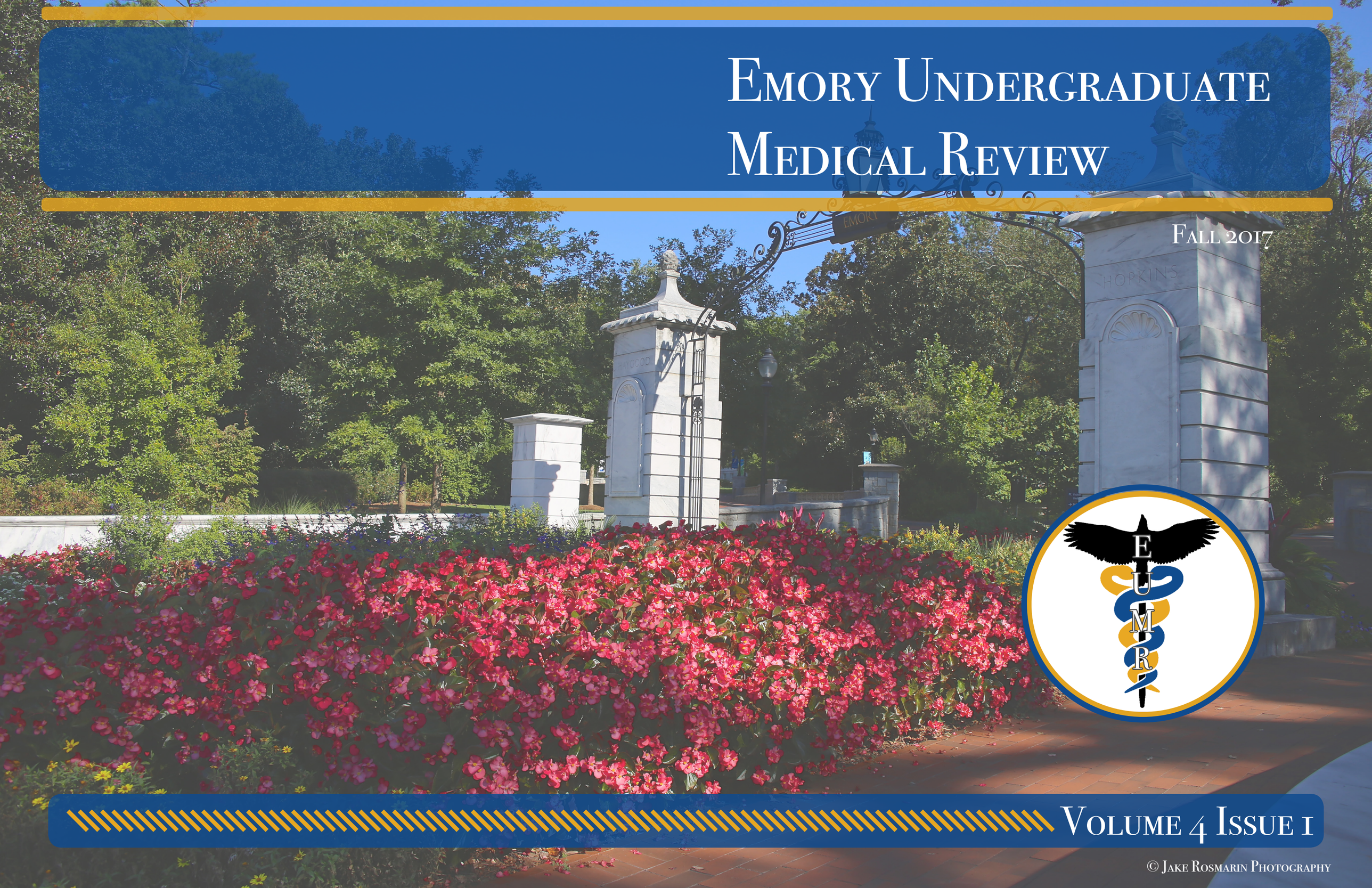
Emory Undergraduate Medical Review

Fall 2017



Volume 4 Issue 1

About Eumr

Mission Statement:

The Emory Undergraduate Medical Review is for Emory undergraduates interested in medical or health related careers to engage in scholarly discourse with their peers and medical professionals. EUMR publishes semesterly hard-copy and online-copy journals in addition to shorter blog posts throughout each semester. Each semesterly issue primarily features reviews on interesting and cutting-edge topics in medicine, while medical opinion articles are also welcomed. All semester pieces are reviewed by doctors and researchers from around the country who are featured on our Advisory Board. Blog posts are more succinct and accessible pieces in recurring areas including ethics, biotechnology, public health, nutrition, and more. EUMR also endeavors to put on educational events relevant to students interested in medical or health careers.

Our Advisor

Dr. Michael Crutcher, PhD

Emory

Dr. Michael Crutcher is one of the many distinguished faculty members in Emory's Neuroscience and Behavioral Biology Department. Having received his PhD in Physiology from Johns Hopkins University, he joined the Department of Neurology and of the Neuroscience Ph.D. program at Emory in 1991. His research is primarily focused on the neural mechanisms of visually guided reaching movements in monkeys.

Dr. Crutcher has taught many NBB courses over the years such as: freshman seminar courses (NBB 190) on Brain Enhancement, Curiosities of Neurology and Neuroscience, and Neuroethics as well as Perspectives in Neuroscience and Behavioral Biology (NBB 401 SWR), Biology of Movement Control (NBB 370), Neuroscience Research Methods (NBB 221), Functional Neuroanatomy (NBB 470), and Topics in Neuroscience and Behavioral Biology (NBB 270).

Table of Contents

Executive Board

Copy Editor-In-Chief

Alec Shannon

Layout Editor-In-Chief

Lindsay Hexter

Treasurer

Carli Kovel

Secretary

Phuong Tran

VP Events

Mánsi Maini

Publicity Chair

Talia Burstein

Executive Board Editors

Layout Editors

Sharon Hsieh

Daniel Bujnowski

Swetha Rajagopalan

Divyaansh Raj

Danial Arslan

Copy Editors

Jonathan Regenold

Anna Farrell

Soumya Mandava

Preethi Reddi

Christopher Keyes

Nivedita Potapragada

Writing Staff


Ameya Gangal


Taylor Eisenstein


Lisa Zhang


Ayushi Sharma


Shaily Patel


Deanna Altomara


Anirudh Pidugu


Jake Rosen


Jin Yoo

First Year Liasons


Aditya Jhaveri


Mason Domke


Sharvil Patel


Han Li

Advisory Board


Waqar Azeem, MD
Yale School of Medicine

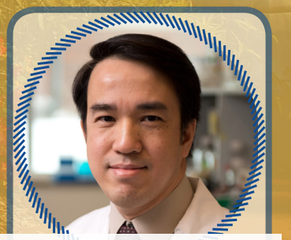

Tyler Cymet, DO
American Association of Colleges of Osteopathic Medicine


Paul Garcia, MD, PhD
Emory School of Medicine


Katherine Heiden, MD
Rush University


Atul Maini, MD
Hackensack Meridian Health


David Pallas, PhD
Emory School of Medicine


Kim Tran, MD, PhD
Des Moines University

Mapping the Future of Sleep Medicine Through Talent Acquisition and Healthcare Innovation

Authored by: Sharon Hsieh
Edited by: Preethi Reddi **Reviewed by: Dr. Waqar Azeem**

A convergence of advances in image-based precision medicine, patient management techniques, and proactive talent acquisition may herald a new age in sleep medicine.

The Georgia Association of Sleep Professionals (GASP) held its 8th annual conference ("GASP 2017") at the Emory Conference Center Hotel October 13-14, bringing together influential national leaders in sleep medicine to facilitate dialogue on sleep medicine education, cutting-edge technologies, clinical management, and patient advocacy. GASP 2017 addressed a plethora of topics ranging from groundbreaking research into 3D printing of customized sleep apnea masks to the looming peril in sleep medicine: workforce shortage.

Sleep Medicine experts gathered to learn more about the prevalence of sleep dysfunctions and disorders in adult women. Hormones are implicated in the gender-related variations in treatment of sleep disorders. (Photo by Sharon Hsieh)

Dr. Ilene Rosen, Professor of Medicine at the University of Pennsylvania and 32nd President of the American Academy of Sleep Medicine, provided the GASP 2017 keynote address. She emphasized the urgency to recruit the best and brightest trainees into sleep medicine fellowship programs both nationally and here in Georgia. "Medical students learn about diabetes the first day they start their studies. Yet, the education in sleep disorders in US medical schools only accounts to a mean of three hours in the four-year curriculum. There are 245.2 million patients undiagnosed with sleep apnea—we need to reassess the medical school curriculum and invest in a pipeline of sleep physicians who will provide cost-conscious and patient-centered care," Dr. Rosen addressed in her speech. When asked about the acute sleep physician shortage across the state of Georgia, Dr. Barry Fields, an Assistant Professor at the Emory School of Medicine who serves as the President of GASP and the VA site director for the Emory sleep medicine fellowship program, noted, "Only three trainees are doing sleep fellowships in the entire state of Georgia—that's a huge shortage! You cannot sustain sleep medicine if you do not get enough trainees."

"Medical students learn about diabetes the first day they start their studies. Yet, education in sleep disorders in US medical schools only accounts to a mean of three hours in the four-year curriculum..." Dr. Rosen addressed in her speech.

Dr. Scott Holliser, Professor of Biomedical Engineering at Georgia Tech, discussed the use of 3D printing as the cornerstone of making customized sleep apnea masks. The emerging frontier and application of personalized 3D-printed tracheal splints has helped save newborns with collapsed airways. This success could precipitate the technology's use for sleep apnea treatment. However, while the user-friendly 3D software enables accurate modeling of anatomical structures, the cost-effectiveness of such customized health care is questionable; sleep apnea masks are typically replaced at least every six months. As the cost of personalized mask production decreases, they may become more popular in general use.

Technological capability does not imply clinical feasibility. With the paradigm shift from volume to value-based payment models and the emerging prevalence of telehealth, physicians often question whether it is possible to provide care through technology and whether they can be compensated enough to sustain a quality medical practice. Mr. Daniel Brown, a corporate and healthcare attorney at Taylor English Duma LLP, presented the Georgia statutes of telemedicine practice. He discussed gray areas in the qualifications to utilize telemedicine and further addressed the governmental and private payer reimbursement policies.

GASP 2017 provided a local venue for these leaders from diverse realms of sleep medicine to share their work, learn from others, and discuss ideas for future collaboration. "Sleep Medicine is a multidisciplinary field involving many stakeholders from nurses, psychologists, dentists, advanced care practitioners, and physicians, to legal professionals and policy makers. A primary goal of GASP 2017 was to encourage discussion between these different groups to improve the delivery of care to patients with sleep disorders," said Dr. Barry Fields. "It is a very fertile ground to generate innovative, evidence-based ideas and insights."

The GASP 2017 Symposium featured a poster session. It drew 5 posters that focused upon improving the delivery of sleep care to patients. (Photo by Sharon Hsieh)

Innovation to Industry: Office of Technology Transfer

Authored by: Ayushi Sharma
Edited by: Alec Shannon **Reviewed by: Dr. Katherine Heiden**

University Technology Transfer resides at the intersection of scientific discovery, law, and business and is found at every major research institution. Technology Transfer is the relay station from innovation to industry and is comprised of a team of lawyers, scientists, and experts who drive the process of making biomedical research applicable to the public. Our discoveries as students, faculty, and inventors become publicized and can begin to impact individuals once the University Technology Transfer office catapults our ideas beyond the university and into the real world, leading to the production of new drugs, medicines, and technologies. The primary goal of any innovation or technology is to benefit the lives of others, and the arrival of scientific discovery to the market is key to making steps towards impact. The unique junction where medicine meets market is streamlined by the Office of Technology Transfer. Technology Transfer identifies, targets, and drives new innovations and protects those inventions through patents and copyrights, ultimately preparing the invention for commercial marketing ("A Better World," 2017).

The Office of Technology Transfer serves as a relay station between discoveries at the hand of the researchers to the industry that has the power to take a potentially life-saving innovation globally (Phillips, 2013).

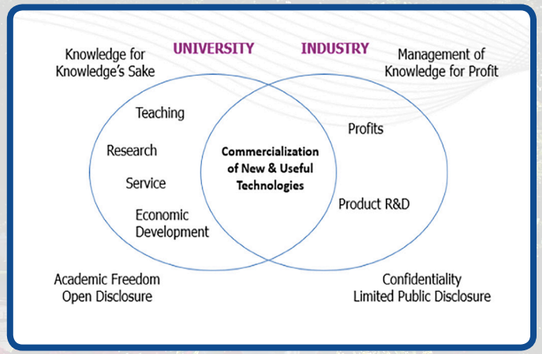
The idea of a technology transfer office emerged from a desperate need to regulate the inventions made by researchers and innovators. Before World War II there existed no major federal research system through which discoveries could be pipelined; however, post-World War II, the industry began to change ("A Better World," 2017). A rapid efflux of scientific advancements meant that there was a monetary incentive for the government to become involved with the production of research. The government began distributing federal grants to fund research at universities, and as a result, the government claimed ownership of many such inventions.

Technology Transfer specifically identifies, targets, and drives new innovations made by a research institution.

The Bayh-Dole Act, introduced in the 1980's, was designed to promote the application of government-funded research to benefit not only the researchers who created them, but also the public that desperately needed them. As a result, universities were suddenly able to own the inventions made by their professors and researchers, and this led to the creation of in-house regulations consolidated into what is today known as Offices of Technology Transfer. The researchers creating life-saving drugs and technologies were granted the power to help the people that they set out to treat in the first place ("A Better World," 2017).

With power came responsibility. Institutions were obligated to share royalties with individual researchers and to use a portion of the income for educational purposes and further research efforts. The government also stipulated that priority must be given to U.S. industry and small businesses to keep the interests of the country and its economy at hand (Emory OTT, 2016). The Office of Technology Transfer arose out of a need to meet these obligations in a centralized way. The office works with researchers at an institution to acquire knowledge about a discovery, gather the resources for mass protection, and navigate the complexities of protecting intellectual properties while acquiring licensing deals in order to make discoveries available to the public as efficiently as possible. As the Office of Technology Transfer negotiates with industry partners to ensure that contracts are legally sound and fair, researchers are then free to conduct their studies without fear of being undercut or exploited (Emory OTT, 2016).

Just as there are regulations on research enforced by the IRB at the institution level, the marketing of research products requires adherence to federal regulations ("A Better World," 2017). In addition, the products must be licensed and marketed through a private third party company tailored to the developed technology. They evaluate research to inspect the commercial viability of each discovery that comes out of the university or institution. Additionally, technology transfer helps us create jobs and additional funding for relevant research projects that will ultimately benefit the public sphere (Emory OTT, 2016). They do this by promoting research to industry and bringing it to the public eye, which could potentially lead to more awareness for the topic being researched.



When science and industry collided, there arose a need to fill a burgeoning niche which required experts who had the expertise and power to commercialize a once-purely scientific product (Emory OTT, 2016).

At Emory University, dozens of innovations have been successfully translated from the bench to the boardroom by bringing innovations produced by Emory researchers to a centralized location. The Emory OTT creates clinical trial, research, and confidentiality agreements in addition to reaching out to relevant companies and marketing the innovations being made at Emory on a day-to-day basis. Emory's recent merge with the Emory Industry Contracting Group has given rise to additional tools for allocating more industry funding and streamlining the contract process. In 2016 alone, Emory University produced a total of 2,144 contracts with industry to help bring innovations to life (Emory OTT, 2016). Emory OTT therefore maintains the university's commitment to its own community and the public via a comprehensive management of innovations and discoveries made every day.

Images:

Emory Office of Technology Transfer. [Digital image]. (2016). Retrieved October 20, 2017.

Phillips, Jason. (23 Mar. 2013). Monitor Network Usage per Computer [Digital image]. Retrieved October 20, 2017, from http://www.techcrates.com/monitor-network-usage-per-computer/

References:

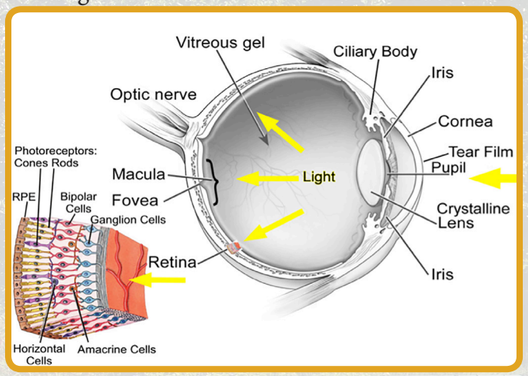
A Better World by Bringing Research to Life. (2017). Retrieved October 14, 2017, from http://www.autm.net/

Emory University Office of Technology Transfer | Atlanta GA. (2016). Retrieved October 14, 2017, from http://www.ott.emory.edu/

Less than One in a Million: Leber's Hereditary Optic Neuropathy Plus

Authored by: Shaily Patel
Edited by: Nivedita Potapragada **Reviewed by: Dr. Kim Tran**

Leber's hereditary optic neuropathy (LHON) is a rare inherited mitochondrial disease that ultimately leads to bilateral vision loss (Meyerson et al., 2015). This disease occurs every 1 in 30,000 to 50,000 individuals ("About LHON," n.d.). However, a subset of this disease, called LHON plus, is much less common yet is much more debilitating. Occurring in less than one individual per one million, LHON plus describes typical patients with LHON symptoms in conjunction with systemic or neurological abnormalities that include much more



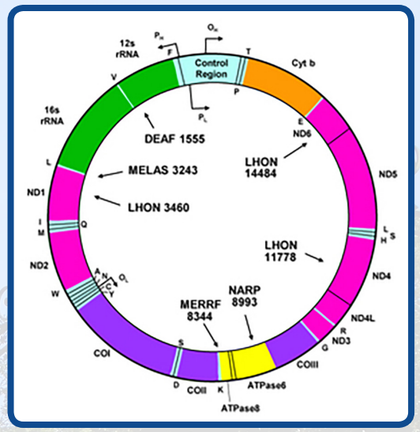
Pathway of light perception in a normal human eye; mitochondrial dysfunction, as a result of LHON, causes selective degeneration of retinal ganglion cells (RGCs). ("Anatomy of Human Eye and Retina," n.d.)

disabling symptoms. These symptoms can be any combination of postural tremors, muscle weakness, motor disorders, multiple sclerosis-like symptoms, and mild encephalopathy, to name a few ("Leber Plus Disease," n.d.). Individuals with LHON or LHON plus are often initially asymptomatic, but symptoms slowly progress from mild unilateral visual blurring to unilateral vision loss leading to eventual severe yet painless bilateral vision loss (Shah et al., 2014). These vision symptoms could occur in one eye or both eyes simultaneously. Normally, vision loss starts in one eye; however, the unaffected eye begins to show symptoms within several weeks or months, which is known as the acute phase of the disorder ("About LHON," n.d.). The acute phase has proven to be a crucial point within the timeline of LHON and LHON plus, as it contributes to testing for many studies and clinical trials. By delving deeper to recognize the pathophysiology, methods of diagnoses, and potential future treatments, a stronger understanding of this rare disease has the ability to raise awareness as well as restore hope for those affected by it.

Patient L.S. is a 67-year-old male who is a patient of Dr. George Wilmot's, an assistant professor for the Department of Neurology at Emory University's School of Medicine. His chief complaint for this visit was his progressive bilateral leg weakness, which has left him wheelchair-bound. The patient's history of present illness included painless loss of vision approximately 5 years prior to this visit. He first lost vision in his left eye, and vision loss in his right eye soon followed about 2-3 months later.

Patient L.S. is a 67-year-old male who is a patient of Dr. George Wilmot's, an assistant professor for the Department of Neurology at Emory University's School of Medicine.

An important aspect that aided in Patient L.S.'s diagnosis of LHON was a positive family history of the disease, with his mother, maternal grandmother, and brother all diagnosed with the disease. LHON is an inherited form of vision loss, with its pathophysiology dependent on the genes found within mitochondrial DNA (mtDNA). Having a positive family history of the disease, especially among maternal family members, is crucial for diagnosis (Shah et al., 2014). In reproductive biology, egg cells are sole contributors of mitochondria to the developing embryo ("About LHON," n.d.). As a result, LHON is maternally inherited by mutations found in mtDNA. There are three main nucleotide positions in mtDNA that are prone to mutations: 11778, 3460, and 14484 (Nikoskelainen et al., 1995). However, a mutation at nucleotide position 11778, which codes for the ND4 gene, constitutes more than 50% of all LHON cases ("About LHON," n.d.). Mitochondrial point mutations cause defects in genes that code for

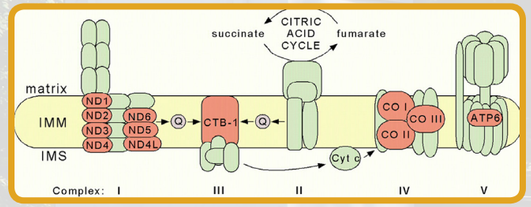


Circular mitochondrial DNA nucleotide positions paired with corresponding genes ("Chromosomal Location on mitochondrial DNA," 2006).

NADH-ubiquinone oxidoreductase chains (Koilkonda & Guy, 2011). This subsequently results in mitochondrial dysfunction and impairs glutamate transport, increases reactive oxygen species production, causes selective degeneration of retinal ganglion cells (RGCs), and causes atrophy and demyelination of optic nerves, tracts, and chiasms (Beretta et al., 2004). RGCs are highly metabolically active and require large amounts of adenosine triphosphate (ATP), which is produced by mitochondria. As a result, RGCs have high numbers of mitochondria and are highly sensitive to mitochondrial dysfunction (Meyerson et al., 2015). Thus, the mutations in mtDNA greatly impact vision, and in LHON, result in vision loss.

LHON is an inherited form of vision loss, with its pathophysiology dependent on the genes found within mitochondrial DNA.

In order to diagnose LHON plus, multiple tests are required to confirm the disease, as some of its symptoms resemble other neurological disorders. In the case of patient L.S., there was initial ambiguity for his diagnosis because his symptoms could be a result of any of the following disorders: multiple sclerosis (MS), neuromyelitis optica (NMO), Leber's hereditary optic neuropathy (LHON), and Leber's hereditary optic neuropathy plus (LHON plus). Often, a blood test is initially conducted to check for the presence of the antibody NMO IgG, and a lumbar puncture is recommended for cerebrospinal fluid analysis of oligoclonal bands (OCBs), which are often indicative of MS. A magnetic resonance imaging (MRI) scan is also conducted in an attempt to localize the origins of a potential lesion ("Leber… Reference," n.d.). Upon diagnostic testing, Patient L.S. showed no OCBs, which eliminated the diagnosis of MS, and had no NMO antibodies, which eliminated the diagnosis of NMO. Results of the MRI showed extensive T2 lesions throughout the dorsal and lateral areas of the spinal cord, which is likely responsible for his "plus" symptoms of LHON. The final method of testing for an ensured diagnosis of LHON is genetic testing for mutations in mtDNA affecting the ND1, ND4, or ND6 genes, which code for nucleotide positions 3460, 11778, and 14484, respectively. Patient L.S.'s results for genetic testing yielded positive results for a mutation on the ND4 gene.



Key genes involved in aerobic mitochondrial mechanisms, such as the electron transport chain (ETC) (Lemire, 2005).

Although there are no current FDA approved treatments or cures for LHON or LHON plus, Emory University is involved in clinical trials for gene therapy for LHON. The goal of this gene therapy is to assess the effectiveness of GS010, a recombinant adeno-associated viral vector (rAAV2), in improving visual outcomes in patients with LHON (GenSight Biologics, 2017. This rAAV2 viral vector contains the human wild-type ND4 gene, which is predicted to allow localization of the wild-type protein to mitochondria in an attempt to restore mitochondrial function (GenSight Biologics, 2017). If GS010 successfully restores mitochondrial function, it can improve the visual outcomes of patients

with LHON because of the 11778 ND4 mtDNA mutations. Emory's unique role in this process is to help recruit patients with the ND4 gene mutation as well as to contribute to other mechanisms of gene therapy. Understanding the basic pathophysiology of LHON has the potential to improve our understanding of similar mitochondrial diseases. However, the support Emory Healthcare provides for patients and families affected by LHON is immense. It raises awareness for such a rare yet debilitating disease and restores hope for those affected by it.

Images:

Anatomy of human eye and retina. [Digital Image]. (n.d.). Retrieved September 22, 2017, from http://www.lhonsociety.org/about-lhon

Chromosomal Location on mitochondrial DNA. [Digital Image]. (2006, August). Retrieved September 22, 2017, from https://ghr.nlm.nih.gov/gene/MT-ND4

Lemire, B. (2005). Schematic representation of the mitochondrial respiratory chain [Digital image]. Retrieved September 22, 2017, from http://www.wormbook.org/chapters/www_mitogenetics/mitogenetics.html

References:

"About LHON." (n.d.). LHON Society. Retrieved from http://www.lhonsociety.org/about-lhon

Beretta S, Mattavelli L, Sala G, Tremolizzo L, Schapira AH, Martinuzzi A, Carelli V & Ferrarese C (2004). "Leber hereditary optic neuropathy mtDNA mutations disrupt glutamate transport in cybrid cell lines." Brain. Vol 127. pp 2183-2192. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/15342361

Chinnery PF (2000). "Mitochondrial Disorders Overview." GeneReviews. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK1224/

GenSight Biologics (2017). "Efficacy Study of GS010 for Treatment of Vision Loss From 7 Months to 1 Year From Onset in LHON Due to the ND4 Mutation (Reverse)." Retrieved from https://clinicaltrials.gov/ct2/show/NCT02652780?cond=Leber+Hereditary+Optic+Neuropathy&cntry1=-NA%3AUS&state1=NA%3AUS%3AGA&rank=1

Koilkonda RD & Guy J (2011). "Leber's Hereditary Optic Neuropathy-Gene Therapy: From Benchtop to Bedside." Journal of Ophthamology. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3021870/

"Leber hereditary optic neuropathy – Genetics Home Reference." (n.d.) U.S. National Library of Medicine. National Institutes of Health. Retrieved from https://ghr.nlm.nih.gov/condition/leber-hereditary-optic-neuropathy#diagnosis

"Leber Plus Disease." (n.d.) Orphanet. Retrieved from http://www.orpha.net/consor/cgi-bin/OC_Exp.php?lng=en&Expert=99718

Man PYW, Turnbull DM, & Chinnery PF (2002) "Leber hereditary optic neuropathy." Journal of Medical Genetics. Vol 39. Retrieved from http://jmg.bmj.com/content/39/3/162

Meyerson C, Van Stavern G, & McClelland C (2015). "Leber hereditary optic neuropathy: current perspectives." Dove Press. Vol 9. pp 1165-1176. Retrieved from https://www.dovepress.com/leber-hereditary-optic-neuropathy-current-perspectives-peer-reviewed-article-OPTH

Nikoskelainen EK, Marttila RJ, Huoponen K, Juvonen V, Lamminen T, Sonninen P, & Savontaus ML (1995). "Leber's 'plus': neurological abnormalities in patients with Leber's hereditary optic neuropathy." Journal of Neurology, Neurosurgery & Psychiatry. Vol 59. pp 160-164. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC485991/

Ramos CVF, Bellusci C, Savini G, Carbonelli M, Berezovsky A, Tamaki C…Barboni P (2009). "Association of Optic Disc Size with Development and Prognosis of Leber's Hereditary Optic Neuropathy." Investigative Ophthalmology & Visual Science. Vol 50. Pp 1666-1674. Retrieved from http://iovs.arvojournals.org/article.aspx?articleid=2126040

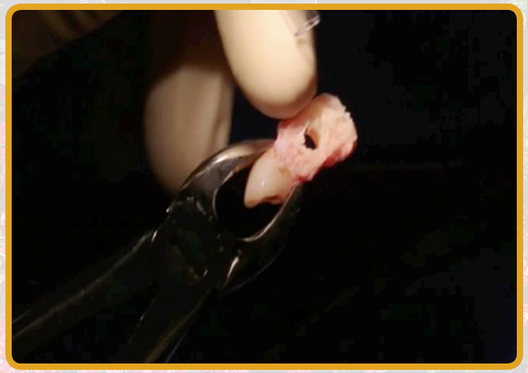
Shah SB, Epley KD, Vaphiades MS, & Levin MR (2014). "Leber Hereditary Optic Neuropathy." American Academy of Opthamology. Retrieved from http://eyewiki.aao.org/Leber_Hereditary_Optic_Neuropathy

Tooth in Eye Surgery for Vision Restoration

Authored by: Soumya Mandava
Edited by: Alec Shannon **Reviewed by: Dr. Tyler Cymet**

Functional fixedness is described as the inability to think of another use for an object beyond its traditional purpose., As we have seen time and again, however, the best inventions arise when we stray from the paved path and start looking at things in ways we never before considered. It is this open-minded approach that led to the conception of Osteo-Odonto Keratoprosthesis (OOKP). This surgery involves harvesting a patient's tooth and inserting it into their eye socket, which restores vision in patients with end-stage blindness.

The first Keratoprosthesis surgery, replacing a damaged cornea with an artificial implant, dates back to 150 years ago. Since then, there have been countless attempts to use a variety of inorganic substances as substitute material. Although the body rejected these replacements in a majority of cases, these experiments have lead to considerable progress in developing a better design for the device material and technique for implantation (Aquavello et al., 2005).



Tooth used in the OOKP Procedure that restored sight to Mr. Ings (Harris, 2017).

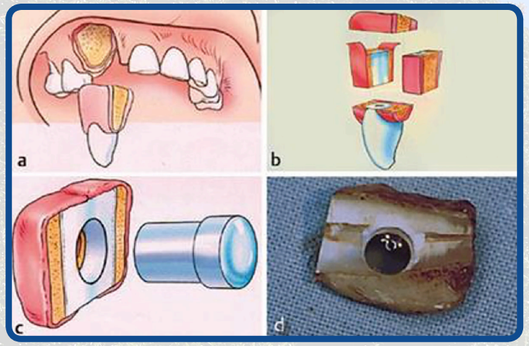
Recently, the two most commonly used devices are Boston type-1 KPro and osteo-odonto-keratoprosthesis (OOKP). Boston type-1 KPro is an artificial lens synthesized from polymethylmethacrylate that requires daily maintenance and is well preserved in the short-term. By contrast, OOKP is synthesized from human tissue and requires monthly maintenance, and it is a long-term cure. Although the choice of device is dependent on diagnosis, eye health, and patient suitability, data has shown that the OOKP technique is much more commonly utilized (Avadhanam and Liu, 2014 and Liu et al., 2005).

Once a patient expresses interest in undergoing the surgery, the physician performs multiple assessments to determine the patient's eligibility for the procedure. During the ophthalmic assessment, the "better" eye is selected and studied to ensure that the retina and optic nerve are still functioning. The oral assessment tests the health of the oral mucosa and involves selecting a healthy tooth with minimal damage to its surrounding anatomy (Liu et al., 2005). Finally, a psychological assessment determines if the patient understands and can handle a procedure that involves month's to year's worth of operations, potential irreversible complications, and significant financial and emotional stress placed upon both them and their families (Liu et al., 2005). After it has been shown that the patient is well suited for the procedure, the medical team and the patient can begin the first of the two stages in the OOKP surgery.

The first stage involves preparation of the inner cheek surface and the osteo-odontolamina tooth. The surgeon starts by harvesting a single tooth that is large enough for insertion of an optical cylinder, which will act as the artificial cornea. The ideal tooth size is 12mm X 6mm X 3mm with a 3.70mm average diameter for the hole. Once the tooth is extracted, the optical cylinder will be inserted into the hole and secured to the lamina using PMMA cement. This compound is then placed under the orbital rim until stage 2 of the procedure for growth of connective tissue and vascular supply.

The second component of stage 1 is to prepare the ocular surface for device insertion. A section of the buccal mucous membrane (inside lining of the cheek) is grafted onto the surface of the selected eye. This membrane contains many stems cells and has

high proliferative ability. The graft remains on the ocular surface until the second stage of the surgery to allow time for vascular development, which will provide blood supply to the OOKP lamina once it is inserted (Sarode et al., 2011).



Tooth is selected and extracted from the mouth. It is isolated from the gum, tissue, fibers, etc. The tooth is prepared and has a hole drilled into it for insertion of the optical cylinder. The final product is the keratoprosthetic, which is then placed in the eye (Singapore Books of Records: Surgeries and Procedures).

Stage 2 begins once the graft and lamina have properly vascularized and are ready for insertion, which is typically between two and a half to four months after the initial procedures. First, the buccal mucosal graft is incised to create an opening in the eye. The iris is completely removed and the keratoprosthesis is placed in the eye opening. The buccal mucosal membrane is stitched to cover up the cylinder and only a portion of the device protrudes on the anterior surface. After one month, the final steps of the procedure are completed as a cosmetic prosthesis is placed on top of the external ocular surface (Sarode et al., 2011).

In the early post-operational stages, complications may result in fluctuations of the intraocular pressure (IOP), which would result in choroid detachment in case of low IOP or late expulsive hemorrhage in case of high IOP.

Late post-operative complications may lead to overgrowth in the buccal membrane or the mucosal surface, either of which would require corrective laser surgical removal (Tan et al., 2012). In more severe cases, patients may suffer from glaucoma, retinal detachment, or vitro-retinal complications (Liu et al., 2005). The latter three conditions develop largely from difficulties in managing intraocular fluids and intraocular pressures during the surgery. They not only could nullify the benefit of the OOKP procedure by resulting in vision loss, but they also could deteriorate the health of the tissue surrounding the implant, if they are not treated within a timely manner (Roe and McDonald, 2008).

85% of OOKP patients had an intact, functioning graft after 18 years (Liu et al. 2005 and Facinelli et al. 2005).

These complications, however, are associated with most ocular surgical procedures. There are many advantages to OOKP as well. For example, the tooth is long-lasting human tissue, which means this technique provides long-term support, poses a lower risk of extrusion, prevents leakage of aqueous humor and neovascular tissue growth, and can develop immune defense mechanisms for protection against infections (Sarode et al., 2011).The disadvantages of this technique include the previously listed potential complications, it being a two-stage medical procedure, a lifetime commitment to follow-ups, and the low aesthetic of the replacement (Rao et al., 2013).

Mr. Martin Jones underwent OOKP, which restored his vision after being blinded at work twelve years earlier. Eight years later, his implant is still successfully working (Sims, 2003).

All things taken into consideration, there are multiple studies that have found the OOKP surgery to have favorable long-term success rates compared to other devices. A study by Herold et al. showed that 80% of patients who underwent OOKP experienced better vision (1999). Similar results were found in another study where 73.3% of patients had correctable 20/20 vision and 60% had stable 20/20 vision post-op (Tan et al., 2008). Anatomical studies showed that 80% of patients retained an intact graft 20-years after the final surgery (Tan et al., 2012). Relatedly, functional studies found that OOKP implants, compared to other devices, had statistically significant better corrected-decimal visual acuity at a 10 year follow-up. (Paz et al., 2011). Overall, the most commonly cited and agreed upon statistic shows that 85% of OOKP patients had an intact, functioning graft after 18 years (Liu et al. 2005 and Facinelli et al 2005).

With its innovative use of a tooth as an eye, OOKP could be considered one of the most ingenious medical procedures developed. The implant is not only compatible with the body's immune system, but it also provides unique benefits by actively working with that system to fight against future infection at the surgical site. Most importantly, it is able to safely and successfully provide a higher standard of living to those who opt to undergo this procedure by restoring their vision. There is still plenty of progress to be made in further developing and improving this prosthesis. As of right now, however, it is truly an amazing and innovative solution that can be used to help many people.

Images:

Harris, A. (2017, April 15). The tooth which helped restore Mr Ings' sight. [Digital image]. Retrieved from http://www.dailytelegraph.com.au/news/nsw/cure-for-blindness-tooth-sewn-into-mans-eyeball-restores-his-sight/news-story/704e8049dd4c64ab526519e49f229744

Sims, P. (2003, July 3). Blind man sees wife for first time after having a TOOTH implanted into his eye. [Digital image]. Retrieved from http://www.dailymail.co.uk/news/article-1197256/Blind-man-sees-wife-time-having-TOOTH-implanted-eye.html

Singapore Book of Records: Surgeries and Procedures. [Digital Image]. (n.d.).

References:

Aquavella , J., Qian, Y., McCormick, G., & Reddy, J. (2005). Keratoprosthesis: The Dohlman-Doane Device. American Journal of Ophthalmology, 140(6), 1032-1038.

Avadhanam, V. S., & Liu, C. S. (2014). A brief review of Boston type-1 and osteo-odonto keratoprostheses. British Journal of Ophthalmology, 99(7), 878-887.

Falcinelli, G., Falsini, B., Taloni, M., & Colliardo, P. (2005). Modified osteo-odonto-keratoprosthesis for treatment of corneal blindness: long-term anatomical and functional outcomes in 181 cases. Archives of Ophthalmology, 123(10), 1319-1329.

Herold J, Sciscio A, Smith G, Hull C. (1999). Modern Osteo-Odonto-Keratoprosthesis surgery. British J Ophthalmol. 83, 127-128.

Liu, C., Paul, B., Tandon, R., Lee, E., Fong, K., Mavrikakis, I., . . . Hamada, S. (2005). The Osteo-Odonto-Keratoprosthesis (OOKP). Seminars in Ophthalmology, 20(2), 113-128.

Paz, M. F., Toledo, J. Á., Charoenrook, V., Sel, S., Temprano, J., Barraquer, R. I., & Michael, R. (2011). Impact of Clinical Factors on the Long-Term Functional and Anatomic Outcomes of Osteo-odonto-keratoprosthesis and Tibial Bone Keratoprosthesis. American Journal of Ophthalmology, 151(5).

Rao, L., Rajashekar, S., Mahajan, M., Mishra, P., & Singhal, P. (2013). A Tooth for an Eye: The Osteo-Odonto-Keratoprosthesis (OOKP) - A Review. Research & Reviews: Journal of Dental Sciences.

Roe, R., & McDonald, R. (2008). Complications of Vitreoretinal Surgery. Review of Opthalmology.

Sarode, G. S., Sarode, S. C., & Makhasana, J. S. (2011). Osteo-odonto-keratoplasty: A Review. Journal of Clinical & Experimental Ophthalmology, 02(10).

Tan, A., Tan, D. T., Tan, X., & Mehta, J. S. (2012). Osteo-odonto Keratoprosthesis: Systematic Review of Surgical Outcomes and Complication Rates. The Ocular Surface, 10(1), 15-25.

Tan D.T., Tay A.B., Theng J.T., Lye K.W., Parthasarathy A, et al. (2008). Keratoprosthesis surgery for end-stage corneal blindness in asian eyes. Ophthalmology 115, 503-510.

A Second Form of Type II Diabetes?

Authored by: Anirudh Pidugu
Edited by: Christopher Keyes **Reviewed by: Dr. Kim Tran**

Type II diabetes is becoming a larger problem and will continue to grow globally. Research has shown that there might be an alternative form of diabetes that is slowly causing a rising epidemic.

Diabetes is a metabolic disorder that develops from elevated blood sugar levels over a long period of time. Symptoms include frequent urination, increased thirst, and increased hunger. However, long-term complications arise when the condition is left untreated, including cardiovascular disease, stroke, and other serious problems (Venkat et al., 2004). There are two major types of diabetes. Type I diabetes, also known as juvenile diabetes, begins often in children and young adults and eliminates insulin production by destroying the cells that release insulin. About 5-10% of diabetes cases are type I. Type II diabetes is characterized by the inability of the body to use insulin properly--a condition known as insulin resistance. Almost 90% of diabetes cases are type II and have been seen to develop at any age. While the major cause has always been attributed to sedentary lifestyle and obesity, recent research seems to show that this might not be the only reason.

Currently, 387 million people have diabetes worldwide, and that number is expected to increase by 205 million by 2035. We are winning the war against diabetes domestically, but we are losing to it globally.

Type II diabetes is becoming a major problem throughout the world. While there has been a large decrease in the number of cases in much of the United States, many lower and middle income countries are still seeing an increased rate of diabetes, especially in Southeast Asia and Africa (Gregg & Auchmutey, 2008). Currently, 387 million people have diabetes worldwide, and that number is expected to increase by 205 million by 2035. We are winning the war against diabetes domestically, but we are losing it globally.

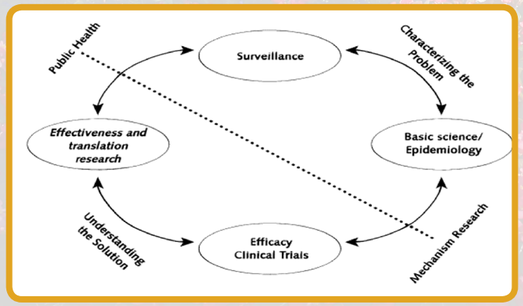
Much of the recent research on type II diabetes has been conducted in Western countries, leading to a decrease in the number of cases in these countries. However, this is not the case in other countries, especially in Southeast Asia and Africa, where type II diabetes has only increased. There needs to be a shift in diabetes research towards countries in the lower and middle income bracket. The traditional model for limiting the spread of diabetes emphasizes cure rather than prevention. However, that strategy fails to address the current rise in diabetes cases. A new model recently has shifted the focus to research projects and public health initiatives that are guided toward the prevention of type II diabetes.

DIABETES CASES, MILLIONS

COUNTRY	2013	2035 (projected rise)
CHINA	98.4	142.7
INDIA	65.1	109
USA	24.4	29.7
BRAZIL	11.9	19.2
RUSSIA	10.9	11.2
INDONESIA	8.6	14.2
MEXICO	8.7	15.7
EGYPT	7.5	13.1
GERMANY	7.6	8.1
TURKEY	7	11.8
JAPAN	7.2	6.7
PAKISTAN	6.7	12.8

SOURCE: International Diabetes Federation World Diabetes Atlas

The projected rise of cases will increase by more than 200 million and will significantly affect many countries. Many of the countries that are affected by the diabetes epidemic are lower and middle income countries (International Diabetes Federation, 2015).



New model that enforces more of an emphasis on prevention rather than cure. This model includes more research and programs that will help to stop the spread of Type II diabetes (Venkat Narayan et al., 2004).

An example of the new model of research is the CARRS (Centre for cArdiometabolic Risk Reduction in South-Asia) Translational Trial which took place in Pakistan and India in 2012 (Gurjal et al., 2013). The trial revealed an explosion of cases from this area of the world. Surprisingly, the majority of patients were not obese, unlike most patients who are diagnosed with type II diabetes in other regions of the world.

There are hardly any research studies on Asian Indian diabetes cases. For this reason, a research group performed a follow-up study to CARRS that compared Pima Native American and Asian Indian diabetic patients (Gurjal et al., 2015). Both groups display high rates of obesity but this association is the only commonality between the groups. The study compared the triglyceride levels, weights, and lifestyle factors of the two populations. The major difference between the two groups is their respective weights. The Natives were generally overweight or obese while most of the Asian Indians were thin or underweight. This cohort study identifies a huge difference between the types of diabetes in the two groups.

The comparative study of the two groups highlights the fact that there might two different types of type II diabetes. The first type (Type 2A) for which we have significant evidence is the one found in Pima Native Americans. Type 2A is associated with lower insulin action and has a two-hour plasma glucose period. Plasma glucose periods are the time it takes to return to normal glucose levels within the blood. It usually takes diabetics longer to reach this point, and the levels are also at a much wider range in the blood as compared to non-diabetics. This is caused by physical inactivity. The second type (Type 2B) has some of the opposite associations compared to type 2A. It has lower insulin secretion and a much shorter plasma glucose period, which lasts about thirty minutes. The reason behind type 2B is unknown, and that is where current research is lacking.

The Delhi Study focused on finding the causes of type 2B diabetes. The study was done in India, where there are high rates of malnourished and underweight children. It was noticed that children who grew up malnourished and underweight had higher rates of contracting type II diabetes (Tripathy et al., 2016). This correlation is a possible explanation, but still more evidence is needed to explain this correlation.

A next step to fight type II diabetes worldwide is to continue studying this disease in people from non-Western countries. Finding the cause of type 2B diabetes is key to understanding the reason why some thin people might acquire type II diabetes. Currently, Emory University has a large number of on-going diabetes research projects. Two important current projects include the CARRS Pollutants Study and the D-CLIP (Diabetes Community Lifestyle Improvement Program) Study. The CARRS Pollutants Study examines the effects of organic pollutants in India to see if there is any association between them and the substantial amount of type II diabetes cases. D-CLIP is a diabetes prevention trial using guideline-based, stepwise diabetes preventive techniques in prediabetic patients in the United States. This technique has had prior success in India. Outside of Emory, there have been many efforts to develop a diabetes pill as a replacement for the injection that controls blood sugar. Many therapies and programs have been put in place to make sure people make correct and healthy lifestyle decisions to lower the numbers of type II diabetes. Hopefully, as these efforts continue, we can start winning our battle against type II diabetes globally.

Images:

International Diabetes Federation. IDF Diabetes Atlas, 7th edn. Brussels, Belgium: International Diabetes Federation, 2015. http://www.diabetesatlas.org

Venkat Narayan, K., Benjamin, E., Gregg, E. W., Norris, S. L., & Engelgau, M. M. (2004, June 1). Translation research in the context of other types of research and public health assessments. [Digital image]. Retrieved from http://annals.org/data/Journals/AIM/20066/37FF1.png

References:

Gregg, V. and Auchmutey P. (2008). No matter what language you speak, DIABETES is a global problem. *A Global Solution for Diabetes.*

Gujral, U. P., Pradeepa, R., Weber, M. B., Narayan, K. V., & Mohan, V. (2013). Type 2 diabetes in South Asians: similarities and differences with white Caucasian and other populations. *Annals of the New York Academy of Sciences*, 1281(1), 51–63. http://doi.org/10.1111/j.1749-6632.2012.06838.x

Gujral U. P., Narayan V.K.M, Pradeepa R., Deepa M., Ali M., Anjana R., Kandula N., Mohan V., Kanaya A.M. (2015) Comparing Type 2 Diabetes, Prediabetes, and Their Associated Risk Factors in Asian Indians in India and in the U.S.: The CARRS and MASALA Studies. Diabetes Care. 38 (7) 1312-1318;

Tripathy J.P., Thakur J.S., Jeet, G., Chawla S., Jain S., Pal A., Prasad R., Saran R. (2016). Prevalence and risk factors of diabetes in a large community-based study in North India: results from a STEPS survey in Punjab, India. *Diabetology & Metabolic Syndrome* 9:8. https://dmsjournal.biomedcentral.com/articles/10.1186/s13098-017-0207-3

Venkat Narayan KM, Benjamin E, Gregg EW, Norris SL, Engelgau MM. Diabetes Translation Research: Where Are We and Where Do We Want To Be?. Ann Intern Med. 2004;140:958–963. doi: 10.7326/0003-4819-140-11-200406010-00037

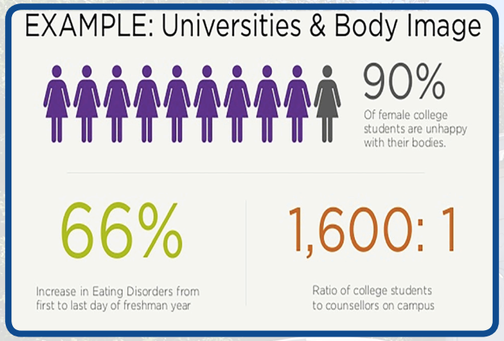
Fitness Technology: Calorie Counting or College Concern?

Authored by: Jinny Yoo
Edited by: Preethi Reddi
Reviewed by: Dr. Waqar Azeem

Swamped with responsibilities from labs, lunch plans, and club meetings to office hours, sports practice, and exams, college students can find themselves overburdened with the increasingly frenetic pace of life. Adjusting to the availability of food on campus, students reach for those late night meals and snacks as a solution to stress, only to realize that comfort food has added onto the mountain of weight they carry on their shoulders. Going to the gym feels like a chore after spending hours at the library, and meal prepping feels like wasting meal plan dollars such as DUC swipes and Dooley Dollars. The simple math behind weight management is calories in should equate calories out, and as basic as it sounds, it is difficult to follow while trying to balance a myriad of other responsibilities. It is the oversight of these dietary basics which could trigger the start of mental, social, or physical health deterioration (Hoerr, 2002). It is essential to discuss how these factors, technology, and other biological characteristics can tie in to affect college students' eating habits to shed light and awareness on this augmenting concern.

Students reach for those late night meals and snacks as a solution to stress, only to realize that comfort food has added onto the mountain of weight they carry on their shoulders.

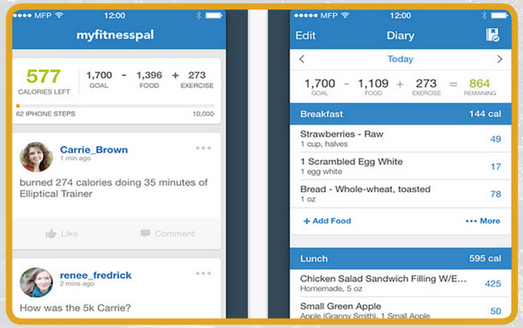
Because of this transition and the inevitable weight gain, students tend to turn to quick solutions for lifestyle habits. With easily accessible online apps, the usage of fitness calorie counting has sharply augmented, particularly for young adults. These online apps, such as MyFitnessPal, can track one's daily calories eaten, step count, calories burned through exercise, water intake, and nutritional content with the push of a button. However, some users can find themselves sucked in by the numbers, meticulously calculating every gram of each ingredient eaten in order to maintain an unreasonable daily caloric intake goal. The diligence required by fitness apps can potentially lead to an unstable path towards eating disorders, conditions that are defined by abnormal eating habits (Levinson, 2017).



According to Dr. Megan Jones of Stanford University, 90% of female college students are unhappy with their bodies, and the count of eating disorders increases by 66% after freshmen year. (Jones, 2016).

A significant number of college students struggling with serious body dissatisfaction and eating disorders use methods of laxatives, vomiting, and excessive exercise to compensate for their overeating. In a particular study of undergraduate students, 11.9% of the sample had an elevated risk of developing an eating disorder; 40.2% had experienced objective binge eating in the past month; and 30.2% had taken action in response to their eating habits through taking pills, vomiting, or exercising in the past month (Lipson, 2016). In another study of 107 individuals diagnosed with eating disorders, 73% of the subjects believed that MyFitnessPal contributed to their disorders. A third study of undergraduate students found that symptoms of eating disorders were correlated with fitness tracking device usage, with nearly one-seventh of the sample already regular users of fitness tracking apps (Rubanovich, 2017). These numbers confirm that undergraduate students struggle with their weight and health maintenance.

Although some features of fitness apps may be triggering or motivationally detrimental for users, the benefits of an online community of resources and empathetic members should still be considered. Indeed, there have been many successes for fitness app users. Thus, another question arises: what distinguishes fitness app users who develop unhealthy eating habits from those who do achieve their health goals? There are various characteristics that have been identified with victims of eating disorders, but these traits are also quite distinguishable between the two biggest types of eating disorders: bulimia and anorexia nervosa.



Screenshot of a popular fitness app, MyFitnessPal, which encourages users to log daily caloric intake and exercise and share it on an online community. (Dholakia, 2015).

Bulimia, a condition in which an individual partakes in purging activities through vomiting or excessive exercise after consuming substantial amounts of food, is associated with those who display a higher inclination towards impulsiveness and a heightened sense of reward and motivation. For instance, it was discovered that when money was factored in as a reward, bulimic women were faster at card-sorting activities than were non-bulimics. Also, the nature of bulimia, in which many victims feel a loss of control over the food they consume, can be very impulsive and based on a sensitivity for reward (Frank, 2004). These defining characteristics of bulimia could be associated with how apps such as MyFitnessPal perpetuate the misconception that exercise alone can compensate for excessive daily caloric intake; although this holds true in some cases, it is possible that this can be taken to an extreme level of belief and support unhealthy exercise routines and dietary habits.

On the other hand, anorexia nervosa, in which patients restrict their diets to unhealthy caloric amounts, has been associated with certain personality traits such as obsessiveness, perfectionism, and rigidity (Frank, 2004). The practice of strict calorie-counting can result in a disproportionate regulation of dietary intake, ultimately creating an addictive game that encourages this type of obsessive behavior. Correlational research has found that calorie-counting apps further reinforce the controlling tendencies that are highly prevalent among anorexics. However, it is rather impossible to assuredly categorize people as these defining traits, and assessing each potential user prior to accessing the apps is not likely. Thus, all college students should tread the world of fitness apps with caution. Developing and maintaining a healthy sleep schedule, exercise regime and beneficial nutrition is a lifestyle change that cannot occur overnight, but with due practice will be very rewarding.

The desire to lose weight, paired with perfectionism and misunderstanding of healthy weight loss practices, makes college students particularly susceptible to the dangerous, calculative nature of easily accessible calorie counting and fitness apps. Reduction of caloric intake, however, is not always the only factor involved in weight loss, as every human body reacts differently to compensate for the caloric deficit (Benton, 2017). While this investment may prove rewarding if managed properly, it can unknowingly initiate a spiraling road of obsession that affects not only one's physical health, but also one's emotional, social, and academic well-being. Remembering this is the first step to a healthy lifestyle, to which balance is key.

Images:

Dholakia, S. (2015, September 14). A New Definition For Marketing: Lessons From MyFitnessPal. [Digital Image]. Retrieved October 24, 2017, from https://marketingland.com/new-definition-marketing-lessons-my-fitnesspal-140893

Jones, M. (2016, February 26). New technologies in the prevention and treatment of eating disorders. [Digital Image]. Retrieved October 09, 2017, from https://www.slideshare.net/MeganJones28/new-technologies-in-the-prevention-and-treatment-of-eating-disorders

References:

Benton, D., & Young, H. A. (2017). Reducing Calorie Intake May Not Help You Lose Body Weight. Perspectives on Psychological Science,174569161769087. doi:10.1177/1745691617690878

Frank, G. K. (2004). The Role of Neurotransmitter Systems in Eating and Substance Use Disorders. Eating Disorders, Addictions and Substance Use Disorders,28(3), 47-70. doi:10.1007/978-3-642-45378-6_3

Hoerr, S. L., Bokram, R., Lugo, B., Bivins, T., & Keast, D. R. (2002). Risk for Disordered Eating Relates to both Gender and Ethnicity for College Students. Journal of the American College of Nutrition,21(4), 307-314. doi:10.1080/07315724.2002.10719228

Levinson, C. A., Fewell, L., & Brosof, L. C. (2017). My Fitness Pal calorie tracker usage in the eating disorders. Eating Behaviors,27, 14-16. doi:10.1016/j.eatbeh.2017.08.003

Lipson, S., & Sonneville, K. (2017). Eating disorder symptoms among undergraduate and graduate students at 12 U.S. colleges and universities. Eating Behaviors,24, 81-88. doi:10.1016/j.eatbeh.2016.12.003

Pappa, G. L., Cunha, T. O., Bicalho, P. V., Ribeiro, A., Silva, A. P., Jr, W. M., & Beleigoli, A. M. (2017). Factors Associated With Weight Change in Online Weight Management Communities: A Case Study in the LoseIt Reddit Community. Journal of Medical Internet Research,19(1). doi:10.2196/jmir.5816

Rubanovich, C. K., Mohr, D. C., & Schueller, S. M. (2017). Health App Use Among Individuals With Symptoms of Depression and Anxiety: A Survey Study With Thematic Coding. JMIR Mental Health,4(2). doi:10.2196/mental.7603

Simpson, C. C., & Mazzeo, S. E. (2017). Calorie counting and fitness tracking technology: Associations with eating disorder symptomatology. Eating Behaviors,26, 89-92. doi:10.1016/j.eatbeh.2017.02.002

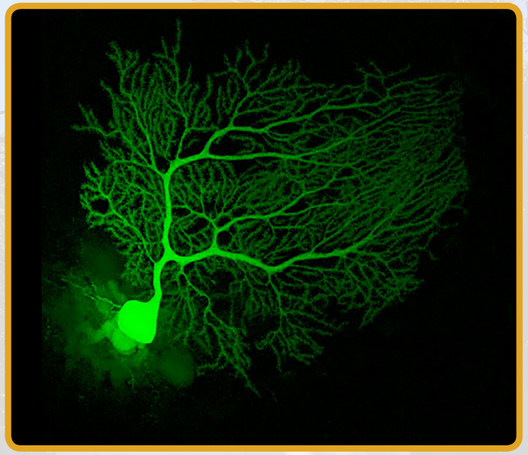
Solbrig, L., Jones, R., Kavanagh, D., May, J., Parkin, T., & Andrade, J. (2017). People trying to lose weight dislike calorie counting apps and want motivational support to help them achieve their goals. Internet Interventions,7, 23-31. doi:10.1016/j.invent.2016.12.003

A Matter of Life and Death: Can We Explain Near-Death Experiences?

Authored by: Deanna Altorama
Edited by: Preethi Reddi **Reviewed by: Dr. Paul Garcia**

Momento mori. Remember that, you too, will die.

You are going to die. It is a fact. But what is death going to be like? What happens in those final few minutes of life—and the ones that come immediately thereafter? Survivors of near-death experiences (NDEs) often recount their interactions with the afterlife. Until now, these stories, and the religions they kindle, have been all we have had to learn about death. But modern science is beginning to explore what happens to the brain when we die—and is revealing that death is much more complex than we have ever imagined. The brain undergoes mysterious changes in chemistry and electrical activity immediately before and after death. Could these changes explain the stories of bright lights, tunnels, and even heaven itself? How will these discoveries impact religion? Where is the line between life and death, and what impact does that have on end-of-life decisions?



Colorized image of a mouse neuron ("Purkinje cell from mouse cerebellum injected with Lucifer Yellow," 2016).

But modern science is beginning to explore what happens to the brain when we die—and is revealing that death is much more complex than we have ever imagined.

According to critical-care physician Sam Parnia in his book Erasing Death, dying should be seen as "a process, not a moment" (Marantz, 2016). Different parts of the body shut down at different rates, as tissues continue to function until they exhaust their oxygen supply. This is why some living processes, such as excretion, may continue for hours after death is officially declared. The brain, on the other hand, requires intense amounts of energy, making it the first organ to begin to lose power. But as the body slowly shuts down, what is happening inside the brain? Studies have shown unusual patterns of brain activity immediately before death, lending the living some clues into their own post-mortem futures.

Early stages of oxygen deprivation primarily affect the hippocampus—a delicate structure of the brain that is responsible for short-term memory. This process explains why many people who experience blackouts during a trauma will not remember the events immediately preceding the injury. Once the hippocampus loses function, the cerebral cortex, which directs cognition and individual personality, is damaged as well (Marantz, 2016). According to neurologist Cameron Shaw, "our sense of self, our sense of humor, our ability to think ahead— that stuff all goes within the first 10 to 20 seconds [of dying]. Then, as the wave of blood-starved brain cells spread out, our memories and language centres short out, until we're left with just a core" (Morris, 2017). In these final moments, the brain undergoes a final surge in electrical activity before fading out. Dr. Shaw takes this as evidence that near-death experiences (NDEs), like the light at the end of the tunnel, are simply an illusion propagated by our brains. According to this argument, as the brain regions involved in reasoning begin to falter, strange electrical phenomena create sensations that are often misperceived by the areas of the brain that are still struggling to operate.

No one knows what actually happens during a near-death experience. Survivors often give accounts

that are rich in detail and imagery, sometimes paranormal or heavenly in nature. One of the first recorded instances of a NDE appears in Plato's Republic, where the Myth of Er describes a soldier who died in battle and remained dead for ten days, only to awaken and share insights into the afterlife with his living compatriots. Indeed, many believe that NDEs contain some of the best clues available about the afterlife, and are even considered by some as evidence of heaven. Many NDE survivors tell of similar sensations: in one study examining the testimonies of survivors, 80% expressed a feeling of being at peace, 69% recalled seeing a bright light, and 63% encountered certain loved ones or figures (Martial, 2017). But are these similarities caused by spiritual or physical transformations? Are they descriptions of a common afterlife or of perceptual "glitches" in the dying brain?

It is possible that those experiencing death are perceiving things that the living cannot.

Some argue that the process of death, rather than making people less aware, raises them to a state of heightened consciousness. It is possible that those experiencing death are perceiving things that the living cannot. A study of brain wave activity in rats in cardiac arrest examined the patterns of gamma-ray oscillations, theta rays, and alpha rays. The results corresponded with normal cognitive function, but occurred at a higher level of intensity, suggesting that information was consciously being processed at a higher-than-normal state of awareness (Borjigin, 2013).

The idea of varying states of consciousness may sound familiar—brain activity is known to correspond with alternating levels of awareness during sleep. And sleep may lend another clue to how this state of consciousness works; people who have experienced NDEs are also more likely to report a sleep disturbance called REM-intrusion (Lickerman, 2011). REM (rapid eye movement) is a phase in the sleep cycle where the eyes (though remaining closed) move rapidly and randomly. It is also the state in which muscles are relaxed beyond waking control and in which dreaming occurs. REM-intrusion is when the REM pattern occurs while awake or

The brain is responsible for many things... Can the same processes that underlie dreaming also cause NDEs? (Walker, 2016)

awakening, resulting in sleep paralysis—the sensation of being unable to move despite being awake. It is possible that people susceptible to REM-intrusion are more likely to experience NDEs, as their perceptions blur the lines between the different states of consciousness they transition through.

Is death a process? An illusion? With brain-dead patients now able to survive indefinitely on life support, the definition of death is becoming increasingly murky. Some coma patients have exhibited an ability to communicate through deliberately altering their brain activity while undergoing fMRI scans. One patient in particular was able to respond 'yes' to yes/no questions by imagining himself playing tennis, a former hobby. This patient correctly answered five of the six yes/no questions asked of him (one of which had an inconclusive response). Out of the 54 patients tested, five demonstrated evidence of awareness (Monti, 2010). Brain death is diagnosed by the presence of three conditions: coma, apnea, and irreparable loss of brainstem-controlled reflexes. Is it possible that people who are clinically brain dead are still conscious? That they have perhaps been elevated to an otherworldly level of consciousness? These ethical questions have powerful ramifications not only in personal faith, but also in issues as to when it is appropriate to take someone off of life support or to collect organ donations.

These questions of mortality might never be answered. Perhaps they should never be answered—or only answered in death itself. On his deathbed, Henry Ward Beecher proclaimed his last words, "Now comes the great mystery!" The one thing that is not a mystery about death?

It stuns us all.

Images:

Purkinje cell from mouse cerebellum injected with Lucifer Yellow [Digital image]. (2017, September 3). Retrieved from https://commons.wikimedia.org/wiki/File:3_recon_512x512.jpg

Walker, L. (2016, November 17). An illustration to showcase the brainactivity during REM-sleep. [Digital image]. Retrieved from https://upload.wikimedia.org/wikipedia/commons/5/54/REM-s%C3%B8vn.jpg

References:

Britt, R. R. (2006, April 12). Near-death experiences linked to sleep oddities. Retrieved September 25, 2017, from http://www.nbcnews.com/id/12274186/ns/technology_and_science-science/t/near-death-experiences-linked-sleep-oddities/#.WdZ3WpOGPVo

Goila, A. K., & Pawar, M. (2009). The diagnosis of brain death. Retrieved September 23, 2017, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2772257/

Greyson, B., Long, J. P., Nelson, K. R., Mattingly, M., Lee, S. A., & Schmitt, F. A. (2006). Does the arousal system contribute to near death experience? Neurology,67(12), 2265-2265. doi:10.1212/01.wnl.0000252725.89247.7b

Lamacchia, J. C., Frazier, H. N., & Roth, M. B. (2015). Glycogen Fuels Survival During Hyposmotic-Anoxic Stress in Caenorhabditis elegans. Genetics, 201(1), 65-74. doi:10.1534/genetics.115.179416

Lickerman, A. (2011, May 15). The Neurology Of Near-Death Experiences. Retrieved September 23, 2017, from https://www.psychologytoday.com/blog/happiness-in-world/201105/the-neurology-near-death-experiences

Marantz Henig, R. (2016, April). Crossing Over: How Science Is Redefining Life and Death. National Geographic. Retrieved September 23, 2017, from http://www.nationalgeographic.com/magazine/2016/04/dying-death-brain-dead-body-consciousness-science/

Martial, C., Cassol, H., Antonopoulos, G., Charlier, T., Heros, J., Donneau, A., . . . Laureys, S. (2017). Temporality of Features in Near-Death Experience Narratives. Frontiers in Human Neuroscience, 11. doi:10.3389/fnhum.2017.00311

Monti, Martin M., et al. "Willful Modulation of Brain Activity in Disorders of Consciousness." New England Journal of Medicine, vol. 362, no. 7, 2010, pp. 579–589., doi:10.1056/nejmoa0905370.

Morris, Lulu. (2017, March 27). This is What Happens 30 Seconds Before You Die. Retrieved September 23, 2017, from http://www.nationalgeographic.com.au/science/this-is-what-happens-30-seconds-before-you-die.aspx

Norton, L., Gibson, R. M., Gofton, T., Benson, C., Dhanani, S., Shemie, S. D., . . . Young, G. B. (2016). Electroencephalographic Recordings During Withdrawal of Life-Sustaining Therapy
Perri, C. D. (2014). Measuring consciousness in coma and related states. World Journal of Radiology, 6(8), 589. doi:10.4329/wjr.v6.i8.589

Triggle, D. (2013). Faculty of 1000 evaluation for Surge of neurophysiological coherence and connectivity in the dying brain. F1000 - Post-publication peer review of the biomedical literature. doi:10.3410/f.718073954.793482247

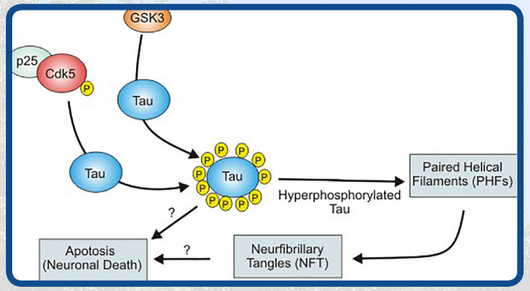
Until 30 Minutes After Declaration of Death. Canadian Journal of Neurological Sciences / Journal Canadien des Sciences Neurologiques,44(02), 139-145. doi:10.1017/cjn.2016.309

Detecting Dementia: Does Your Blood Tell the Future?

Authored by: Daniel Bujnowski
Edited by: Jonathan Regenold **Reviewed by: Dr. David Pallas**

Although usually associated with the brain, Alzheimer's Disease(AD) is connected to several human organs. The spectrum of bodily abnormalities in AD patients ranges from blood cells to liver cells and ultimately affects the brain. This progressively neurodegenerative disease then ensues with dementia and death on average around eight years after diagnosis ("What Is Alzheimer's?", n.d.). Dementia proceeds with the loss of memory and cognition, which decreases the patient's autonomy and inflicts the social burden accompanying memory loss on relatives and friends. So how can molecules in your blood indicate brain damage?

In order to understand the several players that contribute to AD progression, it is necessary to comprehend AD's effects on the human body. Currently, researchers attribute many of the symptoms of AD to abnormalities in Tau protein function. Tau is responsible for microtubule organization, neurite growth, and axonal transport lanes (Bloom, 2014). In AD patients' brain tissue, Tau is found abnormally aggregated to itself in Neurofibrillary Tangles (NFTs). The complex process of forming aggregates is caused by several mechanisms, but most often, by Tau hyperphosphorylation. The signaling cascade behind this process is traced back to several biochemical abnormalities, one of which is the malfunction or reduced level of a methyltransferase, specifically Leucine Carboxyl Methyltransferase-1 (LCMT-1). In healthy organisms, this enzyme methylates an amino acid, Leucine 309, in the protein PP2A's catalytic tail. However, when LCMT-1 malfunctions, it cannot methylate PP2A, preventing the binding of other subunits that require PP2A methylation for their binding (Tolstykh, Lee, Vafai, and Stock, 2000; Yu et al. 2001). These subunits are necessary for Tau dephosphorylation, a process that permits Tau to carry out its microtubule organizing functions, thus preventing the formation of NFTs. The absence of these subunits contributes to Tau hyperphosphorylation, a prerequisite for NFTs (Xu, Chen, Zhang, Jeffrey, & Shi, 2008).

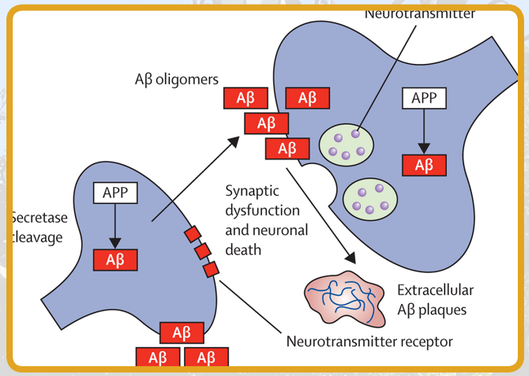


Final Reactions of the Tau Hyperphosphorylation Signaling Cascade (MCDB 109L: Tau hyperphosphorylation, n.d.).

It is still unknown how the ensuing NFTs contribute to AD or whether they are just passive symptoms; however, their presence is an accurate indicator of the disease. Currently, the scientific community generally regards NFTs as one of the causes of dementia rather than simply a peripheral marker for the disease's onset. The presence of amyloid beta plaques is another known indicator of AD thought to be involved in Alzheimer's dementia phenotype (Sadigh-Eteghad et al., 2015).

In AD patients, segments of the healthy amyloid precursor protein are found clumped in presumably toxic plaques between neuronal synapses and are thought to disrupt the transfer of electrical signals. These beta amyloid plaques consist of several 40-42 amino acid peptide chains of the amyloid precursor protein and beta amyloid ("What Happens to the Brain," n.d.). The formation of toxic beta amyloid plaques has been extensively studied since its discovery in 1906; however, despite the vast amount of research on the amyloid protein, drugs have been unsuccessful in preventing AD progression by disrupting these plaques. To this day, there is no cure or viable treatment.

Blood is a prime suspect in the development of many neurological diseases and dementia. Although blood does not make direct contact with the brain, molecules found between blood cells that can cross the blood-brain barrier (BBB) readily nourish neurons (Jimenez et al., 2014). The BBB is permeable to lipid soluble molecules which can passively diffuse through it while selective transport regulates the movement of other substances. Although amyloid beta plaques are not able to diffuse between healthy BBB's, beta amyloid precursor proteins can easily flow into and out of the brain. (Laterra, Keep, and Betz, 1999).



Amyloid-beta plaques blocking synapses (Ballard et al., 2011).

Currently, AD risk detection is restricted to rare genetic testing (which is only useful for certain carriers of risk markers for AD) and to physical and mental symptom analysis. This second method of testing mentioned is extremely disadvantageous since it can only be practiced once a patient begins noticing symptoms of AD, a point where the damage from dementia is irreversible with today's medicine ("Diagnosing Alzheimer's," 2016). The lack of testing and treatment leaves the patient completely helpless to improving the symptoms of dementia.

In contrast, there are several new AD tests that are being released to the mass market which claim to have the ability to diagnose the disease several years before symptoms may arise. One new accurate test can diagnose dementia or AD up to 15 to 20 years before symptoms are observed (Coghlan, 2017). This detection method is a simple blood test for beta amyloid precursor proteins which circulate through AD patients' and healthy individuals' blood streams. Researchers at Washington University in St. Louis discovered that the concentrations of these proteins vary in AD patients and healthy individuals and developed a method that tests the ratio between beta amyloid 42 and beta amyloid 40.

"Levels of amyloid beta 42 relative to amyloid beta 40 were consistently 10 to 15 percent lower in the people with amyloid plaques" (Washington University School of Medicine, 2017).

This slight but regular difference in beta amyloid types is an accurate indicator of the disease, allowing the researchers to correctly diagnose whether the patient had a buildup of beta amyloid plaques in his brain 89% of the time (Washington University School of Medicine, 2017). The precursors to beta amyloid plaques can be found in blood several years before any irreversible damage occurs to the patient. Previously, the only way to test for beta amyloid plaque buildup was by expensive PET scans and painful and dangerous spinal taps. This test boasts several positive features such as its non-invasive structure, relatively inexpensive cost, and early detection; however, it may result in false positive results since it is unclear whether the buildup of beta amyloid plaques is the root of AD and not just a side effect ("Diagnosing Alzheimer's," 2016).

The invention of new methods for disease diagnosis is always communally beneficial. As the human population exponentially grows, individuals will suffer from more variations of diseases and will require increasingly custom tests to diagnose and protect themselves. Consequently, the production of safer, less invasive techniques that are relatively inexpensive will continue to increase the life expectancy of human beings. The success of the aforementioned blood test is the first step in extending this goal for AD patients, despite the uncertainty of the disease's injury to the human body and the current lack of effective therapies.

Images:

Ballard, C., Gauthier, S., Corbett, A., Brayne, C., Arsland, D., & Jones, E. (2011, March 1). Alzheimer's disease. [Digital image].

MCDB 109L: Tau hyperphosphorylation. [Digital image]. (n.d.). Retrieved October 10, 2017, from https://hhmi.mcdb.ucsb.edu/course/mcdb-109l-tau-hyperphosphorylation

References:

Bloom, G. S. (2014). Amyloid-β and TauThe Trigger and Bullet in Alzheimer Disease Pathogenesis. JAMA Neurology, 71(4), 505–508. doi:10.1001/jamaneurol.2013.5847

Coghlan, A. (2017, July 19). Blood test detects Alzheimer's plaques building up in brain. Retrieved October 5, 2017, from https://www.newscientist.com/article/2141198-blood-test-detects-alzheimers-plaques-building-up-in-brain/

Diagnosing Alzheimer's: How Alzheimer's is diagnosed. (2016, October 13). Retrieved October 12, 2017, from https://www.mayoclinic.org/diseases-conditions/alzheimers-disease/in-depth/alzheimers/art-20048075

Erickson, M. A., & Banks, W. A. (2013). Blood–brain barrier dysfunction as a cause and consequence of Alzheimer's disease. Journal of Cerebral Blood Flow & Metabolism, 33(10), 1500–1513. http://doi.org/10.1038/jcbfm.2013.135

Jimenez, S., Navarro, V., Moyano, J., Sanchez-Mico, M., Torres, M., Davila, J. C., Vizuete, M., Gutierrez, A., Vitorica, J. (2014). Disruption of Amyloid Plaques Integrity Affects the Soluble Oligomers Content from Alzheimer Disease Brains. PLoS ONE, 9(12); http://doi.org/10.1371/journal.pone.0114041

Laterra, J., Keep, R., Betz, L. A., et al. (1999). Blood—Brain Barrier. Basic Neurochemistry: Molecular, Cellular and Medical Aspects. 6th edition. Philadelphia: Lippincott-Raven; Available from: https://www.ncbi.nlm.nih.gov/books/NBK28180/

Sadigh-Eteghad, S., Sabermarouf, B., Majdi, A., Talebi, M., Farhoudi, M., Mahmoudi, J. (2015). Amyloid-Beta: A Crucial Factor in Alzheimer's Disease. Medical Principles and Practices, 24, 1-10

Tolstykh, T., J. Lee, S. Vafai, and J.B. Stock. Carboxyl methylation regulates phosphoprotein phosphatase 2A by controlling the association of regulatory B subunits. Embo J, 2000. 19(21): p. 5682-5691; PMCID: PMC305779.

Washington University School of Medicine. (2017, July 19). Blood test identifies key Alzheimer's marker: Study findings are significant step in predicting disease risk. ScienceDaily. Retrieved October 29, 2017 from www.sciencedaily.com/releases/2017/07/170719084821.htm

What Happens to the Brain in Alzheimer's Disease? (n.d.). Retrieved October 20, 2017, from https://www.nia.nih.gov/health/what-happens-brain-alzheimers-disease

What Is Alzheimer's? (n.d.). Retrieved October 13, 2017, from https://www.alz.org/alzheimers_disease_what_is_alzheimers.asp

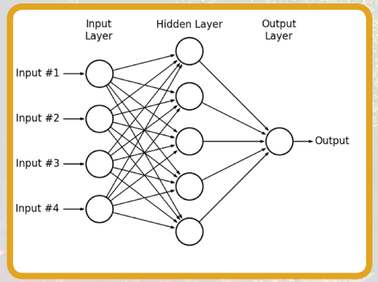
Xu, Y., Chen, Y., Zhang, P., Jeffrey, P. D., & Shi, Y. (2008). Structure of a Protein Phosphatase 2A Holoenzyme: Insights into B55-Mediated Tau Dephosphorylation. Molecular Cell, 31(6), 873. http://doi.org/10.1016/j.molcel.2008.08.006

Yu, X.X., X. Du, C.S. Moreno, R.E. Green, E. Ogris, Q. Feng, L. Chou, M.J. McQuoid, and D.C. Pallas. Methylation of the protein phosphatase 2A catalytic subunit is essential for association of Balpha regulatory subunit but not SG2NA, striatin, or polyomavirus middle tumor antigen. Mol Biol Cell, 2001. 12(1): p. 185-199; PMCID: PMC30577. 1.

Artificial Intelligence 101

Authored by: Lisa Zhang
Edited by: Anna Farrell
Reviewed by: Dr. Katherine Heiden

Imagine that a car is stopped at a red light, and everything seems normal until you look at the driver's seat: no one is there. Artificial intelligence (AI) has evolved so quickly in the last 50 years that we now have self-driving cars. Movies like Ex Machina explore a major goal that AI proposes: exhibiting intelligence equal to a human's. Accomplishing this objective comes with a plethora of technical problems such as neural networks, natural language processing, and computer vision. In addition to technical considerations, AI also raises ethical dilemmas of whether or not it is justified for a robot to take over jobs and human tasks. The world of artificial intelligence is very complex and is continually advancing from new technological and biological findings. Since its beginnings in the 1950s, AI's vast growth has raised ethical issues which cause many to question whether or not to continue with AI research.

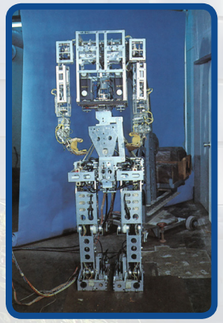


Example of how a neural network would work (Nielsen, 2017).

AI is known generally as the application of cognitive functions of the human mind onto a machine. In the early 1950s, research showed that neurons fire within neural networks (Von Foerster, 1952). Work began to form artificial neural networks in computers, progressively improving technological performance and learning (Hinton et al., 2012). This eventually led to Alan Turing's pioneering paper Computing Machinery and Intelligence, where he hypothesized that machines have the ability to think (Turing, 1950). He devised the famous Turing Test: if talking to the machine is indistinguishable from talking to a human, it has exhibited thinking. However, AI was not acknowledged as a formal area of study until 1956, when research funding began to materialize, encouraging widespread interest in the field.

With this influx of funds, a variety of different programs emerged, from solving word problems to speaking English (Norvig and Russel, 1995). While these may seem like simple operations today, at the time they were groundbreaking. These early - and now seeminlgy rudimentary - machines with natural language processing, vision, and problem solving skills eventually led to the development of deeply learned and human-like machines, such as the modern day robot. In 1972, the WABOT, the first semblance of a robot, was released in Japan, and it was equipped with a limb and vision and voice systems (Snyder, 2017). Excitement around the WABOT propelled the field forward, leading to the development of machines with wide-ranging abilities, including infectious disease diagnosis, corporate cost analysis, and interpretation of spectrometer results, etc. (Norvig & Russell, 1995).

The world of artificial intelligence is very complex and is continually advancing from new technological and biological findings.



One of the first robots with basic perception such as vision, hearing and speech (Waseda University, n.d.).

These advances gave rise to computers that harbored the ability to outsmart professionals in chess, Jeopardy, Go, and other reasoning games. In addition to building computers that could outthink humans, these researchers also built computers that could help humans—even in the domain of healthcare. AI technology has foremost facilitated advancements in technology used for data analysis in the medical field: such robust computing power, for example, endows researchers with the proper tools to target, study and edit specific sequences

of DNA in the genome with CRISPR technology (Ledford, 2016). AI—specifically machine learning—can greatly decrease the amount of time it takes to analyze genetic data, design constructs for CRISPR libraries, and resolve other diagnostic issues. However, these technologies are all relatively new developments in AI that occurred between lulls in research and funding, which gave rise to what are called "AI Winters."

Google's DeepMind AI group created AlphaGo, a computer program that beat Lee Sedol, considered a master at the game Go (Ormerod, 2016).

There have been two AI Winters since the conception of AI. Both winters accompanied a sharp decrease in funding, stalls in advancements of coding, and a decrease in general interest in research. The central reason behind the AI winters stems from the immense computing power that these programs require and the relatively limited capacities of computers at the time. This technical shortcoming, coupled with limited funding, engendered a positive feedback loop of decreased attraction. Moreover, based on our limited understanding of the biological mechanisms underlying human consciousness, some philosophers caution against attempts to endow machines with this capacity (Norvig & Russell, 1995). With this obstacle in mind, AI poses a core philosophical question as technology rapidly advances: can machines replicate the neural networks and circuits that govern our thought processes and ultimately give rise to consciousness?

... can machines replicate the actions of neurons that form our minds and ultimately consciousness itself?

When empowering something inanimate with the capacity for consciousness, we as a society must apply our own morals and ethics to define its function in society and impose regulations on its abilities. The Trolley Problem offers a well-known example of this ethical dilemma at play today. Questions regarding the degree of autonomy that we grant self-driven cars (e.g. programming a car to avoid a group of people but harm the driver versus allowing the car to save the driver at the expense of others) not only raises issues of technology, but also brings up novel ethical dilemmas. Another widespread concern is that AI will result in job loss, as robots continue to replace humans, including cashiering, transportation of goods, assembly lines, and more. How can humans ensure that AI does not get so complex that we cannot control it? Before we continue making strides in artificial intelligence, we must first address the ethical implications that this technology poses.

Images:

Humanoid Robotics Institute, Waseda University. (n.d.). WABOT-1 [Digital image]. Retrieved from http://www.humanoid.waseda.ac.jp/booklet/kato_2-j.html

Nielsen, Michael. (2017). Using Neural Nets to Recognize Handwritten Digits. Neural Networks and Deep Learning. Retrieved from http://neuralnetworksanddeeplearning.com/chap1.html.

Ormerod, David. (13 March, 2016). Lee Sedol Defeats AlphaGo in Masterful Comeback - Game 4. Go Game Guru. Retrieved from https://gogameguru.com/lee-sedol-defeats-alphago-masterful-comeback-game-4/.

References:

Bostrom, N. and Yudkowsky, E. (2011). The Ethics of Artificial Intelligence. Cambridge University Press.

Harnish, R.M. (2002). Minds, Brains, Computers: an historical introduction to the foundations of cognitive science. Blackwell.

Hinton, G.E., Krizhevsky, A., Sutskever, I (2012). ImageNet Classification with Deep Convolutional Neural Network. Neural Information Processing Systems 2012.

Humanoid Robotics Institute, Waseda University. Retrieved from http://www.humanoid.waseda.ac.jp/booklet/kato_2-j.html

Muller, Joann. (12 September, 2012). With Driverless Cars, Once Again it is California Leading the Way. Retrieved from https://www.forbes.com/sites/joannmuller/2012/09/26/with-driverless-cars-once-again-it-is-california-leading-the-way/#2345cd754b10

Somers, J. (2017) Is AI a One Trick Pony? MIT Technology Review. Retrieved from https://www.technologyreview.com/s/608911/is-ai-riding-a-one-trick-pony/
Norvig, P and Russell, S.J. (1995). Artificial Intelligence: A Modern Approach. Prentice Hall, Inc.

Turing, A. M. (1950). Computing Machinery and Intelligence. Mind 49: 433-460.

Warwick, K. (2013). The Future of Artificial Intelligence and Cybernetics. OpenMind. Retrieved from https://www.bbvaopenmind.com/en/article/the-future-of-artificial-intelligence-and-cybernetics/?fullscreen=true

Von Foerster, Heinz. (1952). Biological Ideas for the Engineer. New Scientist.

Featured Articles from our Blog!

Health Reform's Impact on Litigation

Authored by: Sharvil Patel

As the American sphere of healthcare innovation progresses, the political and commercial background that facilitates the implementation of procedures and techniques to reduce adverse health outcomes has become a realm of discord and controversy. Because medical advances in America operate under a strict regulatory environment, perturbations in bureaucratic contexts disrupt beneficial movements in the medical sphere.

More recently, the Congressional gridlock stemming from the inability to reach a functional compromise in dispersing health insurance has increasingly diminished the ability of healthcare providers to maneuver the logistics of healthcare. Physicians are mired in confusing, contradictory policy shifts at the federal and state level. The inefficiencies from the highest levels of policymaking then trickle down into individual hospitals and practices, affecting every patient at the individual level. Indeed, a nationally representative survey conducted by the Deloitte Center for Health Solutions reported that only fifty percent of the surveyed physicians had ever heard of the Obama administration's revolutionary health reform in 2015 for physician reimbursement, known as MACRA (Copeland, Phelps, & Cruse, 2017). Unfortunately, the changing health policies have not only created turbulent financial waters, in terms of insurance policies, for physicians to navigate, but have also redesigned the litigatory landscape that physicians must navigate.

Dramatic shifts in healthcare policy can help explain the recent explosion general malpractice claims through the country. A study by RAND in 2014 quantifies this impact, estimating a $120 million increase in medical malpractice claims as a response to healthcare reform law (Demko, 2014). As legislators continue to revise existing healthcare policies, lawyers can more easily exploit legal loopholes for patients and, as an unintended consequence, undermine the physicians who tried to save their lives. Indeed, the US Chamber of Commerce indicated that these effects are materializing in the real world as advertisements looking for potential malpractice lawsuits increased by 1,400% because of their promise of an easy payday ("Trial Lawyer TV Ads," 2009).

In state legislatures, the issue of malpractice lawsuits, as a consequence of insurance reform, are neglected. Only six states have holistic caps, limits on economic and non-economic damage payouts, for medical malpractice cases, while 19 states have no cap at all ("Fact Sheets," 2017). Without a legislated restriction on predatory litigation targeting physicians, the complications of defensive medicine, the phenomenon in which physicians recommend excessive diagnostic tests and treatments to reduce legal liability, will only be exacerbated, harming the healthcare providers, patients, and economy in one fell swoop. Furthermore, healthcare reform will magnify defensive medicine regardless of the actual direction of medical litigation claims; physicians aggressively practice defensive medicine when they perceive an increase in their liability risk, a common concern generated by healthcare reform (Seabury, 2016).

An Advertisement Using Easy Pay to Attract Customers ("Advertisement for Malpractice Lawsuit," 2015).

As healthcare reform progresses into its uncertain future, it is essential that improving quality and access constitute the fundamental goals of reform; however, that end is unachievable if healthcare providers must combat legal challenges along with their medical challenges. Consequently, any attempts to implement an equitable health insurance policy without the unintended consequence of commercial exploitation, federal and state legislators need to include tort reforms that both prevent patients and lawyers from taking advantage of employees in the healthcare sector and assuage physicians' fears of malpractice lawsuits.

References:

Copeland, B., Phelps, A., & Cruse, C. B. (2017, July 11). MACRA: Disrupting the US health care system at all levels. Retrieved from https://www2.deloitte.com/us/en/pages/life-sciences-and-health-care/articles/macra.html

Demko, P. (2014, April 14). Reform Update: Obamacare will boost malpractice claims, RAND study says. Retrieved from http://www.modernhealthcare.com/article/20140414/NEWS/304149963

Fact Sheet: Caps On Compensatory Damages: A State Law Summary. (2017, June 22). Retrieved from https://centerjd.org/content/fact-sheet-caps-compensatory-damages-state-law-summary

Seabury, S., Jena, A.B. (2016, May 16). Why do so Many Doctors Practice Defensive Medicine? Maybe Because it Works. Retrieved from http://evidencebase.usc.edu/why-do-so-many-doctors-practice-defensive-medicine-maybe-because-it-works/

Trial Lawyer TV Ads for Medical Malpractice Lawsuits Grew 1,400 Percent in Last Four Years, Study Shows. (2009, September 7). Retrieved September 22, 2017, from https://www.uschamber.com/press-release/trial-lawyer-tv-ads-medical-malpractice-lawsuits-grew-1400-percent-last-four-years

Image:

[Advertisement for Malpractice Lawsuits]. (2015, July 26). Retrieved September 22, 2017, from https://www.youtube.com/watch?v=X_kAsEWMcUE

Aging in Healthcare — Perspectives from an Older Population

Authored by: Han Li

We live in a Golden Age of medicine. With a cutting edge and increasingly diverse wealth of disease diagnostics, prevention, and treatment, people across the world are living stronger, healthier, and longer. In the past fifty years alone, the average lifespan of citizens in the US leaped from 69 to 78 (World Bank Group, 2015). Especially in developed countries, population aging is expected to rapidly accelerate in the next fifty years; the number of people aged 65 or older is projected to triple from 500 million in 2010 to nearly 1.5 billion in 2050 (National Institute on Aging, 2011).

Population aging is a powerful and multifaceted demographic force, yet we are only just beginning to see its impact on healthcare resources. With a population characterized by aging more than ever before, how can our healthcare system adjust to the increasing costs? How can we optimize care for our seniors, even as the number of retirees begins to outnumber the working population? How are current policymakers and public health researchers collaborating to address potential issues caused by population aging?

Faced with a never-before-seen challenge, public health professionals are encouraged to adapt their strategies in order to better support an accelerating aging population. These approaches divide population aging into three challenges: an increased healthcare burden, a reduction in workforce size, and a dramatic increase in non-communicable diseases (Bloom, 2011). The Centers for Medicare and Medicaid Services (CMS) have led a number of initiatives tackling the foremost of these challenges, aiming to provide preventive and restorative measures to Medicare beneficiaries inside their own homes and to reduce unnecessary medical costs ("Aging and Health," 2017). These initiatives have had a lot of success, reducing the patient hospitalization rate to less than 2% and patient quarterly Medicare expenditures to near zero in some cases. Because of the realization that premature mortality can result from factors beyond the expected physiological scope, CMS has also focused on reducing the use of unnecessary psychoactive drugs and the rates of rehospitalization. Deemed the "enhanced care and coordination providers," the CMS partnered with several healthcare providers to send pods of nurse practitioners and physician assistants to maintain on-site "clinics" in long-term care facilities in order to reduce the need to transfer unnecessarily to hospitals. Generally, the new programs have been designed to bring healthcare to the patient and to prevent disease proactively.

Indeed, one of our most powerful weapons against non-communicable diseases, like stroke, diabetes, and dementia, involves disease prevention (Fries, 2005). Armed with data from 32 programs involving employee health risk reduction, the CMS identified several characteristics that consistently enabled employees to care for themselves, even after the end of the programs (Goetzel et al., 2007). In 2007, CMS created the Senior Risk Reduction Demonstration, which again partnered with private companies to disseminate tailored programs for elderly health. The findings, released in 2012, saved up to $958 in healthcare costs per patient, and it reduced their likelihood for hospitalization by 14.2% (Kahvecioglu et al., 2012). Since then, there's been an explosion of private vendor programs, all aiming at providing evidence-based health promotion for seniors (National Council on Aging, 2017).

Finally, public health researchers and policymakers have been collaborating to address the issue of a diminishing workforce. In theory, allowing older adults to continue engaging in work will allow them to better maintain their mental faculties (Williams & Kemper, 2010), as well as reduce the stress on the Medicare system. Many argue to do this by delaying the retirement age; however, current policymakers have utilized less drastic measures in order to prepare the political climate for this change. For example, the Social Security Administration offers up to 32% additional benefits for those who retire after age 70 (Maranjian, 2017; Wohlner, 2017), which has led to a number of articles exploring the opportunities and highlighting the personal benefits of delayed retirement. It seems that the effects of this policy have yet to be fully understood, but for now, the results certainly seem promising (Shoven & Slavov, 2012).

The relationship between health and age involves not just public health but an interdisciplinary wealth of economic, political, and environmental factors. A better understanding of what exacerbates aging is a fundamental step to building infrastructure in order to support our aged population. In recent decades, geriatric public health has initiated many more holistic approaches to elderly care, and it will be exciting in future years to see how health and aging intertwine.

References:

Aging and Health. (2017). Health Affairs,36(10), 1696-1697. doi:10.1377/hlthaff.2017.0874. Retrieved October 19, 2017, from https://www.healthaffairs.org/doi/abs/10.1377/hlthaff.2017.0874

Bloom, D. E., Börsch-Supan, A., McGee, P., & Seike, A. (2011). Population aging: facts, challenges, and responses. St. Gallen: WDA-Forum, Univ. of St. Gallen.

Evidence-Based Health Promotion Programs for Seniors. (2017). Arlington, VA: National Council on Aging. Retrieved October 18, 2017, from https://www.ncoa.org/resources/ebpchart/

Fries, J. F. (2005). Frailty, heart disease, and stroke: the Compression of Morbidity paradigm. American Journal of Preventive Medicine, 29(5 Suppl 1), 164–168. https://doi.org/10.1016/j.amepre.2005.07.004

Global health and aging. (2011). Bethesda, MD: National Institute on Aging, National Institutes of Health, U.S. Department of Health and Human Services. Retrieved October 20, 2017, from https://www.nia.nih.gov/sites/default/files/2017-06/global_health_aging.pdf.

Goetzel, R. Z., Shechter, D., Ozminkowski, R. J., Stapleton, D. C., Lapin, P. J., McGinnis, J. M., … Breslow, L. (2007). Can health promotion programs save Medicare money? Clinical Interventions in Aging, 2(1), 117–122.

Kahvecioglu, D., Fout, B., Weinberg, D., Bill, N., Kahn, K., & Sen, N. (2012, April 04). Evaluation of the Senior Risk Reduction Demonstration (SRRD) Under Medicare-First Year Report [Abstract]. Retrieved October 18, 2017, from https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/Reports/Research-Reports-Items/SRRD_Eval_First_Year_Report.html

Life expectancy at birth, total (years). (2015). Washington, DC: World Bank Group. Retrieved October 19, 2017, from https://data.worldbank.org/indicator/SP.DYN.LE00.IN

Maranjian, S. (2017, February 26). 3 Reasons to Delay Taking Social Security. Retrieved October 19, 2017, from https://www.fool.com/retirement/2017/02/26/3-reasons-to-delay-taking-social-security.aspx

Shoven, J., & Slavov, S. N. (2012). When Does It Pay to Delay Social Security? The Impact of Mortality, Interest Rates, and Program Rules. Journal of Pension Economics and Finance,121-144. doi:10.3386/w18210

Williams, K., & Kemper, S. (2010). Exploring Interventions to Reduce Cognitive Decline in Aging. Journal of Psychosocial Nursing and Mental Health Services, 48(5), 42–51. https://doi.org/10.3928/02793695-20100331-03

Wohlner, R. (2017, September 05). Tips on Delaying Social Security Benefits. Retrieved October 19, 2017, from http://www.investopedia.com/articles/financial-advisors/010416/tips-delaying-social-security-benefits.asp

Looking into the Future of Heart Procedures

Authored by: Jake Rosen
Edited by: Alec Shannon **Reviewed by: Dr. Atul Maini**

Cardiovascular disease is the leading cause of death in the world. The World Health Organization reported that over 17 million people died from cardiovascular disease in 2015 (World Health Organization, 2017). Open heart operations have proven to be dangerous among patients who are considered high-risk because of existing comorbid conditions in their health. Luckily, new surgeries are continuing to be created in order to increase survival rates and limit potential complications from the procedure (i.e. strokes). A surgery at the forefront of innovation in this field is the transcatheter aortic valve replacement procedure, commonly known as TAVR.

Clinicians designed the TAVR procedure as a minimally invasive alternative to open heart surgery for patients with moderate to severe aortic stenosis—a term that describes the narrowing of the aortic valve from fat buildup (American Heart Association, 2017). When a stenosis hinders proper functioning of the aortic valve, the heart struggles to pump blood from the left ventricle to the aorta and, by extension, to the rest of the body. As a result, the heart must work much more strenuously and could lead to heart failure and an eventual cardiac arrest.

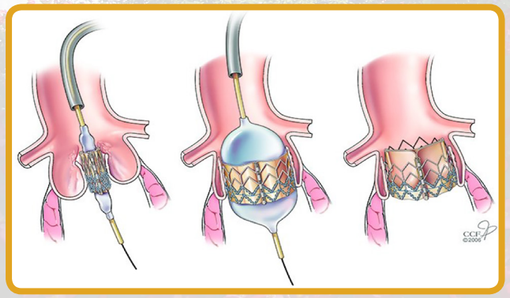


Diagram showing the catheter reach the aortic valve ("Understand Aortic Valve Stenosis," 2016).

Before the advent of TAVR, surgeons would perform an open-heart aortic valve replacement to treat the stenosis; in fact, this invasive procedure was the only option for patients who lacked a fully functioning aortic valve. However, as one would expect, there are many potential risks of receiving open heart surgery. According to the National Institutes of Health, some of the major risks that correlated with receiving open-heart surgery include stroke, bleeding, infection, and the possibility of death (American Heart Association, 2017).

> The World Health Organization reported that over 17 million people died from cardiovascular disease in 2015 (World Health Organization, 2017).

In order to find a way to fix an aortic valve with minimal intervention, the idea of using a catheter to go through one of the major arteries to the aorta came to fruition. In 2002, a patient was deemed inoperable by surgeons after an unsuccessful balloon aortic valvuloplasty (BAV), a procedure in which a catheter is inserted through an artery in the groin or arm and an expandable balloon is then used to widen the valve. The patient's overall health had diminished significantly a week after the BAV, and as surgery was no longer an option, the first TAVR was performed (Bourantas, 2014).

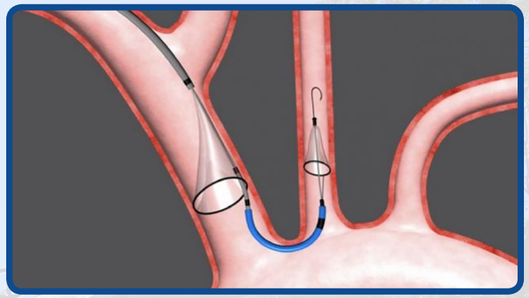
The TAVR involves a catheter that is inserted in the femoral artery in the groin or through a small cut in the left ventricle—a technique known as the apical approach. The catheter has a collapsible artificial valve that positions itself into the old valve area and expands, widening the tissue of the original valve. Then, it begins to function as the normal aortic valve, pumping blood to the rest of the body (Bourantas, 2014).

Only five years later in 2007, the first randomized trial called the Placement of Aortic Transcatheter Valves (PARTNER) began at select hospitals in the United States. This trial recruited people who were classified as high-risk or inoperable for an open aortic valve replacement (AVR) (Bourantas, 2014). The first group, Cohort B, compared TAVR patients to patients who had BAVs or were being medically treated (control). Based on one-year follow-up reports, the patients who had the TAVR reported mortality of 20.5%, while follow-ups in patients in the control group had a mortality rate of 44.6% (Bourantas, 2014). The reported hazard ratio was 0.39, meaning that the control group was 40% more likely to have died than the treatment group. Fittingly, the p-value in this study was less than 0.001. This cohort of the PARTNER trial was instrumental in furthering research on TAVRs (Bourantas, 2014).

Surgical AVRs, also known as SAVRs, were also compared in effectiveness to TAVRs. The cohort A of the PARTNER trial compared high risk patients who underwent either surgery or TAVR (Bourantas, 2014). Contrary to expectations, the results indicated no significant difference in mortality rates reported at follow-ups within one and two years. Furthermore, this piece of the trial helped unravel some of the main issues with the TAVR procedure. Foremost, TAVRs in the PARTNER trial were found to have an 11.2% rate of postoperative stroke versus SAVR's rate being 6.5% (p-value = 0.05) (Bourantas, 2014). A manuscript highlighting the complications from the TAVR procedure discusses how neurological events, like transient ischemic attacks, or TIAs, ("mini-stroke") and strokes were observed more in early TAVR patients than in SAVR patients (Miller et al., 2012). The researchers attributed this pattern in the data to patient selection.

> In order to find a way to fix an aortic valve with minimal intervention, the idea of using a catheter to go through one of the major arteries to the aorta came to fruition.

Most patients in the trial were considered extremely high-risk because of factors in their health, which were calculated into a risk score. The risk score typically used by cardiovascular surgeons is the Society of Thoracic Surgery (STS) risk score. It takes into account many factors, ranging from age and sex to various conditions or problems the patient has had in the past. These patients' valves were smaller because of the calcification buildup in the area, thus deeming them high risk. Consequently, when the artificial valve comes to push the natural valve out, fat tissue is released into the bloodstream and travels to the brain (Miller et al., 2012). This embolization can ultimately cause neurological accidents, including strokes and TIAs.



The sentinel device placed in order to catch debris (Wood, 2017).

Along with strokes, TAVRs reported a much higher rate of postoperative vascular complications than the SAVR patients (p-value < 0.001) (Bourantas, 2014). Vascular complications consist of access-related problems, aortic dissections and ruptures, or even ventricular dissections. In another European study of the Sapien valve, 10.6% of patients who had a TAVR from the transfemoral approach had a vascular complication (Thomas et al., 2010). The research group reported a considerably higher 30-day survival rate in patients that did not have a vascular complication in a transapically performed TAVR versus people who did have a vascular complication (90.7% versus 72.8%, p <0.001) (Thomas et al., 2010). Patient selection and catheter size are two important factors for explaining the high frequency of vascular complications.

Fortunately, the TAVR procedure has improved significantly in the past decade since it was introduced to the United States. In 2011, the Food and Drug Administration approved the valve for patients and, since then, over 100,000 patients in the United States have received this procedure as an alternative to an open-heart procedure (Shurren, 2017). The unprecedented rate of advancement in heart procedures has revolutionized the treatment of patients with severe cardiovascular disease. FDA approval of new heart procedures has helped to address many of the problems patients have reported in their postoperative courses. Cardiologists can address the postprocedure complication of a paravalvular leak (when crevasses occur between the outer part of the valve and the calcified tissue) by using devices to move the valve to cover the leak. They can also

use devices, such as the Sapien 3, to place a bioprosthetic valve inside of another that is not functioning properly.

To address stroke prevention in patients, new devices have been used to "catch" the tissue that can become dislodged when the valve is being put in place. One in particular is the Sentinel Cerebral Protection Device, approved by the FDA in 2017 and offered at a limited number of hospitals in the nation, the Emory Heart and Vascular Center being one of them (Woodruff Health Sciences Center, 2017). The device consists of cone-shaped structures that the physician inserts into the body via catheter in the radial artery for placement between two important arteries that connect the heart to the brain. The cones serve to trap any displaced tissue from the valve before the tissue travels to the brain. In its initial trial, it captured 99% of debris (Woodruff Health Sciences Center, 2017). Moreover, devices have evolved over time to address potential vascular complications. The sizes of the valve have decreased and researchers have investigated new methods with previously untested arteries. By decreasing the size of the valves and giving them a new sleek profile, they can navigate the arteries with fewer complications (Bourantas 2014).

TAVR has become a highly innovative procedure and has opened the door to many patients for the best treatment at the lowest risk. Although there are still underlying issues with the procedure, it has become safer and more effective with the evolution of both devices and operation practices. Ultimately, TAVR is one of the procedures that has set the course for other cardiovascular operations on the way to a less invasive future.

Images:

Understand Aortic Valve Stenosis [Digital image]. (2016, November). Retrieved from http://www.heart-advisor.com/issues/19_11/features/New-TAVR-Valves_1755-1.html#.WgkbYROPJyp

Wood, S. (2017, February 23). FDA Advisors Positive on Sentinel Cerebral Protection Device in TAVR [Digital image]. Retrieved from https://www.tctmd.com/news/fda-advisors-positive-sentinel-cerebral-protection-device-tavr

References:

American Heart Association. (2017). What is TAVR? Retrieved from http://www.heart.org/HEARTORG/Conditions/More/HeartValveProblemsandDisease/What-is-TAVR_UCM_450827_Article.jsp#.WhHoCrT81fQ

Bourantas, C. V., & Serruys, P. W. (2014, March 14). Evolution of Transcatheter Aortic Valve Replacement.

Miller, D. C., Blackstone, E. H., Mack, M. J., Svensson, L. G., Kodali, S. K., Kapadia, S., . . . Smith, C. R. (2012). Transcatheter (TAVR) versus surgical (AVR) aortic valve replacement: Occurrence, hazard, risk factors, and consequences of neurologic events in the PARTNER trial. The Journal of Thoracic and Cardiovascular Surgery,143(4). doi:10.1016/j.jtcvs.2012.01.055

Sharabiani, M. T., Fiorentino, F., Angelini, G. D., & Patel, N. N. (2016). Long-term survival after surgical aortic valve replacement among patients over 65 years of age. Open Heart,3(1). doi:10.1136/openhrt-2015-000338

Shurren, J., MD, JD, & Zuckerman, B., MD. (2017, June 14). How Creative FDA Regulation Led to First-in-the-World Approval of a Cutting-Edge Heart Valve.

Thomas, M., Schymik, G., Walther, T., Himbert, D., Lefevre, T., Treede, H., . . . Wendler, O. (2010). Thirty-Day Results of the SAPIEN Aortic Bioprosthesis European Outcome (SOURCE) Registry: A European Registry of Transcatheter Aortic Valve Implantation Using the Edwards SAPIEN Valve. Circulation,122(1), 62-69. doi:10.1161/circulationaha.109.907402

World Health Organization. (2017). Cardiovascular diseases (CVDs). Retrieved from http://www.who.int/mediacentre/factsheets/fs317/en/

Woodruff Health Sciences Center. (2017, June 06). Emory among first to use device to protect patients from stroke risk during TAVR. Retrieved from http://news.emory.edu/stories/2017/06/jjm_emory_among_first_to_offer_stroke_risk_protection_device_used_during_tavr/index.html

Antibiotic Alternatives: Essential Oils in the Fight Against Antibiotic Resistance

Authored by: Ameya Gangal
Edited by: Christopher Keyes
Reviewed by: Dr. Tyler Cymet

Nearly a century-ago, Professor Alexander Fleming serendipitously discovered the world's first known antibiotic: penicillin. Since that discovery, penicillin has become a standard prescription for infections that were once fatal. For the modern physician, antibiotics remain the weapon of choice against a host of diseases. Fleming understood the profound impact that antibiotics would one-day have on the human race: in his Nobel Prize acceptance speech in 1945, Fleming publicly announced one of the first warnings regarding antibiotic resistance (AR). Although the use of antibiotics has undoubtedly improved the health and longevity of countless people, the issue of AR has become equally prevalent. The dangers posed by antibiotic resistance have incited a worldwide concern that multiple countries and health organizations seek to address.

Agriculture plays a significant role in the fight against antibiotic resistance (Amelinckx, 2015).

Although it is tempting to assume AR is solely a problem tied to the treatment of human bacterial infections, the issue extends into the fields of agriculture and popular medical practice. In the case of agriculture, antibiotics are commonly fed to animals to prevent disease and improve production (Cheng et al., 2014). The over-prescription of antibiotics in primary care is another root cause of AR. Over 90% of all antibiotic prescriptions are written by general practitioners (Llor & Bjerrum, 2014). These compounded issues illustrate why the enormous issue of AR requires a significant change in order to be solved.

Because of the immense impact that AR can have on an array of human practices, antibiotic alternatives present the possibility to treat bacterial infections with a reduced risk of AR. Antibiotic alternatives, loosely defined as non-compound approaches that target bacteria or host structures, include essential oils and extracts that inhibit their respective target's pathogenicity (Czaplewski et al., 2016). In particular, essential oils and natural extracts have the added benefits of reduced adverse effects, increased patient tolerance, relatively low cost, and improved renewability (Yap, Yiap, Ping, & Lim, 2014).

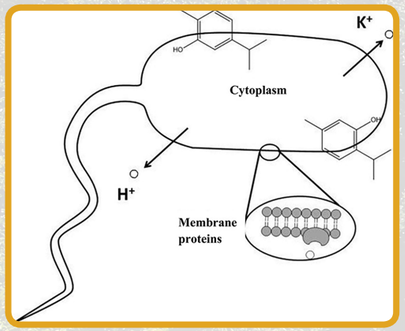
Cinnamon may be a viable alternative to antibiotics. Essential oils of cinnamon have shown beneficial effects in reducing bacterial growth in antibiotic-resistant strains (Villiis, 2017).

A common theme in the mechanism of antibiotics involves a disruption in the cellular structure of enzymatic activity of the target bacterium (Yap et al., 2014). Antibiotic alternatives, including essential oils, similarly operate by reducing the stability of a bacterial cell's components, such as the cell wall, membrane channels, or replicative activities.

Tea tree oil—a commonly used oil in facial products—has shown unique properties regarding AR. The active components of tea tree oil, terpenes, are volatile, aromatic hydrocarbons that lyse and lead to the loss of membrane integrity (Carson, Hammer, & Riley, 2006). Tea tree oil extracts can inhibit glucose-dependent respiration, further comprising another integral function of bacterial cells (Carson et al., 2006).

Another antibiotic alternative growing in popularity is cinnamon. Similar to tea tree oil, cinnamon contains polyphenols and volatile phenols (Nabavi et al., 2015). Cinnamon extracts and essential oils have also been shown to have antibacterial activity

against Gram-negative and Gram-positive bacteria (Nabavi et al., 2015). A famous study on cinnamon even revealed its efficacy against the potentially deadly infection, methicillin resistant S. aureus (MRSA) (Nabavi et al., 2015). Tea tree has also been used against the bacteria responsible for the common wound infection, Staphylococcus aureus. In addition to the clinical applications of cinnamon in antibiotic-resistant infections, cinnamon extract can be useful in the treatment of major acne-causing bacteria (Julianti, Rajah, & Fidrianny, 2017). Tea tree oil was shown to be effective in a vapor method of application in decreasing healing time and significantly improving the recovery process (Chin & Cordell, 2013).



Antibacterial mechanism of thymol and carvacrol, key extracts of oregano, disintegrating the outer membrane and increasing the cell's ion permeability (Garcia-Rodriguez et al., 2012).

In addition to tea tree oil and cinnamon, oregano—an herb commonly known for its culinary applications—may serve as another well-studied example of a compound with antibiotic properties. Oregano contains terpenoid compounds that act in a similar fashion to both cinnamon and tea tree oil. Oregano retains a low impact in terms of side effects and even has the ability to reduce levels of free radicals (Rodriguez-Garcia et al., 2016). A more striking application of oregano in the field of agriculture was its usage for meat storage. Antibiotics are commonly used to prevent the infection of meat that is stored over time; Salmonella typhimurium is a pathogen present on meats that often proliferates without the intervention of antibiotics. By supplementing the meat with a low concentration of oregano essential oil, the meat showed a reduction in bacterial populations (Skandamis, Tsigarida, & Nychas, 2002). These results support the usage of organo extracts in meat storage as a possible antibiotic alternative.

Perhaps the most exciting component of antibacterial alternatives involves a practice known as combination therapy, utilizing multiple extracts. By combining a variety of antibiotic alternatives in tandem with antibiotics, scientists predict that bacteria will experience a reduced ability to adapt to mechanisms that inhibit bacterial function. The synergistic effect of combinations of antibiotics and alternatives comes from a study that combined cinnamon extract and the antibiotic amikacin. The study showed that a multi-drug resistant bacteria showed significant reduction in bacterial growth when antibiotics and the cinnamon extract were implemented in a combination therapy (Guerra et al., 2012). A 2011 study found that chickens supplemented with oregano, cinnamon, and chili peppers actually changed gene expression, leading to increased weight and decreased susceptibility to infections (Rodriguez, 2015). By supplementing livestock with antibiotic alternatives, the researchers essentially observed that similar effects to antibiotics could be achieved. The results of this study therefore have significant implications for agricultural practices, in which animals are typically fed large amounts of antibiotics.

The exploration of antibiotic alternatives is an illuminating and necessary effort. The wide overuse of antibiotics in agriculture and primary care is a large contributor to the issue of AR. Fortunately, the use of essential oils as antibiotic alternatives may prove to be beneficial in the treatment of and protection against bacterial infections. Although the issue of antibiotic resistance may seem daunting, current progress in understanding antibiotic alternatives shows hope and promise.

Images:

Amelinckx, A. (2015 September 17) New reports tracks rise of antibiotic resistance in humans and livestock. https://modernfarmer.com/2015/09/cddep-report-antibiotic-resistance/

Garcia-Rodriguez I., et al (2012, September 4) Oregano Essential Oil as an Antimicrobial and Antioxidant Additive in Food Products. http://www.tandfonline.com/doi/figure/10.1080/10408398.2013.800832?scroll=top&needAccess=true

Villiis, Z. (2017, April 28). Can cinnamon affect blood sugar. https://www.medicalnewstoday.com/articles/317207.php

References:

Carson, C. F., Hammer, K. A., & Riley, T. V. (2006). Melaleuca alternifolia (Tea Tree) Oil: a Review of Antimicrobial and Other Medicinal Properties. Clinical Microbiology Reviews, 19(1), 50–62. https://doi.org/10.1128/CMR.19.1.50-62.2006

Cheng, G., Hao, H., Xie, S., Wang, X., Dai, M., Huang, L., & Yuan, Z. (2014). Antibiotic alternatives: the substitution of antibiotics in animal husbandry? Frontiers in Microbiology, 5. https://doi.org/10.3389/fmicb.2014.00217

Chin, K. B., & Cordell, B. (2013). The effect of tea tree oil (Melaleuca alternifolia) on wound healing using a dressing model. Journal of Alternative and Complementary Medicine (New York, N.Y.), 19(12), 942–945. https://doi.org/10.1089/acm.2012.0787

Czaplewski, L., Bax, R., Clokie, M., Dawson, M., Fairhead, H., Fischetti, V. A., … Rex, J. H. (2016). Alternatives to antibiotics—a pipeline portfolio review. The Lancet Infectious Diseases, 16(2), 239–251. https://doi.org/10.1016/S1473-3099(15)00466-1

Guerra, F. Q. S., Mendes, J. M., Sousa, J. P. de, Morais-Braga, M. F. B., Santos, B. H. C., Melo Coutinho, H. D., & Lima, E. de O. (2012). Increasing antibiotic activity against a multidrug-resistant Acinetobacter spp by essential oils of Citrus limon and Cinnamomum zeylanicum. Natural Product Research, 26(23), 2235–2238. https://doi.org/10.1080/14786419.2011.647019

Julianti, E., Rajah, K. K., & Fidrianny, I. (2017). Antibacterial Activity of Ethanolic Extract of Cinnamon Bark, Honey, and Their Combination Effects against Acne-Causing Bacteria. Scientia Pharmaceutica, 85(2). https://doi.org/10.3390/scipharm85020019

Llor, C., & Bjerrum, L. (2014). Antimicrobial resistance: risk associated with antibiotic overuse and initiatives to reduce the problem. Therapeutic Advances in Drug Safety, 5(6), 229–241. https://doi.org/10.1177/2042098614554919

Nabavi, S. F., Di Lorenzo, A., Izadi, M., Sobarzo-Sánchez, E., Daglia, M., & Nabavi, S. M. (2015). Antibacterial Effects of Cinnamon: From Farm to Food, Cosmetic and Pharmaceutical Industries. Nutrients, 7(9), 7729–7748. https://doi.org/10.3390/nu7095359

Rodriguez, T. (2015, January 16). Essential Oils Might Be the New Antibiotics. The Atlantic. Retrieved from https://www.theatlantic.com/health/archive/2015/01/the-new-antibiotics-might-be-essential-oils/384247/

Rodriguez-Garcia, I., Silva-Espinoza, B. A., Ortega-Ramirez, L. A., Leyva, J. M., Siddiqui, M. W., Cruz-Valenzuela, M. R., … Ayala-Zavala, J. F. (2016). Oregano Essential Oil as an Antimicrobial and Antioxidant Additive in Food Products. Critical Reviews in Food Science and Nutrition, 56(10), 1717–1727. https://doi.org/10.1080/10408398.2013.800832

Skandamis, P., Tsigarida, E., & Nychas, G.-J. E. (2002). The effect of oregano essential oil on survival/death of Salmonella typhimurium in meat stored at 5°C under aerobic, VP/MAP conditions. Food Microbiology, 19(1), 97–103. https://doi.org/10.1006/fmic.2001.0447

Yap, P. S. X., Yiap, B. C., Ping, H. C., & Lim, S. H. E. (2014). Essential Oils, A New Horizon in Combating Bacterial Antibiotic Resistance. The Open Microbiology Journal, 8, 6–14. https://doi.org/10.2174/1874285801408010006