that still need to be addressed. These organs must be grown in animals that are genetically modified for this purpose. This is a point of contention amongst animal rights activists as animals being used in any experiments or tests in medicine are subject to some level of harm or discomfort. The patients who are undergoing these early xenotransplantations are also either brain-dead or have no other treatment options. While family or patient approval is obtained, the question remains whether it is ethical to put humans through procedures that have minimal chance of a beneficial outcome to the patients themselves.

There are still major issues with immune rejection of these organs. Although these procedures are initially successful in the few recent xenotransplantations, they have not yet proven to be viable long-term solutions. However, if the immune barriers can be overcome, millions of lives could be saved. Instead of waiting for years on a transplant list, patients could receive life-saving xenotransplants quickly and avoid the irreversible impacts of long-term organ failure.

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The Transformative Role of Artificial Intelligence in Radiation Oncology

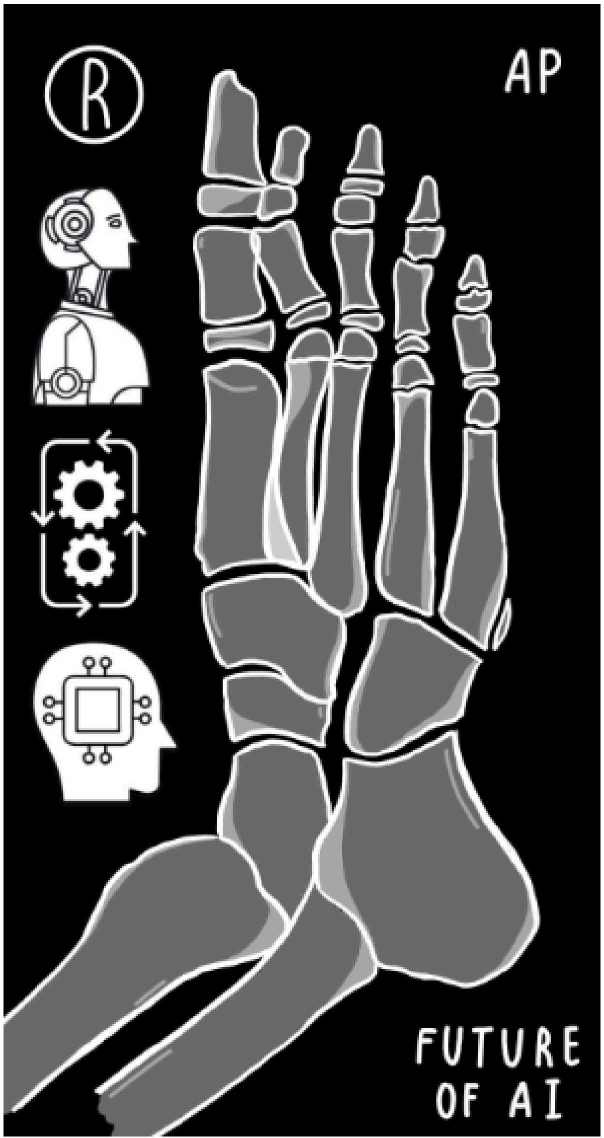
by Tanisha Pallerla, GPHS '27

For a long time, radiation oncology has solely relied on the human eye to capture small changes in a patient's condition, but this practice is changing with the emergence of artificial intelligence (AI). While the human eye is effective at detecting these changes, AI is able to capture them to a degree that is beyond the scope of the human eye's ability. When radiologists analyze a patient's medical images, they use qualitative methods to diagnose patients and track changes in their condition. Due to the tedious nature of this task, it takes time for radiologists to return the results of a scan to a patient. However, AI turns medical image analysis into a quantitative task by using massive amounts of data to create incredible algorithms that can distinguish between health and disease, returning its results almost immediately [1]. This feature of AI makes it a powerful tool in improving the treatment and care of cancer patients.

One widely used type of AI that analyzes medical images in oncology is deep learning, which is a type of machine learning algorithm. Deep learning algorithms are trained by large sets of data, and due to the large quantity of data available online, these algorithms have become very advanced in their ability to replicate the human task of analyzing a cancer patient's medical images [2]. With the improved accuracy and efficiency of deep learning algorithms, radiation oncologists are able to closely monitor a patient's cancer progression. This includes the development of tumors and the spread of cancer cells. With the ability of deep learning algorithms to track even the tiniest changes in a patient's condition, oncologists are able to monitor how effective their treatments are and respond quickly [1].

The ability of AI to replicate this human task may seem too good to be true, and in some way it is. There are limitations to the extent and ability to which AI can contribute to a cancer patient's treatment plan. While deep learning algorithms are able to detect small changes in a patient's condition, they are not always 100% accurate, and they cannot actually make decisions that need to be made by trained radiation oncologists [3]. Deep learning algorithms are trained by data, and the amount and quality of data used to train these algorithms is important to consider [1]. The good news is that the implementation of AI models in clinical settings is regulated. Before an algorithm can be used in a clinical setting, it must undergo testing to ensure its accuracy and get FDA approval [1]. The degree to which it is regulated is an ongoing challenge in healthcare, but the work done by AI to analyze a patient's images will always be checked by a trained and certified physician [4]. Radiation oncologists need to verify the results produced by AI, and they are the ones who actually create and adapt their patient's treatment plan depending on the progression of the cancer as determined by the analysis of the patient's medical images.

While the impact AI has on improving cancer diagnosis and treatment depends on how advanced machine learning algorithms become in mimicking human intelligence, one thing is certain: no matter how advanced these algorithms get, they will never be able to replace the work that radiation oncologists do. AI analysis on cancer patients' images will always need to be checked by physicians to ensure there are no errors and to ensure no diagnostic information was missed [5]. Despite its limitations, AI is a powerful tool that enhances a radiation oncologist's ability to do their job, and will continue to advance and improve cancer diagnosis and treatment.



Artwork by Ngoc Truong

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Categories to Continuums: The Transdiagnostic Approach to Psychiatric Diagnosis

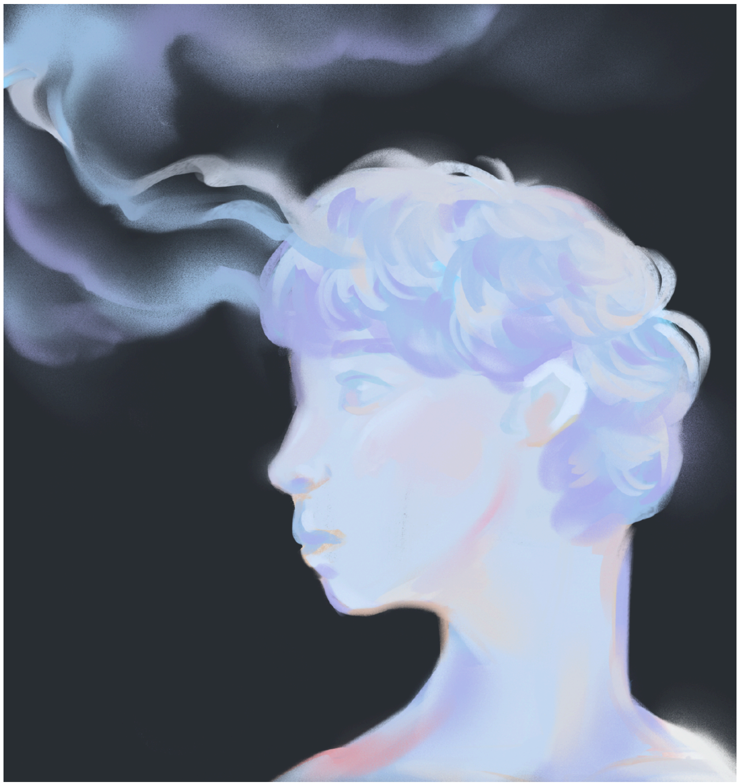
by Lamisa Nubayaat, Biology and Society '24

Sarah lived in fear of her own mind. She spent nights restlessly pacing around her room, mind racing with a million thoughts. A constant sense of worry consumed her, and she began to pull away from activities and people she once loved, weighed down by a deep sense of hopelessness. As days turned to weeks, the cycle persisted, pushing Sarah to seek help. Instead of receiving clarity, her diagnoses only made her more confused. Her symptoms were assessed separately, leading to a fragmented understanding of her overall mental state. Each professional told her something different, and overlooked the interconnected nature of her comorbid anxiety and depression. As she stared at the various scales asking her to rank and rate her symptoms, she couldn't help but feel that they didn't capture the depth of her suffering.

Sarah's experience reflects the historical trend of making sense of psychological suffering through categorization, characterized by an attempt to distill complexities of the human psyche into neatly compartmentalized categories. From Hippocrates to Kraepelin, physicians have long theorized about fitting mental illnesses into distinct groupings [1]. Even the modern tool for diagnosis, the Diagnostic and Statistical Manual of Mental Disorders-5 (DSM-5), is based on separating conditions into taxonomic categories based on symptoms [2]. As our knowledge expands, it's crucial to question the clinical utility of these traditional methods.

This popularized theory, known as the categorical approach, treats psychiatric conditions similarly to physical illnesses by using the presence of symptoms to determine if a person has a disorder. This understanding is concrete and posits that a disorder is present or absent with no in-between, implying two distinct states: normalcy and disorder [1, 3]. By providing a uniform and organized framework to discuss abnormal psychology, this model has become widely accepted and given medical legitimacy to the field. Despite the undeniable benefits, there is growing apprehension due to its inherent limitations. One major issue is its use of binary perspectives, categorizing symptoms as present or absent, disorder or no disorder, ultimately neglecting the nuanced ways symptoms may manifest. Furthermore, the considerable overlap between symptoms of different disorders poses challenges in accurate diagnosis and the identification of comorbidities [2].

Skepticism about this construct has resulted in increased endorsement for an alternative perspective: the transdiagnostic approach. This mechanistic framework emphasizes commonalities in underlying cognitive, emotional, and behavioral processes across various disorders, rather than focusing on individual conditions. Instead of viewing conditions as distinct entities, this method identifies dimensions, or shared processes that contribute to numerous disorders [4]. Notably, dimensions are normative, meaning they exist within all people at all times, ranging from normal to severely ill [1]. Examples include rumination, co-rumination, rejection sensitivity, negative urgency, perfectionism, etc [4]. This viewpoint is supported by evidence that mental disorders are better understood as existing along a continuum rather than in rigid categories [2].



Artwork by Michelle Choi

This perspective offers a number of benefits, as it adeptly addresses many of the constraints of the traditional approach [2]. This approach revolutionizes psychiatric diagnosis by promoting a holistic, nuanced understanding. It is specifically useful in deciphering complex cases of co-occurring disorders, as it focuses on patterns rather than seeking to fit symptoms into discrete boxes [2, 5]. The framework is flexible, allowing for the recognition of evolving symptom trajectories and fluctuations over time, thus acknowledging the fluid nature of one's mental state [2]. It is unique in that it is instrumental in identifying individuals experiencing distress that doesn't align with traditional diagnostic criteria, allowing for a preemptive system of assessing the risk of developing a significant condition [3].

To treat underlying dimensions, a therapeutic framework, known as the Unified Protocol for Transdiagnostic Treatment of Emotional Disorders (UP), was developed in conjunction with this approach. Deviating from conventional disorder-specific methodologies, the UP is an emotion-centered, cognitive-behavioral intervention comprising five core modules that strategically focuses on temperamental traits and the emotion dysregulation underlying mental disorders [6]. Studies have found UP to be extremely successful in treating a wide range of disorders, showing improvements for both the primary diagnosis and comorbidities [6].

The public health implications of adopting this novel approach are profound. By offering a streamlined and cost-effective care plan, this approach will significantly reduce overall treatment length and cost for patients [7]. The clinical practicability and simplified training associated with interventions further enhance their accessibility in routine care settings and reduce training burden. By knowing just a singular protocol, mental health professionals can deliver evidence-based treatments for many disorders [4]. Most notably, the capacity to address multiple diagnoses within a single treatment is advantageous for individuals with comorbidities. Rather than prioritizing one disorder, this approach allows for the comprehensive treatment of all symptoms through a holistic therapeutic strategy [6].

While the transdiagnostic approach and the Unified Protocol mark strides in psychiatric care, their advancement brings forth inevitable challenges. The model prompts questions about whether a universal set of dimensions can effectively encapsulate the diversity of mental distress. There is uncertainty when deciding how many and how severe dimensions have to be to constitute a "disorder" and at what point on the continuum intervention is required [3]. Some suggest a hybrid approach, blending categorical and dimensional elements to harness the unique strengths of both [1]. As we navigate this dynamic landscape, scientists, mental health practitioners, and patients are tasked with evaluating the advantages and drawbacks. These debates are essential in deciding how to effectively integrate diverse perspectives and hopefully help patients like Sarah feel fully understood.

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