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2024 Baptist Health Neuroscience Symposium:

Beating the Odds

TIPPING THE SCALE IN YOUR FAVOR: FUNCTIONAL NEUROSCIENCE

Erika A. Petersen, MD, FAANS, FACS

University of Arkansas for Medical Sciences

Friday, October 4, 2024

DISCLOSURES

- I have served as a consultant for Abbott/St. Jude Medical, Biotronik, Medtronic Neuromodulation, Nalu, Nevro, Presidio, Saluda, and Vertos.
- I hold stock options from SynerFuse and neuro.42.
- I have received research or educational support from Neuros Medical, Nalu, Nevro, Saluda, and Medtronic

- The use of some SCS devices for treatment of pain conditions other than Failed Back Surgery Syndrome, Complex Regional Pain Syndrome, painful diabetic neuropathy, and pain related to Chronic Limb Ischemia is off-label

- The use of DRG for treatment of pain conditions other than Complex Regional Pain Syndrome I and II or peripheral causalgia is off-label

- Peripheral (PNS) and peripheral field stimulation (PNfS) are off-label applications of some FDA approved medical devices

THE CUTTING EDGE

https://www.youtube.com/watch?v=0j9yuBExngw


THE CUTTING EDGE

OBJECTIVES

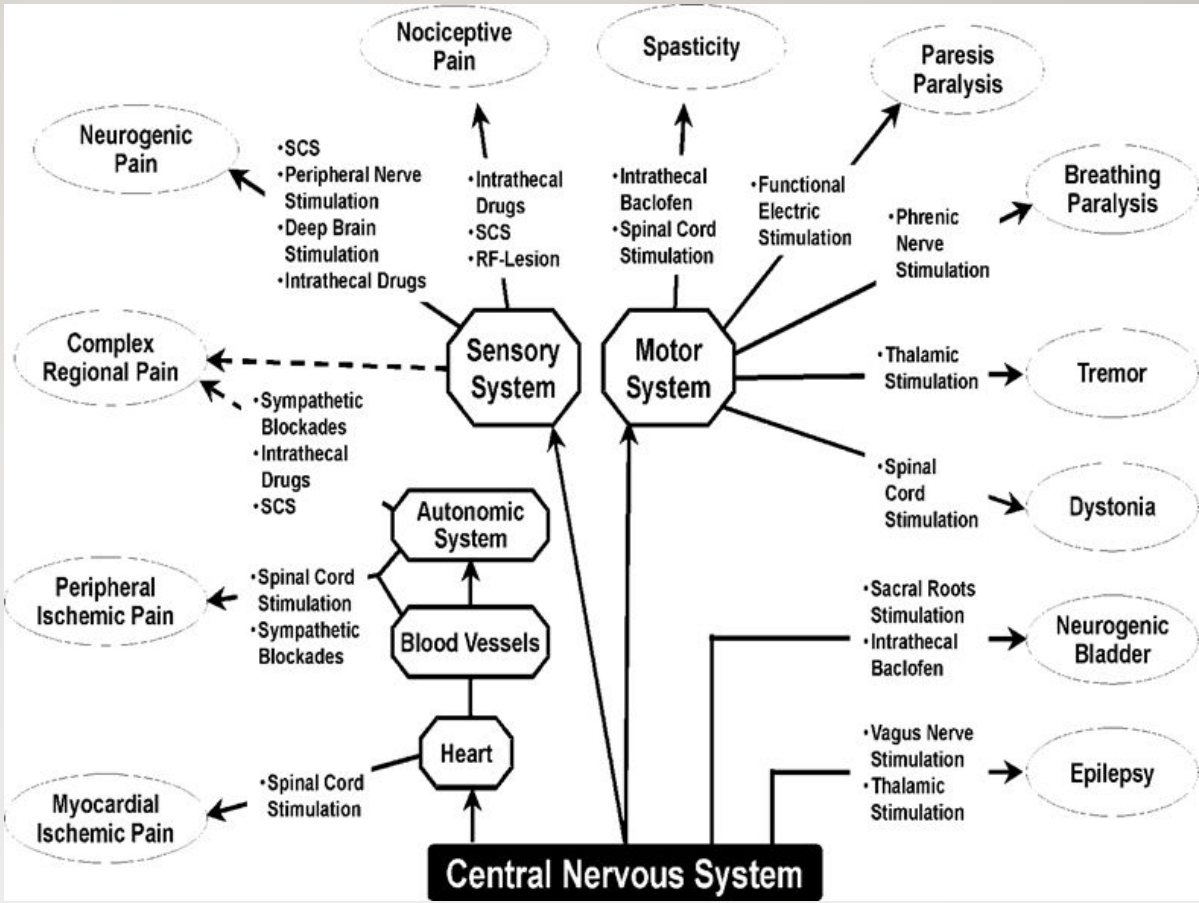
1. **Discuss options for neuromodulation using implantable technologies**
2. **Understand a possible mechanism for neurostimulation**
3. **Describe some indications for use of stimulators targeting the brain, spinal cord, DRG and peripheral nerves and fields**
4. **Review the keys for patient selection**
5. **Discuss possible risks and complications of implanted devices**

NEUROMODULATION

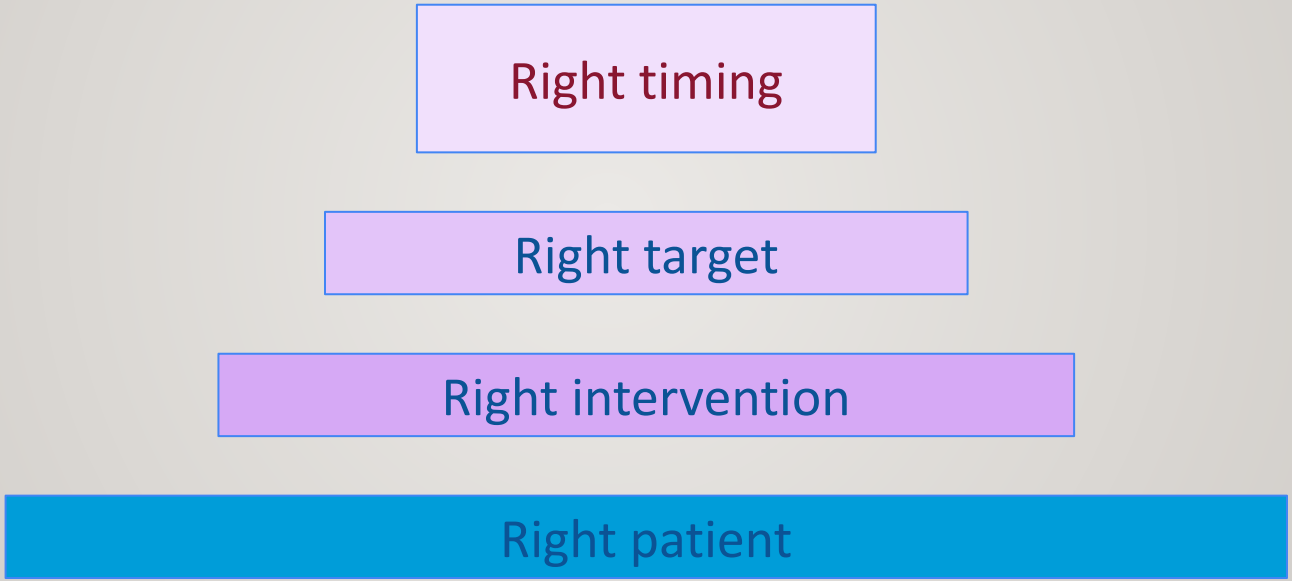
THE THERAPEUTIC ALTERATION OF ACTIVITY IN THE CENTRAL, PERIPHERAL OR AUTONOMIC NERVOUS SYSTEMS, ELECTRICALLY OR PHARMACOLOGICALLY, BY MEANS OF IMPLANTED DEVICES

Source: NANS website, neuromodulation.org

APPLICATIONS FOR NEUROMODULATION

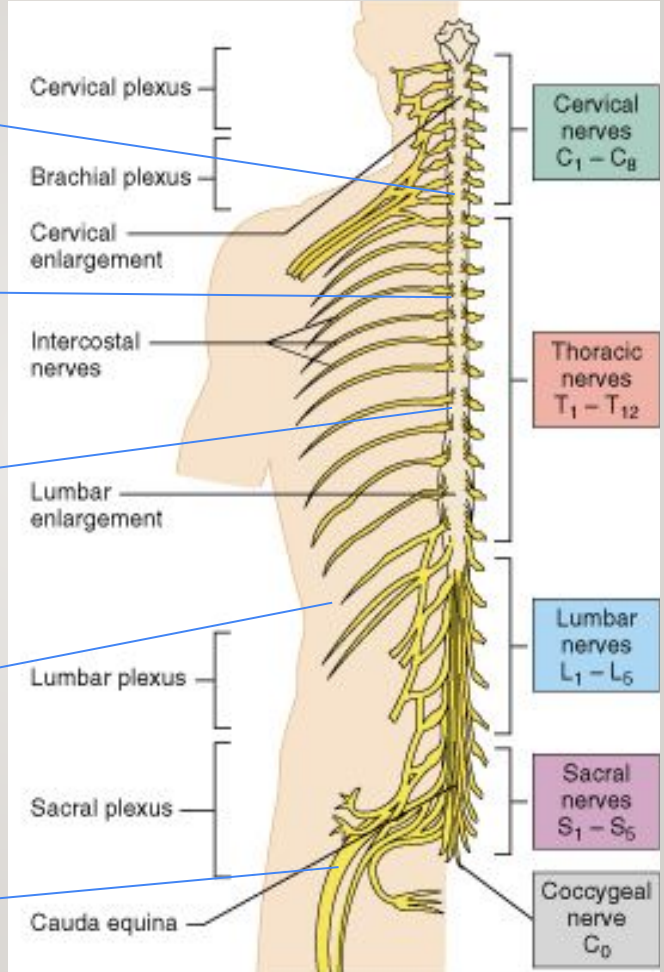


BEST OUTCOMES IN FUNCTIONAL NEUROSURGERY: SELECTION IS KEY



SITES OF INTERVENTION

- Dorsal Columns (SCS)
- Spinal nerve stimulation (lateral recess)
- Dorsal Root Ganglion (intraforaminal)
- Small nerve branches (PNfS)
- Peripheral Nerve (PNS)



20TH CENTURY FUNCTIONAL NEUROSURGERY

Cingulotomy

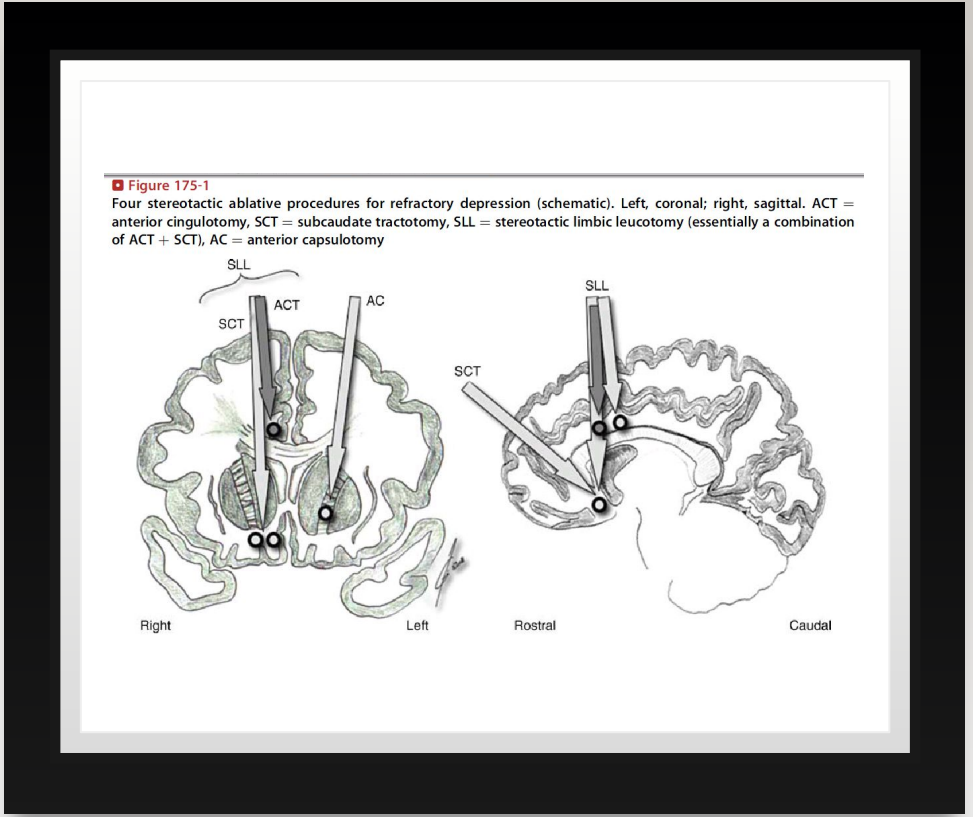
Capsulotomy

Subcaudate Tractotomy

Limbic Leucotomy

Cordotomy

Success rates 30-48%

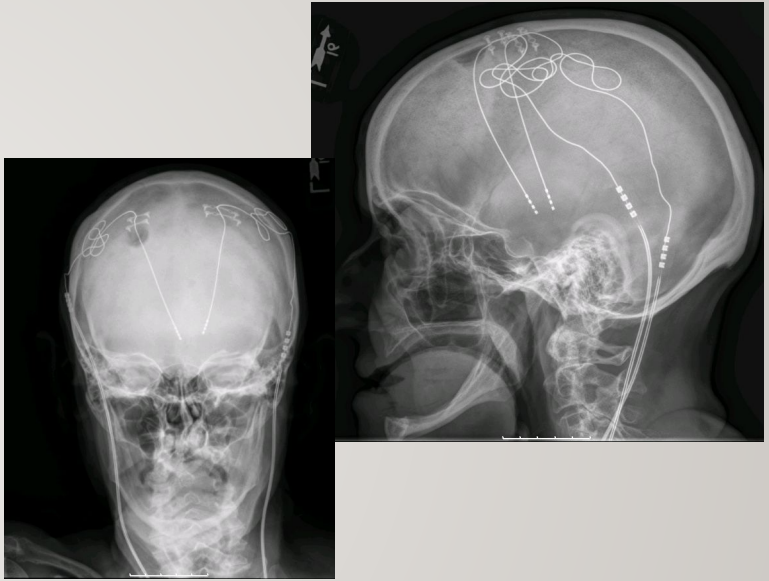


21ST CENTURY FUNCTIONAL NEUROSURGERY

Stimulation
- Deep brain
- Motor cortex
- Spinal cord
- Peripheral nerve
- Transcranial magnetic (rTMS)

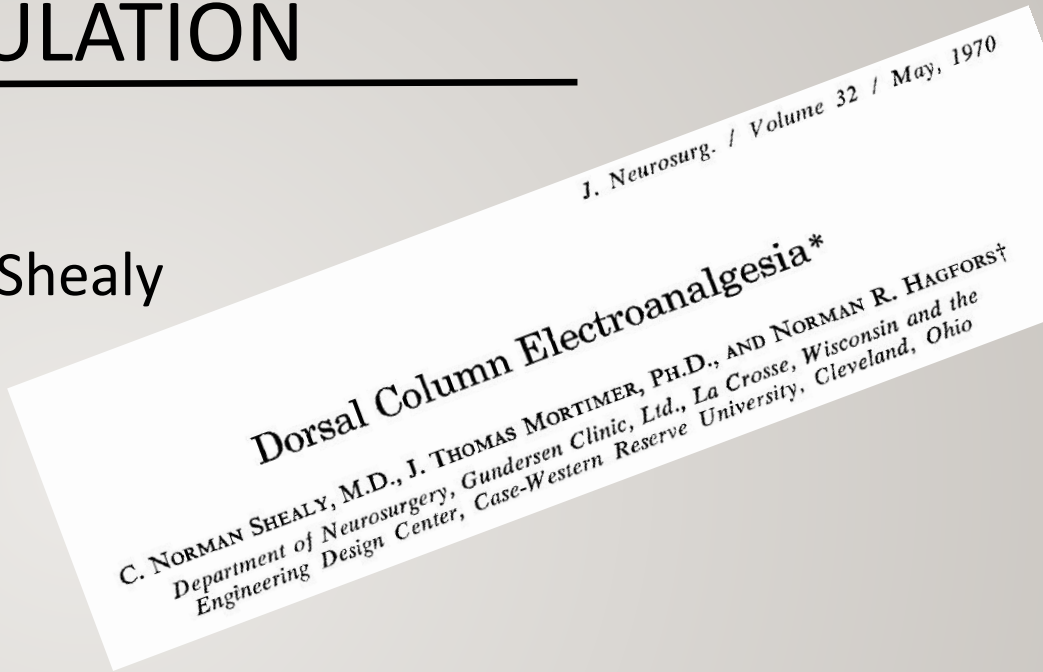
Delivery of drug or vector
- Intrathecal drug pumps
- Stem cell delivery
- Gene therapy

Lesioning (Neuroablation)
- Thalamotomy, pallidotomy (RF, FUS, alcohol, radiosurgery)
- Cordotomy
- Ganglionectomy
- Cingulotomy, capsulotomy



FROM LESION TO STIMULATION

- SCS was introduced in 1967 by Shealy
  - Used intrathecal laminotomy leads
    - Large
    - Cumbersome
    - Not portable
  - Fell out of favor until early 1990s
  - New technology (smaller leads, longer lasting battery, implantable generator, programmability) made it more feasible



J. Neurosurg. / Volume 32 / May, 1970

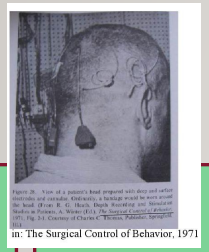
Dorsal Column Electroanalgesia*

C. Norman Shealy, M.D., J. Thomas Mortimer, Ph.D., and Norman R. Hagfors†

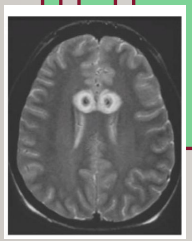
Department of Neurosurgery, Gundersen Clinic, Ltd., La Crosse, Wisconsin and the Engineering Design Center, Case-Western Reserve University, Cleveland, Ohio

A RAPID PROGRESSION IN INNOVATIONS

1960s **2000s** **2010s** **2020s**


in: The Surgical Control of Behavior, 1971

1st SCS



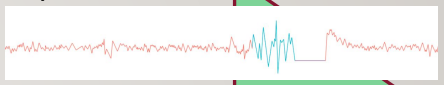
Improved Components

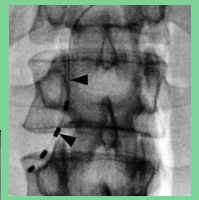
Implant technique improvements

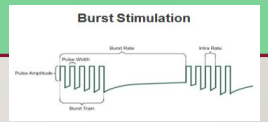
Rechargeable IPGs

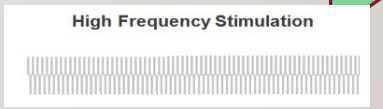
Size Reduction

Closed loop







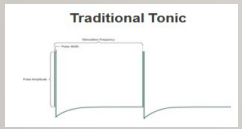


Increased longevity

More electrode configurations

Clinical evidence growth

New Waveforms

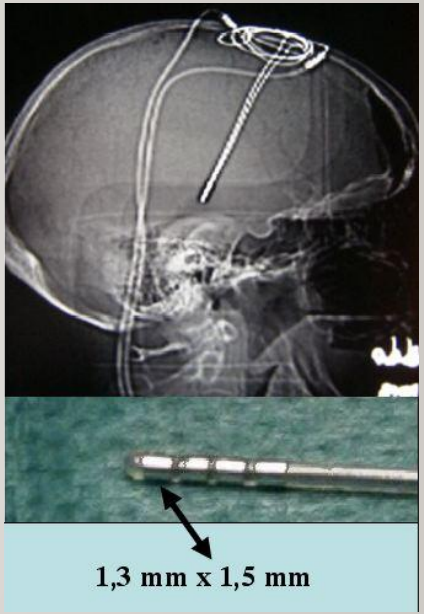


https://www.neuromodulation.com/history-of-neuromodulation

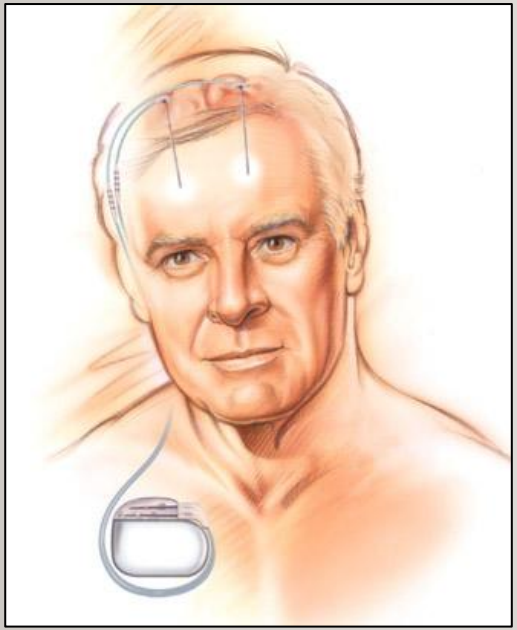
FUNCTIONAL NEUROSURGERY AND NEUROMODULATION

Surgical intervention → Change in function

- Indications (established and investigational):
  - Movement disorders: Parkinson's, dystonia, tremor
  - Chronic pain syndromes: failed back surgery, complex regional pain syndrome, neuropathy, migraine
  - Neuropsychiatric conditions: OCD, depression, addiction
  - Epilepsy
  - Traumatic brain injury: minimally conscious state, vegetative state
  - Patients suffering from chronic neurological disorders *that are rarely life threatening*
- Demands **minimal** risk of inflicting morbidity and mortality; *e*specially true when exploring new indications and brain targets



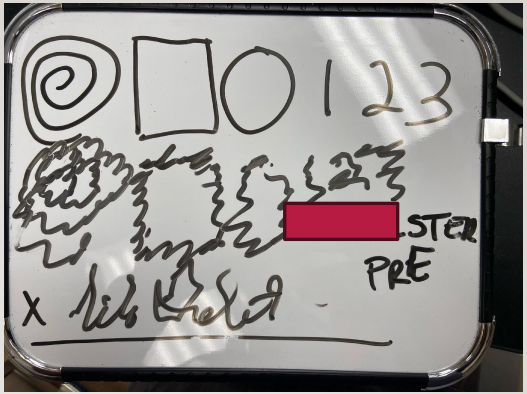
DEEP BRAIN STIMULATION: PACEMAKER FOR THE BRAIN



- Uses an implanted electrode to deliver high-frequency electrical stimulation to brain areas involved in the control of movement
- Electrical stimulation overrides abnormal brain activity in these brain regions
- Brings motor controlling circuitry into a more normal state of function, thus reducing movement disorder symptoms

OR: Awake testing

Testing implanted electrodes in the OR shows immediate improvement in function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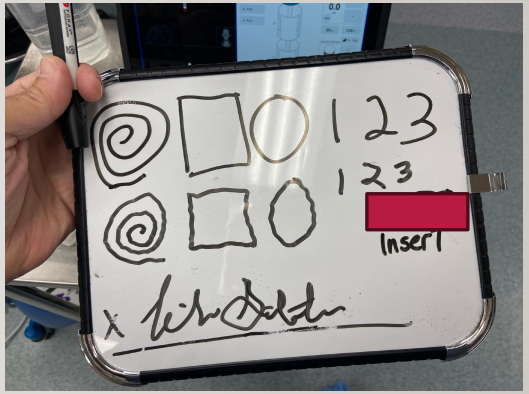
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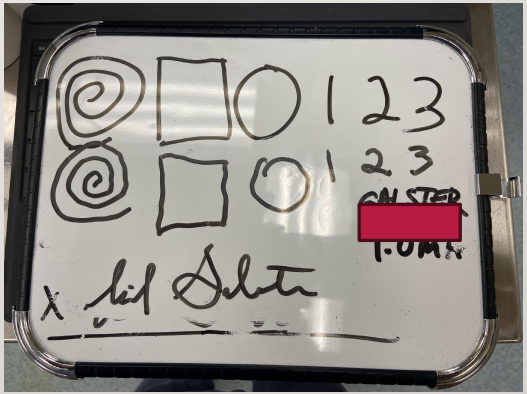
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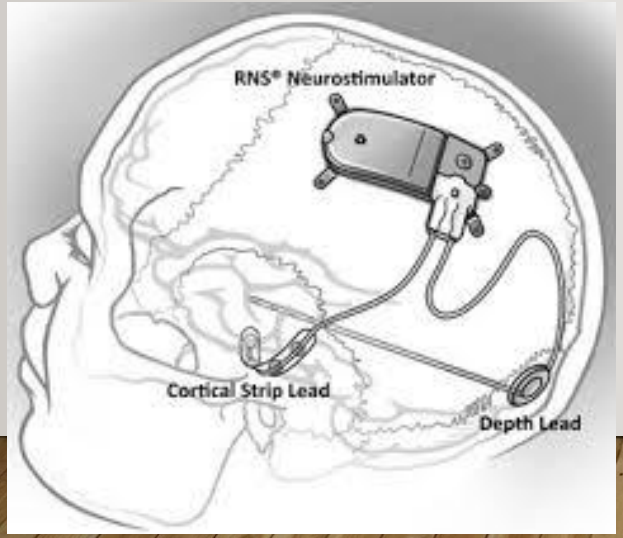
ADAPTIVE AND RESPONSIVE NEUROSTIMULATION

RNS for Epilepsy

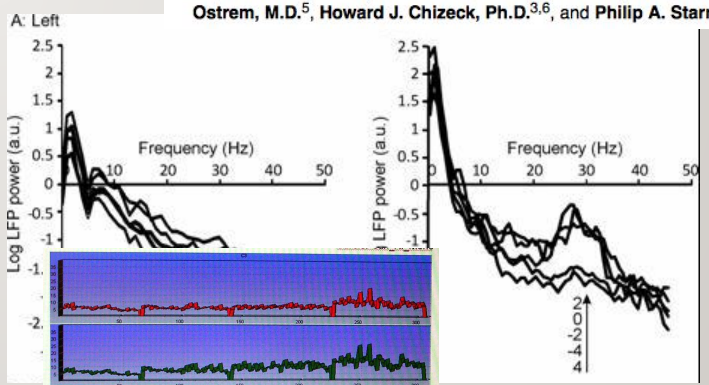


Adaptive DBS for PD

J Neural Eng. 2018 August ; 15(4): 046006. doi:10.1088/1741-2552/aabc9b.

Adaptive deep brain stimulation for Parkinson's disease using motor cortex sensing

Nicole C. Swann, Ph.D.[*,1,2], Coralie de Hemptinne, Ph.D.[1], Margaret C. Thompson, M.A.[3], Svjetlana Miocinovic, M.D. Ph.D.[4], Andrew M. Miller, B.S.[1], Ro'ee Gilron, Ph.D.[1], Jill L. Ostrem, M.D.[5], Howard J. Chizeck, Ph.D.[3,6], and Philip A. Starr, M.D. Ph.D.[1]



DBS NOT THE ONLY OPTION

Lesioning procedures are also possible for candidates who are not appropriate for DBS

- Thalamotomy
- Pallidotomy

Methods of lesioning include

- Gamma Knife radiosurgery
- Radiofrequency
- High frequency ultrasound

NONINVASIVE NEUROMODULATION FOR DEPRESSION

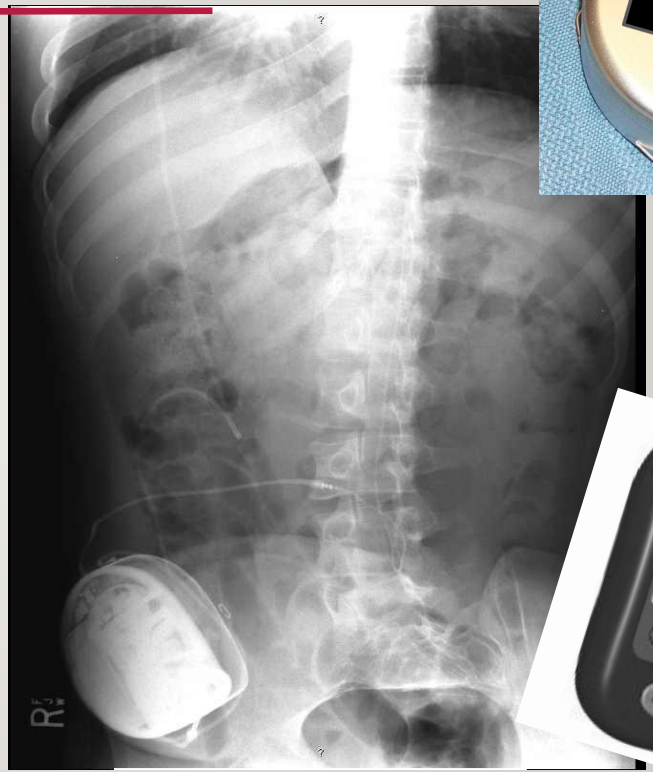
The SAINT neuromodulation system utilizes transcranial magnetic stimulation to treat major depressive disorder.

UAMS First in Nation to Offer Groundbreaking Therapy for Treatment-Resistant Depression

FOCUSED ULTRASOUND FOR TREMOR

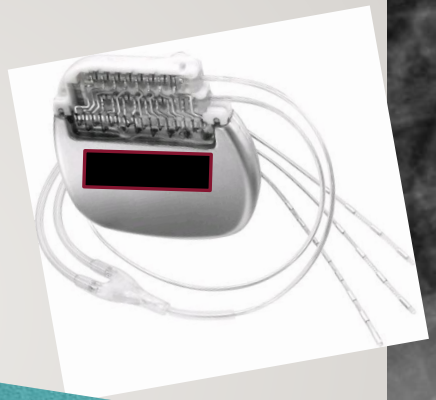
INTRATHECAL DRUG DELIVERY

- Reduce side effects from oral medications
  - Especially important in malignant pain, where improved GI function and appetite have a large impact on quality of life
- More physiologic/continuous delivery into spinal fluid
- More targeted therapy
- Can simplify medical regimen
  - Personal Therapy Manager (myPTM) allows patients to self-administer a bolus within certain parameters.
  - May eliminate need for oral medications altogether



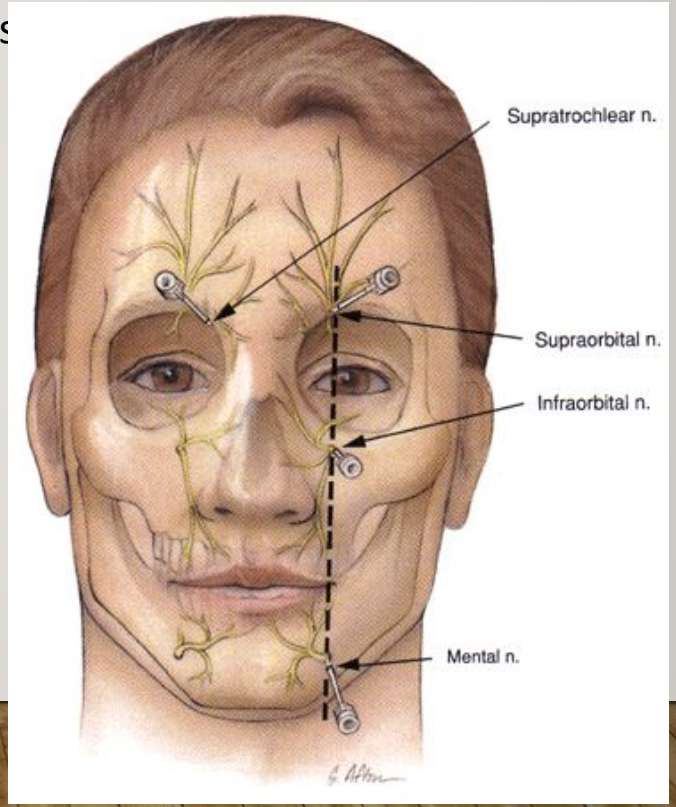
SPINAL CORD STIMULATION FOR PAIN

- Used for over 40 years; rekindled interest due to minimally invasive insertion techniques
- Interest fueled by gate control theory
  - Relatively safe
  - Reversible
  - Adjustable
  - Risks:
    - Infection (4-5%)
    - Lead migration
    - Suboptimal relief
    - Mechanical failure (breaks, disconnects)



PERIPHERAL STIMULATION FOR PAIN

- May be performed using either open or percutaneous techniques
- Stimulation of named nerves
- Variable insurance coverage
    - Risks:
        - Infection (4-5%)
        - Lead migration (may be as high as 50%)
        - Erosion
        - Suboptimal relief
        - Mechanical failure (breaks, disconnects)



SUPRAORBITAL STIMULATION

>50% pain control response in >70% of implanted patients, maintained for up to 44 months of follow-up. (Slavin 2006).

OCCIPITAL NERVE STIMULATION

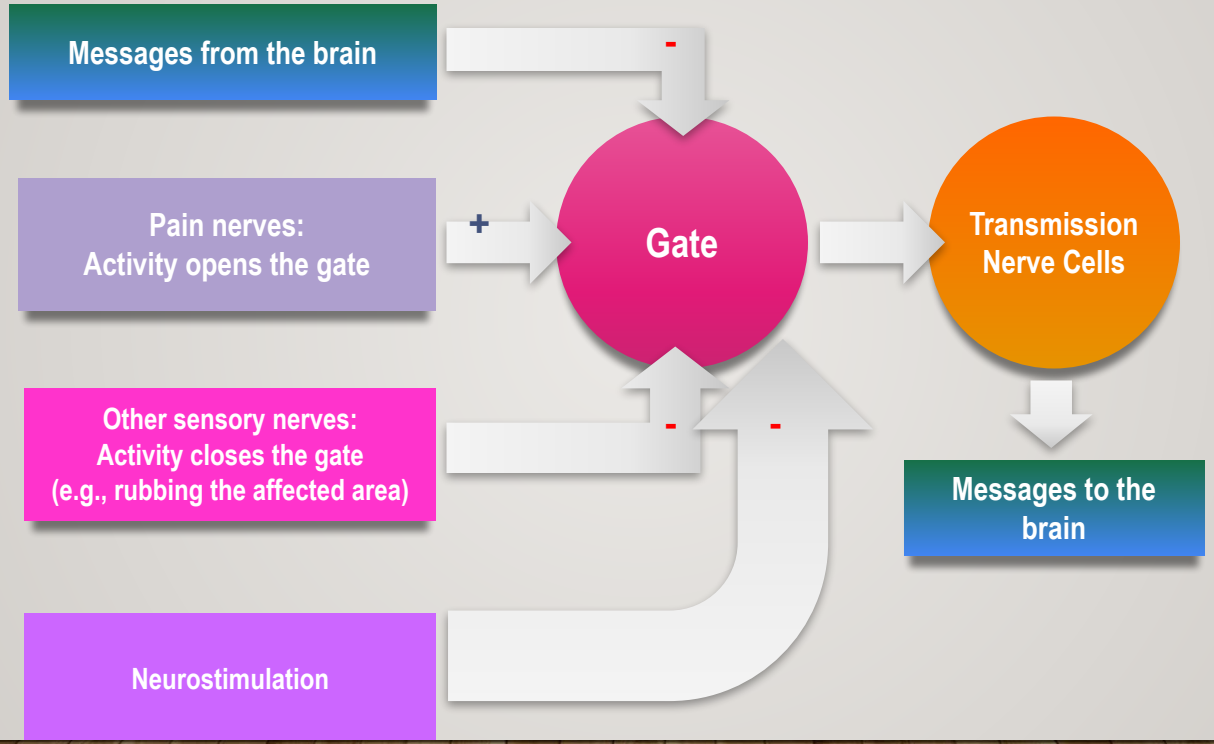
- Positive response in 50-90% of implanted patients.
- 75% good to excellent long-term pain control with VAS drop from 9 to 3. (Weiner 2007).

SPHENOPALATINE GANGLION STIMULATION

- Headache relief using intermittent activation using a patient control unit
- Small implant through incision in oral cavity overlying the SPG

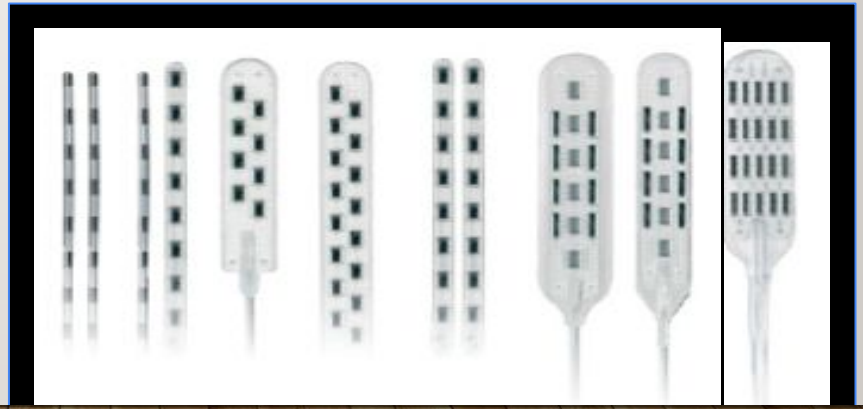
Not available in US
Source: Autonomic Technolgies, Inc (ati-spg.com)

PAIN GATE THEORY

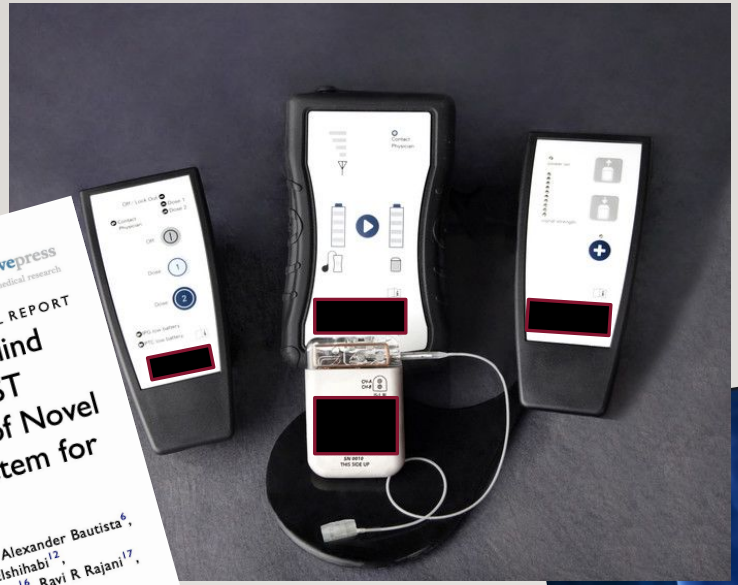


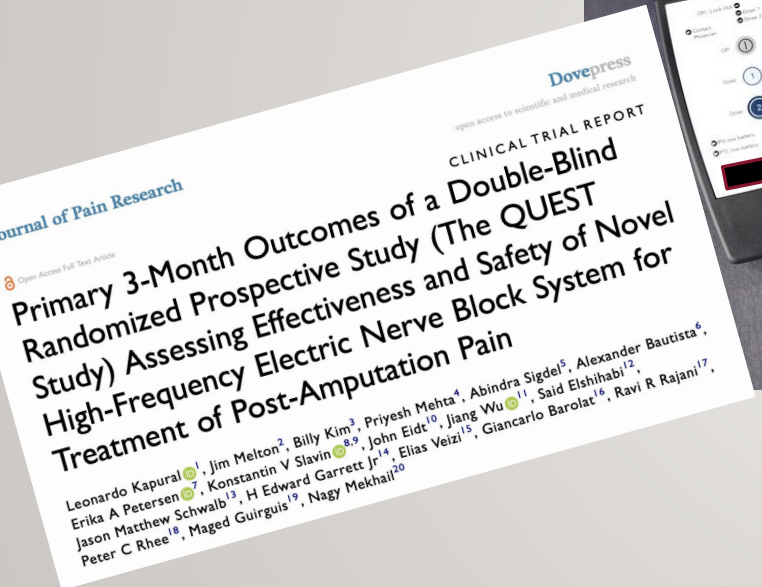
SCS COMPONENTS

- Lead
  - Transmits energy through contacts into neural tissue
  - Cylindrical or paddle, 4 to 32 contacts



PERIPHERAL NERVE STIMULATION





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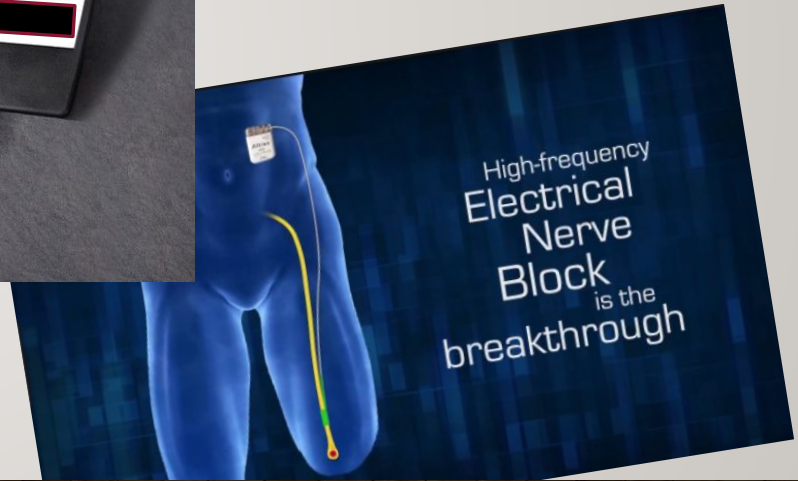
CLINICAL TRIAL REPORT

urnal of Pain Research

Open Access Full Text Article

Primary 3-Month Outcomes of a Double-Blind Randomized Prospective Study (The QUEST Study) Assessing Effectiveness and Safety of Novel High-Frequency Electric Nerve Block System for Treatment of Post-Amputation Pain

Leonardo Kapural[1], Jim Melton[2], Billy Kim[3], Priyesh Mehta[4], Abindra Sigdel[5], Alexander Bautista[6], Erika A Petersen[7], Konstantin V Slavin[8,9], John Eidt[10], Jiang Wu[11], Said Elshihabi[12], Jason Matthew Schwalb[13], H Edward Garrett Jr[14], Elias Veizi[15], Giancarlo Barolat[16], Ravi R Rajani[17], Peter C Rhee[18], Maged Guirguis[19], Nagy Mekhail[20]



Kapural L, Melton J, Kim B, Mehta P, Sigdel A, Bautista A, Petersen EA, Slavin KV, Eidt J, Wu J, Elshihabi S, Schwalb JM, Garrett HE Jr, Veizi E, Barolat G, Rajani RR, Rhee PC, Guirguis M, Mekhail N. Primary 3-Month Outcomes of a Double-Blind Randomized Prospective Study (The QUEST Study) Assessing Effectiveness and Safety of Novel High-Frequency Electric Nerve Block System for Treatment of Post-Amputation Pain. J Pain Res. 2024 Jun 6;17:2001-2014. doi: 10.2147/JPR.S463727. PMID: 38860215; PMCID: PMC11164212.

STIMULATION WAVEFORMS

Burst Spinal Cord Stimulation for Limb and Back Pain

Dirk De Ridder[1,2], Mark Plazier[3], Niels Kamerling[3], Tomas Menovsky[3], Sven Vanneste[4]

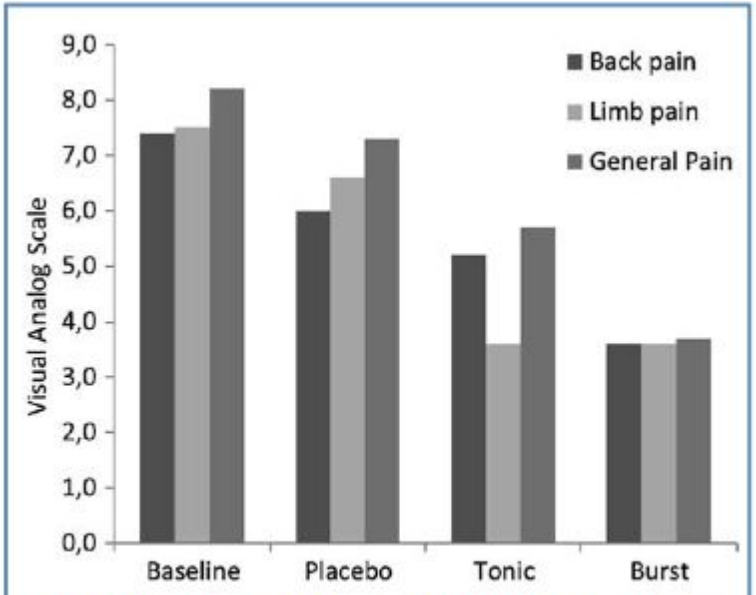


Figure 3. Primary outcome measure. The data represent the mean scores on baseline (placebo, tonic, and burst) for back pain, limb pain, and general pain.

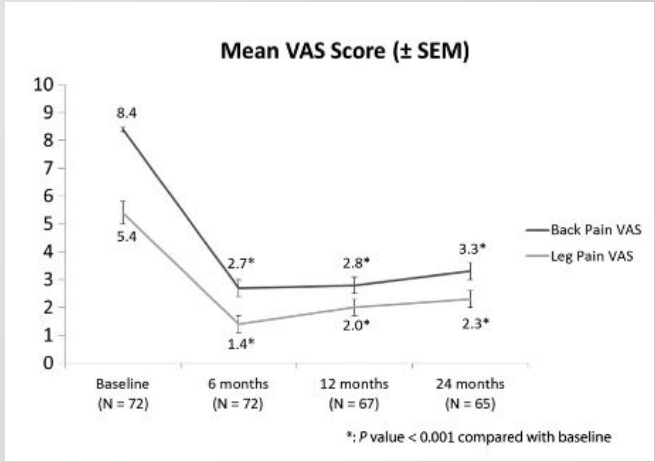
Pain Medicine

Pain Medicine 2014; 15: 347–354
Wiley Periodicals, Inc.

ORIGINAL RESEARCH ARTICLES

Sustained Effectiveness of 10 kHz High-Frequency Spinal Cord Stimulation for Patients with Chronic, Low Back Pain: 24-Month Results of a Prospective Multicenter Study

Adnan Al-Kaisy, MD,*† Jean-Pierre Van Buyten, MD,†‡ Iris Smet, MD,† Stefano Palmisani, MD,* David Pang, MD,* and Thomas Smith, MD*

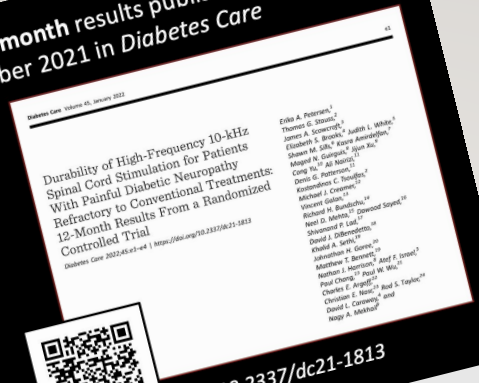


1. De Ridder D, et al. *Neurosurgery.* 2010;66(5):986-990.
2. De Ridder D, et al. *World Neurosurg.* 2013;80(5):642-649.e1.
3. De Ridder et al. A Two Center Comparative Study on Tonic Versus Burst Spinal Cord Stimulation: Amount of Responders and Amount of Pain Suppression. Clin J Pain (2014)
4. Al-Kaisy et al. Sustained effectiveness of 10 kHz high-frequency spinal cord stimulation for patients with chronic, low back pain: 24-month results of a prospective multicenter study. Pain Med (2014) vol. 15 (3) pp. 347-54

Six-month results published April 2021 in *JAMA Neurology*:

doi:10.1001/jamaneurol.2021.0538

Twelve-month results published November 2021 in *Diabetes Care*



doi: 10.2337/dc21-1813

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Contents lists available at ScienceDirect

Diabetes Research and Clinical Practice

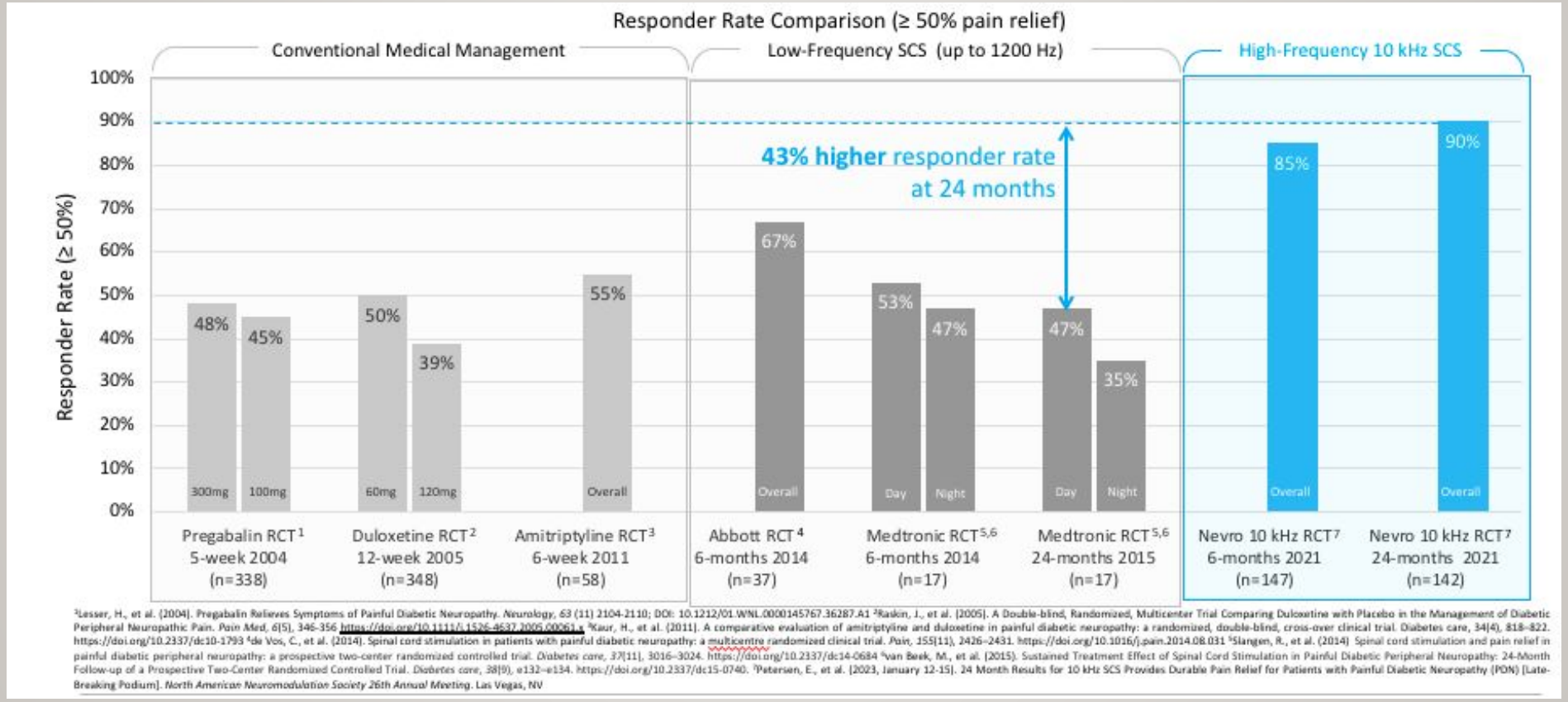
journal homepage: www.journals.elsevier.com/diabetes-research-and-clinical-practice

Long-term efficacy of high-frequency (10 kHz) spinal cord stimulation for the treatment of painful diabetic neuropathy: 24-Month results of a randomized controlled trial

Erika A. Petersen [a,*], Thomas G. Stauss [b], James A. Scowcroft [c], Michael J. Jaasma [d], Elizabeth S. Brooks [d], Deborah R. Edgar [e], Judith L. White [f], Shawn M. Sills [g], Kasra Amirdelfan [h], Maged N. Guirguis [i], Jijun Xu [j], Cong Yu [k], Ali Nairizi [l], Denis G. Patterson [l], Kostandinos C. Tsoulfas [b], Michael J. Creamer [m], Vincent Galan [n], Richard H. Bundschu [o], Neel D. Mehta [q], Dawood Sayed [r], Shivanand P. Lad [s], David J. DiBenedetto [t], Khalid A. Sethi [u], Johnathan H. Goree [p], Matthew T. Bennett [u], Nathan J. Harrison [i], Atef F. Israel [c], Paul Chang [n], Paul W. Wu [v], Charles E. Argoff [w], Christian E. Nasr [x], Rod S. Taylor [y], David L. Caraway [d], Nagy A. Mekhail [z]

Petersen EA, Stauss TG, Scowcroft JA, Jaasma MJ, Brooks ES, et al. Long-term efficacy of high-frequency (10 kHz) spinal cord stimulation for the treatment of painful diabetic neuropathy: 24-Month results of a randomized controlled trial. Diabetes Res Clin Pract. 2023 Aug 1;203:110865. doi: 10.1016/j.diabres.2023.110865. Epub ahead of print. PMID: 37536514.

Clinical Evidence Comparison for PDN

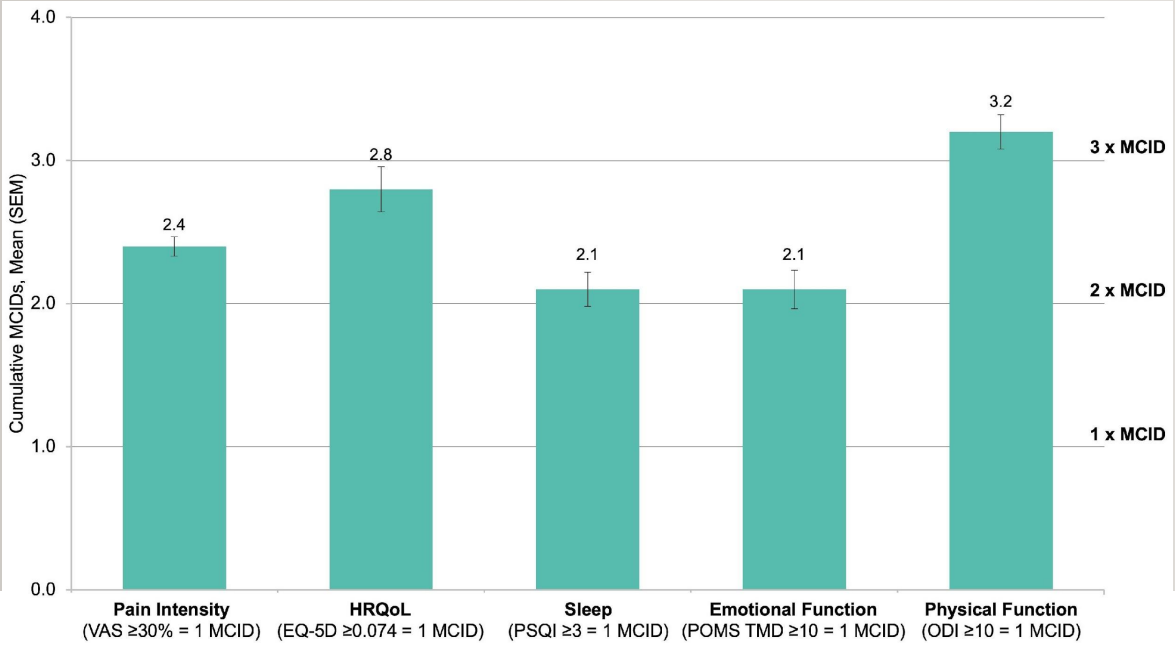


[1]Lesser, H., et al. (2004). Pregabalin Relieves Symptoms of Painful Diabetic Neuropathy. *Neurology, 63* (11) 2104-2110; DOI: 10.1212/01.WNL.0000145767.36287.A1 [2]Raskin, J., et al. (2005). A Double-blind, Randomized, Multicenter Trial Comparing Duloxetine with Placebo in the Management of Diabetic Peripheral Neuropathic Pain. *Pain Med, 6*(5), 346-356 https://doi.org/10.1111/j.1526-4637.2005.00061.x [3]Kaur, H., et al. (2011). A comparative evaluation of amitriptyline and duloxetine in painful diabetic neuropathy: a randomized, double-blind, cross-over clinical trial. Diabetes care, 34(4), 818–822. https://doi.org/10.2337/dc10-1793 [4]de Vos, C., et al. (2014). Spinal cord stimulation in patients with painful diabetic neuropathy: a multicentre randomized clinical trial. *Pain, 155*(11), 2426–2431. https://doi.org/10.1016/j.pain.2014.08.031 [5]Slangen, R., et al. (2014) Spinal cord stimulation and pain relief in painful diabetic peripheral neuropathy: a prospective two-center randomized controlled trial. *Diabetes care, 37*(11), 3016–3024. https://doi.org/10.2337/dc14-0684 [6]van Beek, M., et al. (2015). Sustained Treatment Effect of Spinal Cord Stimulation in Painful Diabetic Peripheral Neuropathy: 24-Month Follow-up of a Prospective Two-Center Randomized Controlled Trial. *Diabetes care, 38*(9), e132–e134. https://doi.org/10.2337/dc15-0740. [7]Petersen, E., et al. (2023, January 12-15). 24 Month Results for 10 kHz SCS Provides Durable Pain Relief for Patients with Painful Diabetic Neuropathy (PDN) [Late-Breaking Podium]. *North American Neuromodulation Society 26th Annual Meeting*. Las Vegas, NV

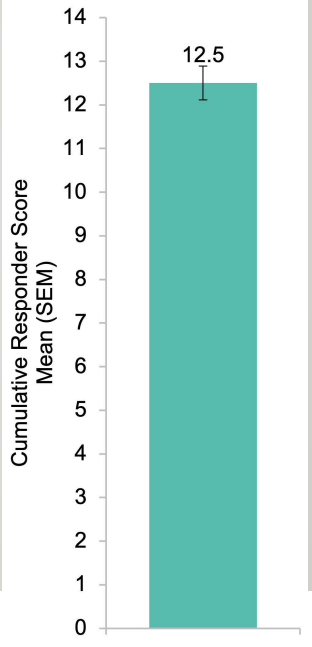
Holistic Outcomes→ Neural Dose Metrics

12.5 MCIDs (units of clinically meaningful change) were observed with:

Neural Dose Metrics	Dose Ratio = 1.4 (IQR 1.2-1.5)	Dose Accuracy = 2.8μV (IQR 2.0-4.6)



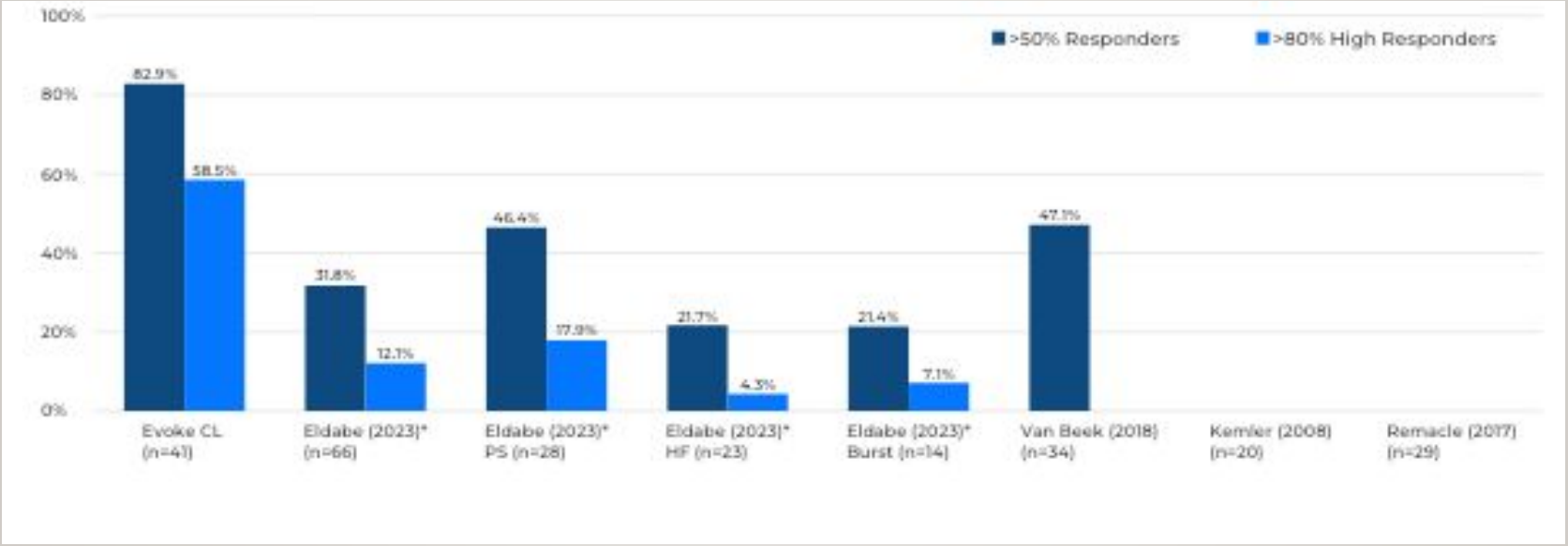
Holistic Domains at MAE: Pooled data



Cumulative Responder Score at MAE

36-MONTH PAIN REDUCTION: EVOKE CL DATA CONTEXTUALIZED WITH STANDARD SCS PUBLICATIONS

- 83% of Evoke closed-loop subjects were responders in pain at 36-months
- 59% of Evoke closed-loop subjects were high responders in pain at 36-months
- Published 36M standard SCS data for context (years 2008-2023)

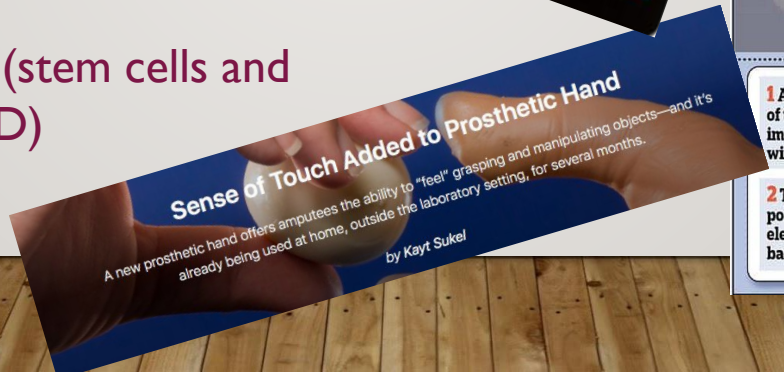


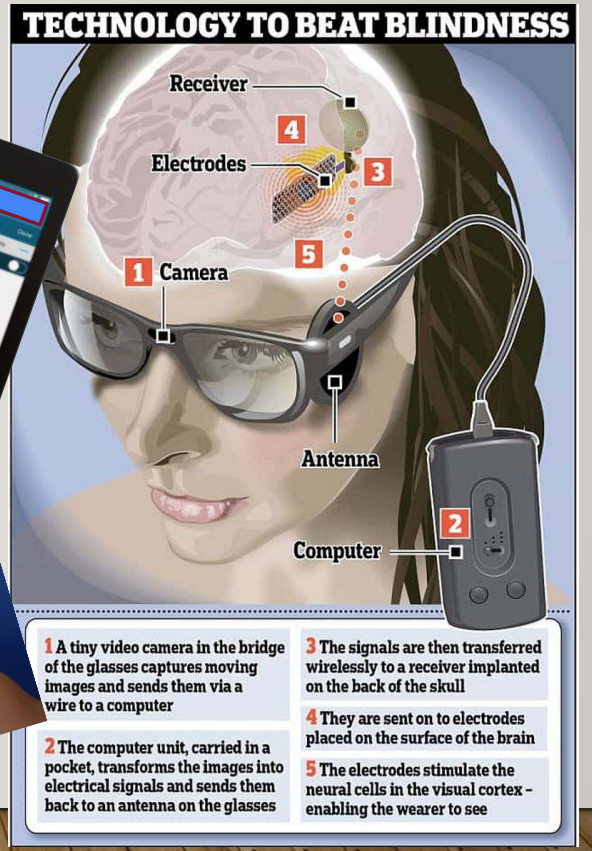
* Calculated with permission using individual patient data for the Eldabe (2023) trial overall population, PS (paresthesia-based stimulation), HF (high-frequency), and Burst outcomes for ≥50% reduction and ≥80% reduction in pain. Programming method missing for 1 patient.

Eldabe S, et al. Neurosurgery 2023; 92(1): 75-82.
Kemler MA, et al. J Neurosurg 2008; 108(2): 292-8.
Remacle TY, et al. Neuromodulation 2017; 20(7): 668-74.
van Beek M, et al. Diabetes care 2018; 41(1): 32-8.

THE “FUTURE” IS ALREADY HERE (IN SMALL SCALE)

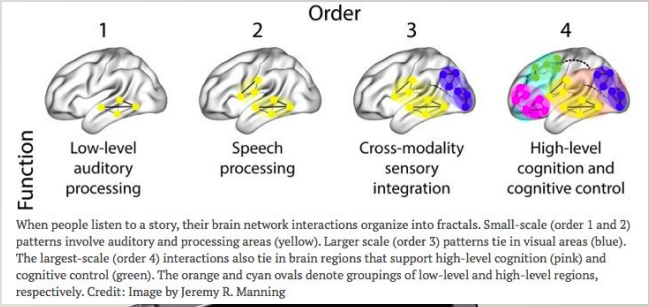
- Closed loop stimulation of brain and spinal cord
- Remote programming
- Use of integrated sensors (vision, myoelectric and pressure sensor-enabled prostheses, accelerometers, SSEPs, LFPs)
- Restorative stimulation (multifidus, stroke, SCI, vision loss)
- Restorative neurosurgery (stem cells and gene therapy for stroke, PD)



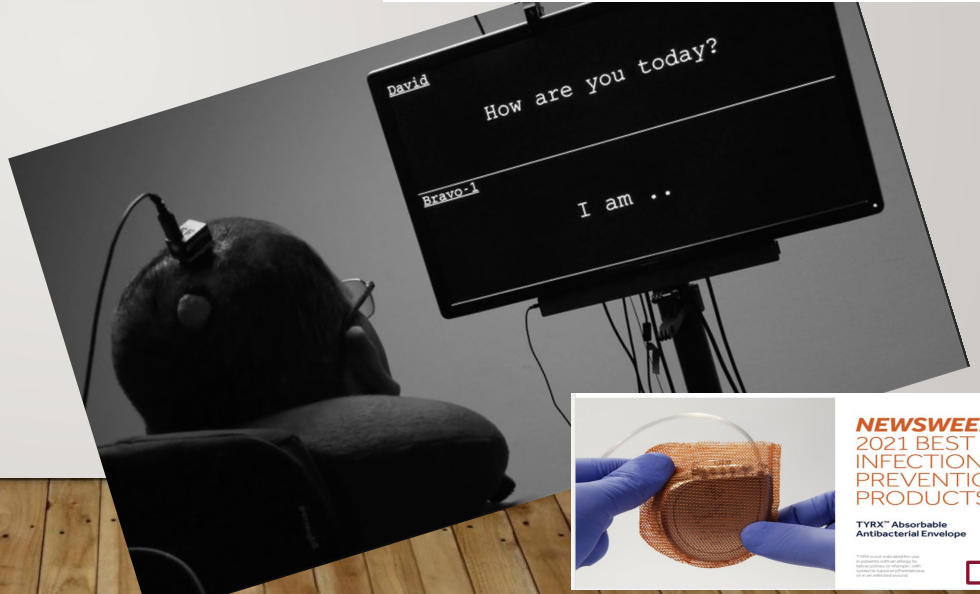


THE “FUTURE” IS ALREADY HERE (IN SMALL SCALE)

- Science on the underpinning mechanisms of action driving clinical advancements
- Dramatic gains in understanding ”circuit-opathies” and treatment
- New indications for existing devices (PDN, Alzheimer’s)
- BCI, neuroprostheses, and assistive device robotics (speech restoration)
- Targeted therapy using imaging and SEEG



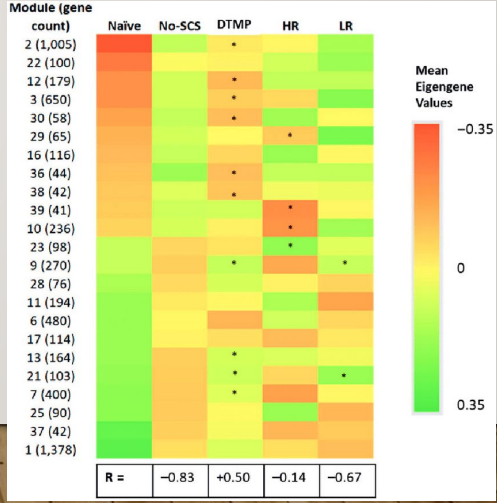
When people listen to a story, their brain network interactions organize into fractals. Small-scale (order 1 and 2) patterns involve auditory and processing areas (yellow). Larger scale (order 3) patterns tie in visual areas (blue). The largest-scale (order 4) interactions also tie in brain regions that support high-level cognition (pink) and cognitive control (green). The orange and cyan ovals denote groupings of low-level and high-level regions, respectively. Credit: Image by Jeremy R. Manning



ENABLING ADVANCES

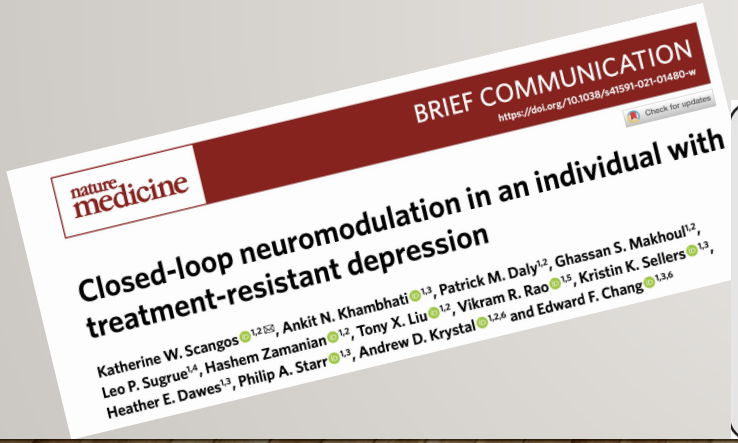
- Miniaturization
- Improved microprocessor technology
- Power management technology
- Biocompatible materials
- **Neuroscience research**
  - Connectomes and complex modeling
  - Mechanisms of action
  - Optogenetics
  - Behavioral neurosciences
  - Large data set outcomes prediction

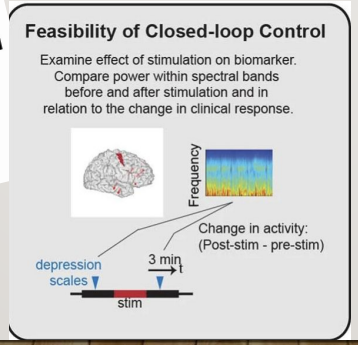
- External device technology
- Sensors
- Machine learning and artificial intelligence
- Data analysis and algorithmic processing



MORE IN STORE FOR NEUROMODULATION

- Precision medicine with tailored targeting and design of individualized treatment delivery
- Improving outcomes for old conditions with improved technology
- New innovations (biologic, devices, or waveforms) for new indications
- Cosmetic neurosurgery for enhancement of cognitive function outside of pathological states





Cosmetic neurosurgery, ethics, and enhancement

Currently, the neurosurgeon's ethical obligation remains strictly to the patient with a clearly defined pathological disorder, with efforts geared towards treatment for established disease and prevention of morbidity and mortality. As researchers, neurosurgeons should be aware of the ethical principles guiding their work, and be mindful that much needs to change, conceptually and technologically, to tip the risk–benefit balance towards intervention in non-pathological states.

I declare no competing interests.

Nir Lipsman, Andres M Lozano

Scangos, K.W., Khambhati, A.N., Daly, P.M. *et al.* Closed-loop neuromodulation in an individual with treatment-resistant depression. *Nat Med* (2021). https://doi.org/10.1038/s41591-021-01480-w

Lipsman N, Lozano AM. Cosmetic neurosurgery, ethics, and enhancement. Lancet Psychiatry. 2015 Jul;2(7):585-6. doi: 10.1016/S2215-0366(15)00206-0. Epub 2015 Jun 30. PMID: 26303544.

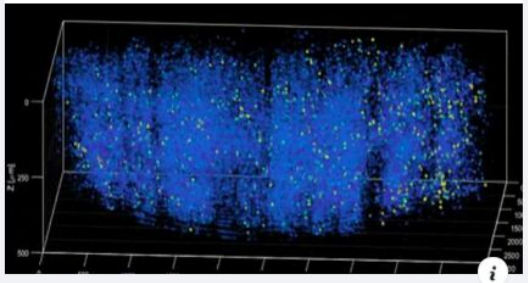
MORE IN STORE FOR NEUROMODULATION

- Objective outcomes measurement with sensors, neurophysiology, and imaging
- Artificial intelligence to process and learn from large data sets of behavioral, neurophysiological, structural and functional neuroimaging, and other patient data
- Machine learning for individualization of therapy/stimulation delivery based on biomarkers
- "brains" on chips storing neural connection patterns

Tiny injectable chips use ultrasound to monitor your body... from the inside

https://www.sciencefocus.com/news/tiny-injectable-chips-use-ultrasound-to-monitor-your-body-from-the-inside/

Researchers have managed to keep tabs on 1 million different neurons in the brains of mice at one time – taking scientists an impressive step closer towards one day being able to track the very-complex activity of human brains.



SCIENCEALERT.COM

In a First, Scientists Track 1 Million Neurons Near-Simultaneously in a Mouse Brain

ACS NANO

ARTICLE

Restoring Tactile Sensation Using a Triboelectric Nanogenerator

Iftach Shlomy,[#] Shay Divald,[#] Keshet Tadmor,[#] Yael Leichtmann-Bardoogo, Amir Arami, and Ben M. Maoz*

Cite This: ACS Nano 2021, 15, 11087−11098 | Read Online

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ABSTRACT: Loss of tactile sensation is a common occurrence in patients with traumatic peripheral nerve injury or soft tissue loss, but as yet, solutions for restoring such sensation are limited. Implanted neuroprosthetics are a promising direction for tactile sensory restoration, but available technologies have substantial shortcomings, including complexity of use and of production and the need for an external power supply. In this work, we propose, fabricate, and demonstrate the use of a triboelectric nanogenerator (TENG) as a relatively simple, self-powered, biocompatible, sensitive, and flexible device for restoring tactile sensation. This integrated tactile TENG (TENG-IT) device is implanted under the skin and translates tactile pressure into electrical potential, which it relays via cuff electrodes to healthy sensory nerves, thereby stimulating them, to mimic tactile sensation. We show that the device elicits electrical activity in sensory neurons in vitro, and that the extent of this activity is dependent on the level of tactile pressure applied to the device. We subsequently demonstrate the TENG-IT in vivo, showing that it provides tactile sensation capabilities (as measured by a von Frey test) to rats in which sensation in the hindfoot was blocked through transection of the distal tibial nerve. These findings point to the substantial potential of self-powered TENG-based implanted devices as a means of restoring tactile sensation.

KEYWORDS: tactile restoration, peripheral nerve injury, triboelectric effect nano generator, TENG, implanted biosensor

Letter | Published: 08 June 2020

Alloying conducting channels for reliable neuromorphic computing

Hanwool Yeon, Peng Lin, Chanyeol Choi, Scott H. Tan, Yongmo Park, Doyoon Lee, Jaeyong Lee, Feng Xu, Bin Gao, Huaqiang Wu, He Qian, Yifan Nie, Seyoung Kim & Jeehwan Kim

Nature Nanotechnology 15, 574–579 (2020) | Cite this article

11k Accesses | 27 Citations | 352 Altmetric | Metrics

A Publisher Correction to this article was published on 23 June 2020

This article has been updated

Abstract

A memristor[1] has been proposed as an artificial synapse for emerging neuromorphic computing applications[2,3]. To train a neural network in memristor arrays, changes in weight values in the form of device conductance should be distinct and uniform[3]. An electrochemical metallization (ECM) memory[4,5], typically based on silicon (Si), has demonstrated a good analogue switching capability[6,7] owing to the high mobility of metal ions in the Si switching medium[8]. However, the large stochasticity of the ion movement results in switching variability. Here we demonstrate a Si memristor with alloyed conduction channels that shows a stable and controllable device operation, which enables the large-scale implementation of crossbar arrays. The conduction channel is formed by conventional silver (Ag) as a primary mobile metal alloyed with silicidable copper (Cu) that stabilizes switching. In an optimal alloying ratio, Cu effectively regulates the Ag movement, which contributes to a substantial improvement in the spatial/temporal switching uniformity, a stable data retention over a large conductance

conductance

arrays that fe

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Neumann cor

With Harvard Researchers, Samsung introduces a new approach to reverse engineer the brain on a memory chip, in a Perspective paper published in Nature Electronics

NEWS.SAMSUNG.COM

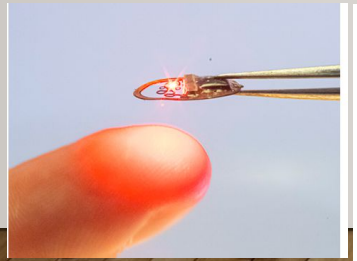
Samsung Electronics Puts Forward a Vision To 'Copy and Paste' the Brain on Neuromorphic Chips

MIT fit tens of thousands of artificial brain synapses on a single chip

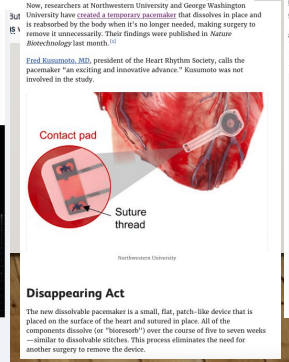
The 'brain-on-a-chip' hardware could lead to tiny, portable AI devices.

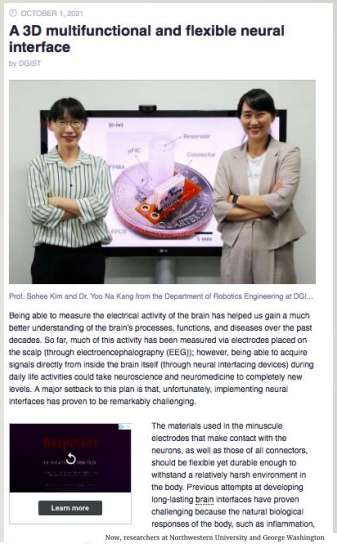
MORE IN STORE FOR NEUROMODULATION

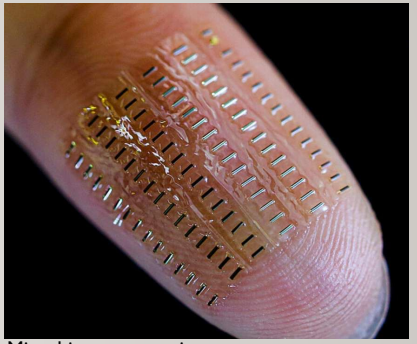
- Micro IPGs and neural interfaces beyond leads
- Advanced curative technologies
- Resorbable devices
- Remote care as a standard
- Miniaturization and individualization
- External and short-term devices (“non-invasives” or “minimally invasives”)
- When will non-invasive techniques accomplish same results as implants?



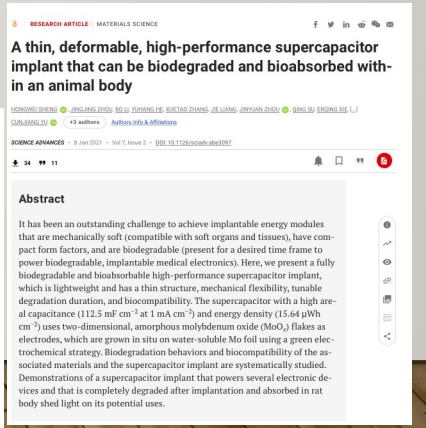
https://www.medgadget.com/2021/08/wireless-light-implant-for-optogenetics-without-skull-damage.html







Microbiosupercapacitors
https://www.slashgear.com/microsupercapacitor-project-packs-aaa-battery-voltage-into-a-speck-of-dust-25688483/



THE CUTTING EDGE

A high-performance neuroprosthesis for speech decoding and avatar control

https://doi.org/10.1038/s41586-023-06443-4
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Accepted: 17 July 2023
Published online: 23 August 2023

Sean L. Metzger[1,2,3,7], Kaylo T. Littlejohn[1,2,4,7], Alexander B. Silva[1,2,3,7], David A. Moses[1,2,7], Margaret P. Seaton[1,7], Ran Wang[1,2], Maximilian E. Dougherty[1], Jessie R. Liu[1,2,3], Peter Wu[4], Michael A. Berger[5], Inga Zhuravleva[4], Adelyn Tu-Chan[6], Karunesh Ganguly[2,6], Gopala K. Anumanchipalli[1,2,4] & Edward F. Chang[1,2,3]✉

Speech neuroprostheses have the potential to restore communication to people living with paralysis, but naturalistic speed and expressivity are elusive[1]. Here we use high-density surface recordings of the speech cortex in a clinical-trial participant with severe limb and vocal paralysis to achieve high-performance real-time decoding across three complementary speech-related output modalities: text, speech audio and facial-avatar animation. We trained and evaluated deep-learning models using neural data collected as the participant attempted to silently speak sentences. For text, we demonstrate accurate and rapid large-vocabulary decoding with a median rate of 78 words per minute and median word error rate of 25%. For speech audio, we demonstrate intelligible and rapid speech synthesis and personalization to the participant's pre-injury voice. For facial-avatar animation, we demonstrate the control of virtual orofacial movements for speech and non-speech communicative gestures. The decoders reached high performance with less than two weeks of training. Our findings introduce a multimodal speech-neuroprosthetic approach that has substantial promise to restore full, embodied communication to people living with severe paralysis.

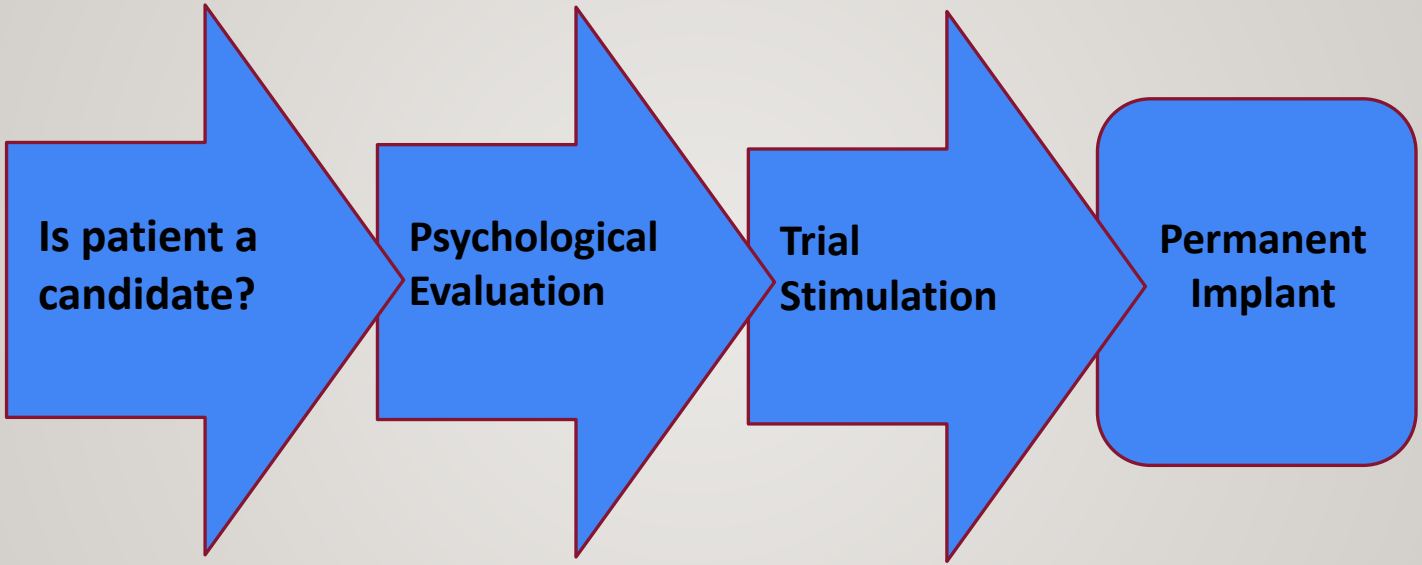
AN AGE OF INNOVATION IN NEUROMODULATION

- Neuromodulation includes use of devices, lesioning and biologics to modify neurological function
- Today neurostimulation is a safe, effective, and drug-free treatment option for many neurological and pain conditions
- Advances in computing, technology, and neuroscience research are unlocking myriad possibilities for human enhancement
- Partnership in cross-disciplinary teams will drive innovation at a breakneck pace
- We must be cautious of the risks and costs associated with this great potential

“WHO IN MY PRACTICE CAN I TREAT NOW?”

- Painful Diabetic Neuropathy
- Chronic refractory neuropathic pain
- Parkinson's
- Essential Tremor
- Trigeminal Neuralgia
- Epilepsy
- Migraine

PATIENT EVALUATION



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@ErikaPetersenMD
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Joined February 2018
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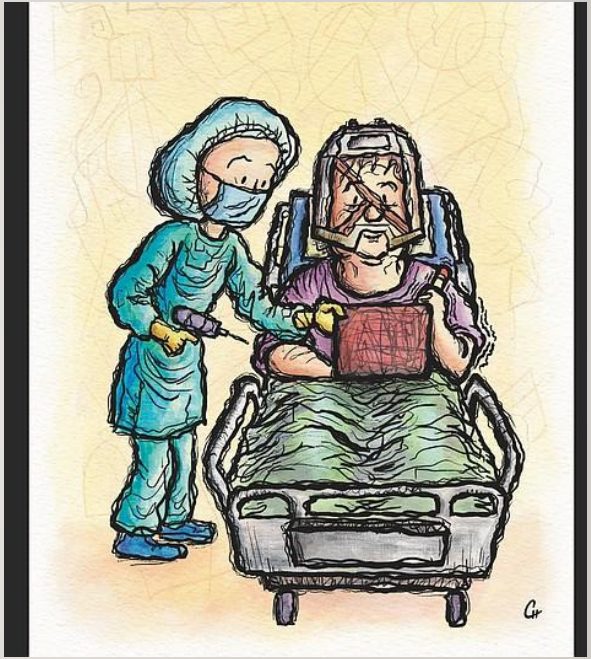

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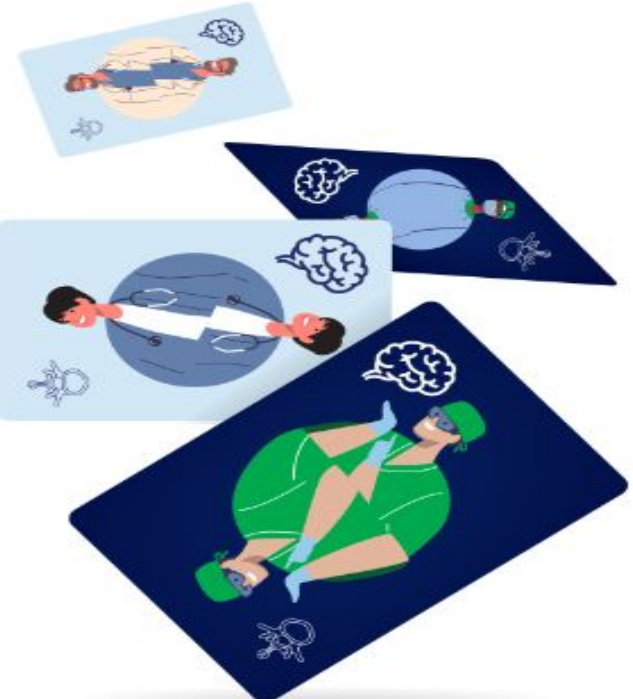
Ace in the Hole:
The Essential Role of the Family Caregiver in Neuroscience Disciplines

Jennifer A. O'Brien, MSOD



BEATING THE ODDS

NEUROSCIENCE SYMPOSIUM

October 4, 2024

Jennifer A. O'Brien, MSOD

no relevant relationships to disclose.

Objectives

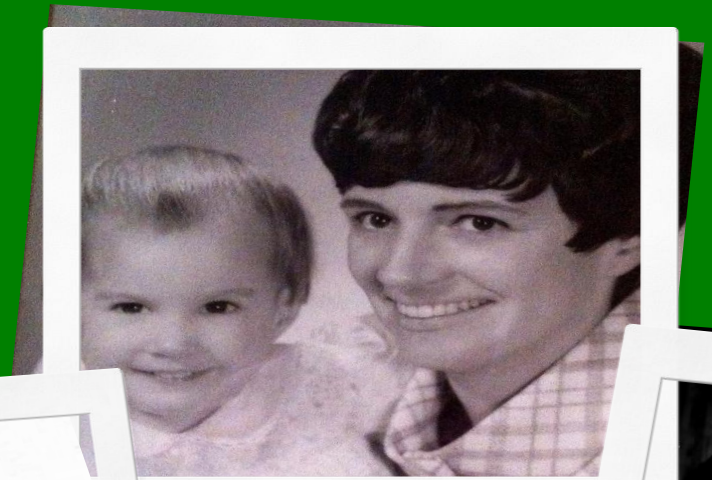
1. Summarize the demographic realities of family caregiving in the US and the implications of that data on clinical practice and patient population.

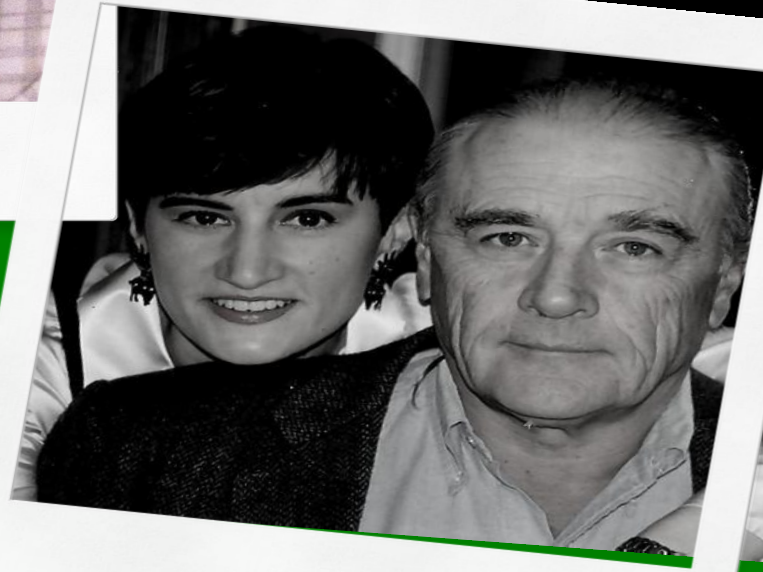
2. Recognize the elements of family caregiver stressors and challenges and how they may play a role in neuroscience healthcare provision.

3. Discuss the aspects of family caregiver fund of knowledge, sense of fulfillment, and resilience.

4. Access and make available resources for both family and professional caregivers.

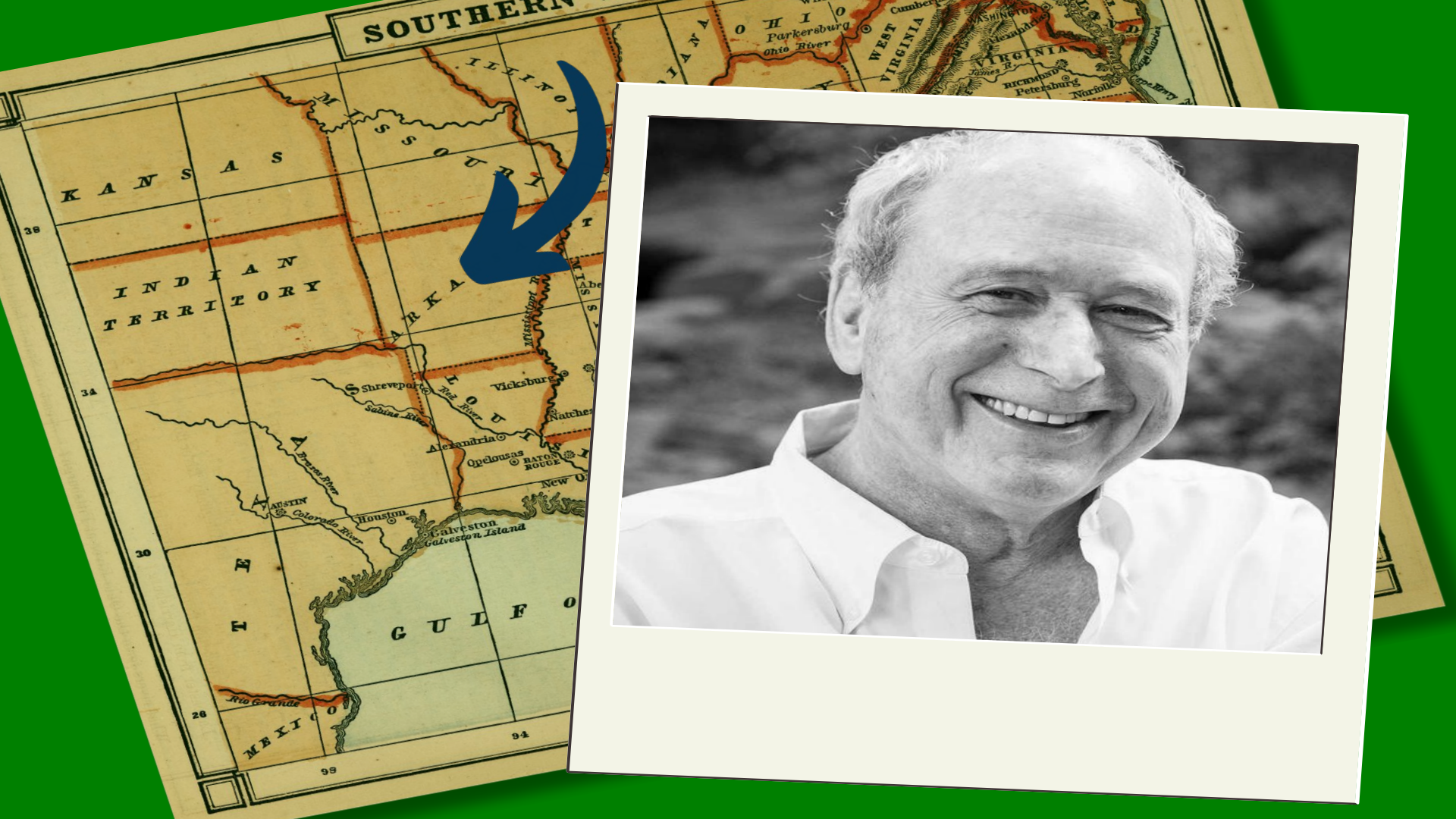
Who?





Who?

- 36+ years in healthcare
- practice management educator and consultant
- MSOD
- interim leadership
- self-taught artist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Petersburg
Shreveport
Red River
Sabine River
Vicksburg
Natchez
Alexandria
Opelousas
BATON ROUGE
Trinity River
Colorado River
Houston
Galveston
Galveston Island
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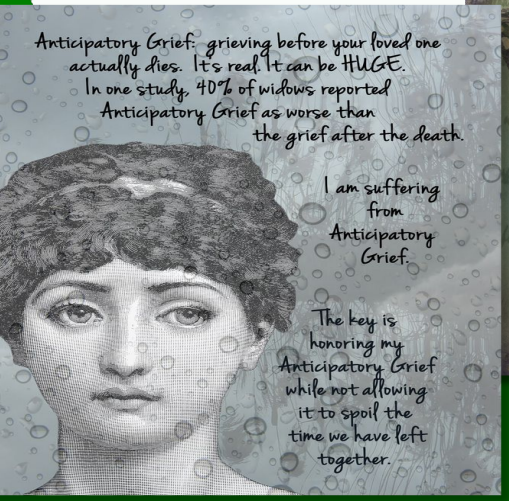
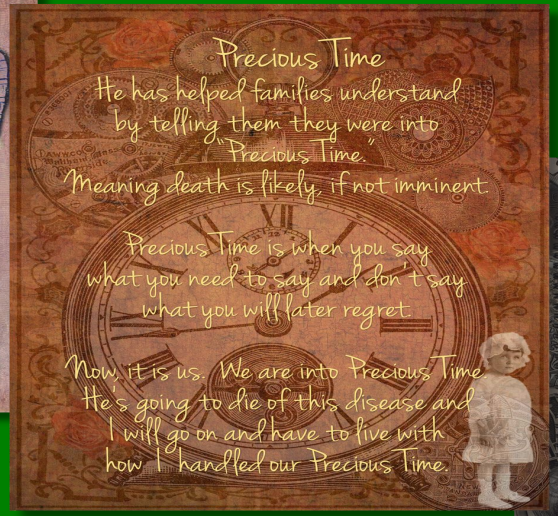
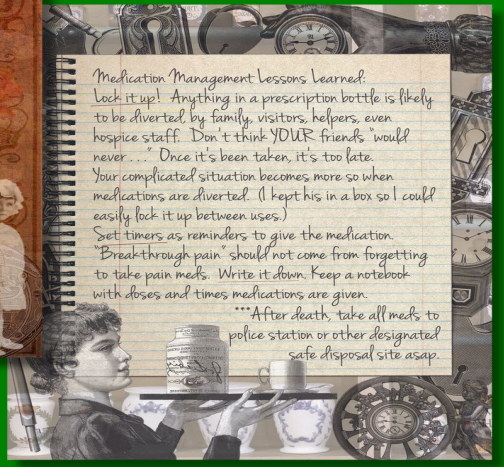
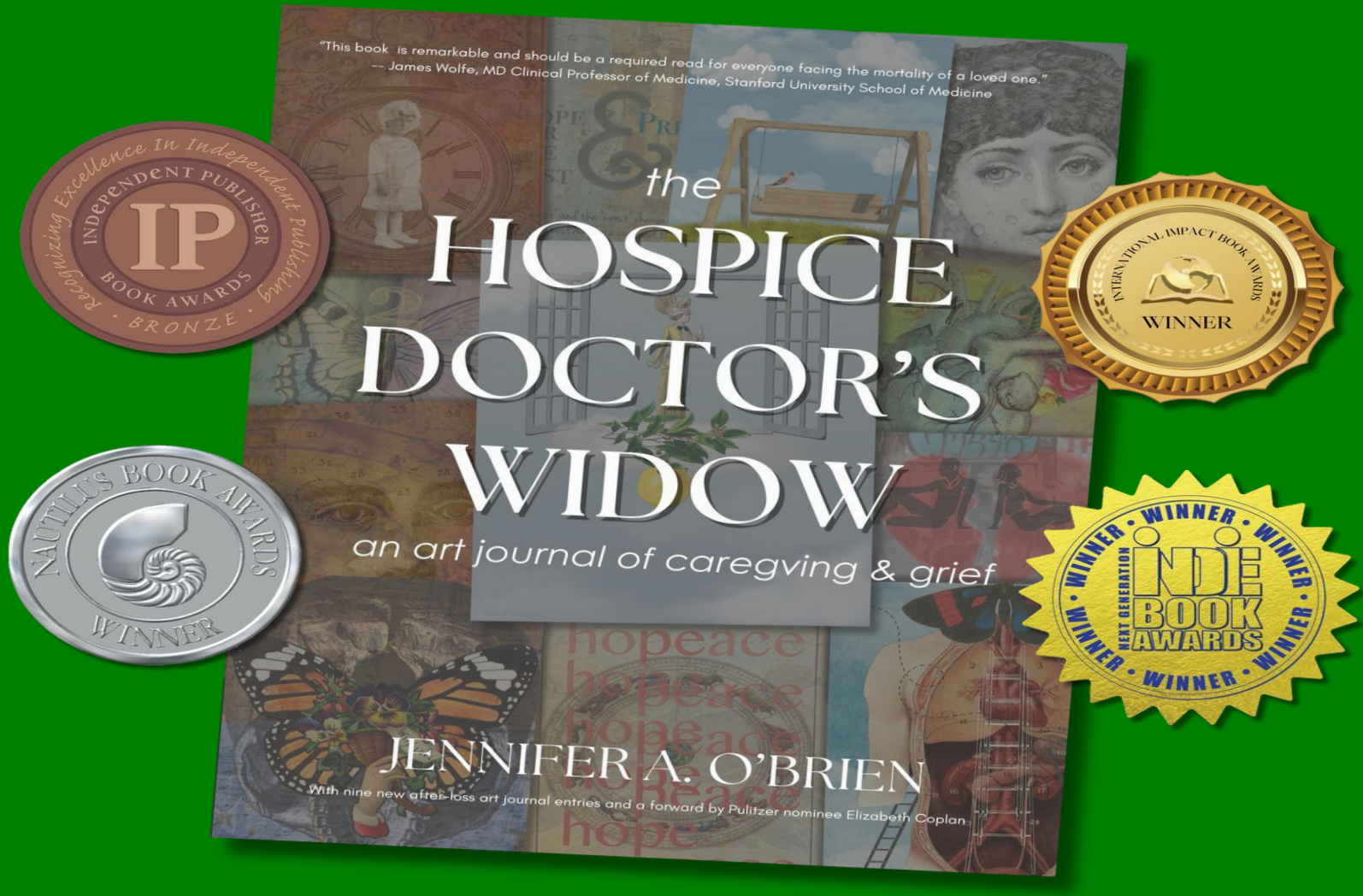
art journal


Anticipatory Grief: grieving before your loved one actually dies. It's real. It can be HUGE.
In one study, 40% of widows reported Anticipatory Grief as worse than the grief after the death.
I am suffering from Anticipatory Grief.
The key is honoring my Anticipatory Grief while not allowing it to spoil the time we have left together.


We're going through different processes.
He is dying
I am surviving


Precious Time
He has helped families understand by telling them they were into "Precious Time."
Meaning death is likely, if not imminent.
Precious Time is when you say what you need to say and don't say what you will later regret.
Now, it is us. We are into Precious Time. He's going to die of this disease and I will go on and have to live with how I handled our Precious Time.


Medication Management Lessons Learned:
Lock it up! Anything in a prescription bottle is likely to be diverted by family, visitors, helpers, even hospice staff. Don't think YOUR friends "would never..." Once it's been taken, it's too late.
Your complicated situation becomes more so when medications are diverted. (I kept his in a box so I could easily lock it up between uses.)
Set timers as reminders to give the medication. "Breakthrough pain" should not come from forgetting to take pain meds. Write it down. Keep a notebook with doses and times medications are given.
***After death, take all meds to police station or other designated safe disposal site asap.


"This book is remarkable and should be a required read for everyone facing the mortality of a loved one."
-- James Wolfe, MD Clinical Professor of Medicine, Stanford University School of Medicine
the
HOSPICE DOCTOR'S WIDOW
an art journal of caregving & grief
JENNIFER A. O'BRIEN
With nine new after-loss art journal entries and a forward by Pulitzer nominee Elizabeth Coplan
Recognizing Excellence In Independent Publishing
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1

Realities of Caregiving in the US

Who are the family caregivers and what do they do?

At any time in the last 12 months, has anyone in your household provided unpaid care to a relative or friend **18 years or older** to help them care for themselves?

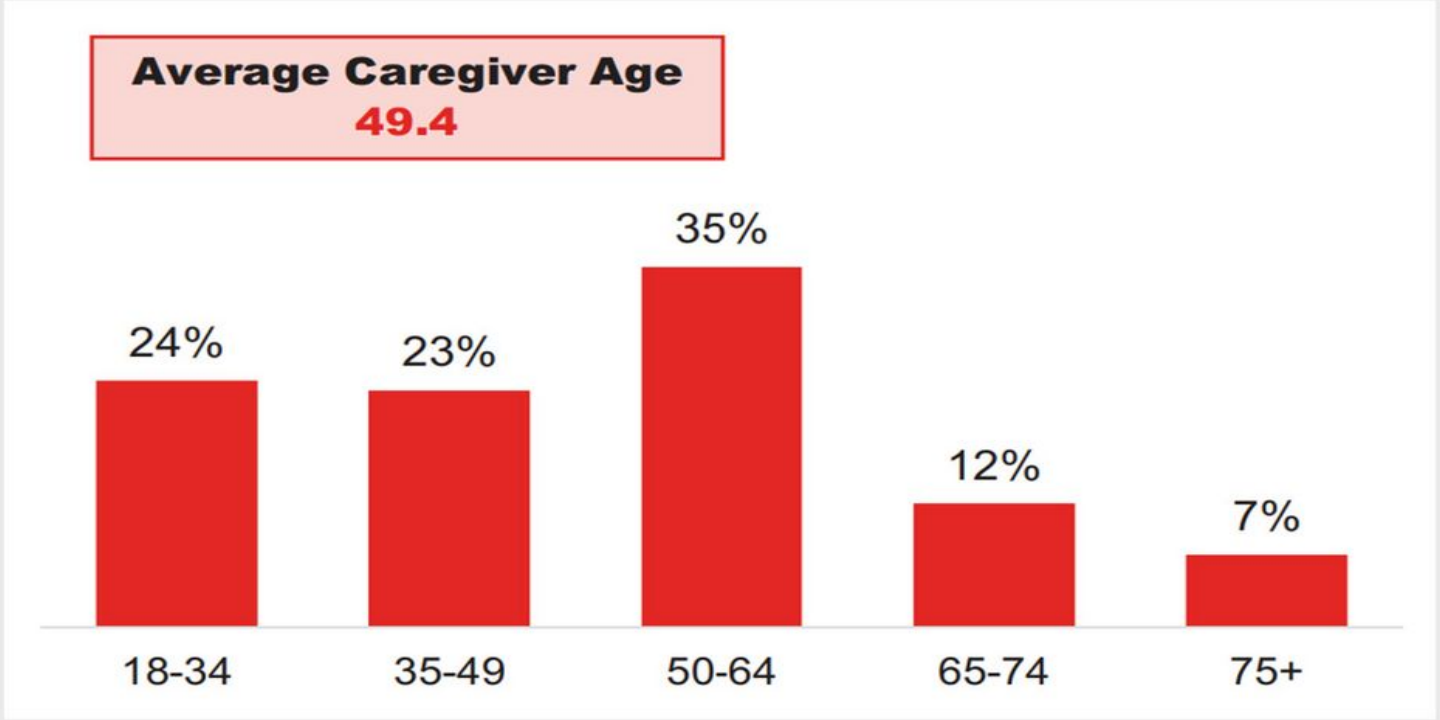
This may include helping with **personal needs or household chores**. It might be managing a person's **finances, arranging for outside services, or visiting regularly** to see how they are doing. This adult **need not live with you**.

Caregivers often don’t identify as caregivers. They say,

“I’m just the _____ .”

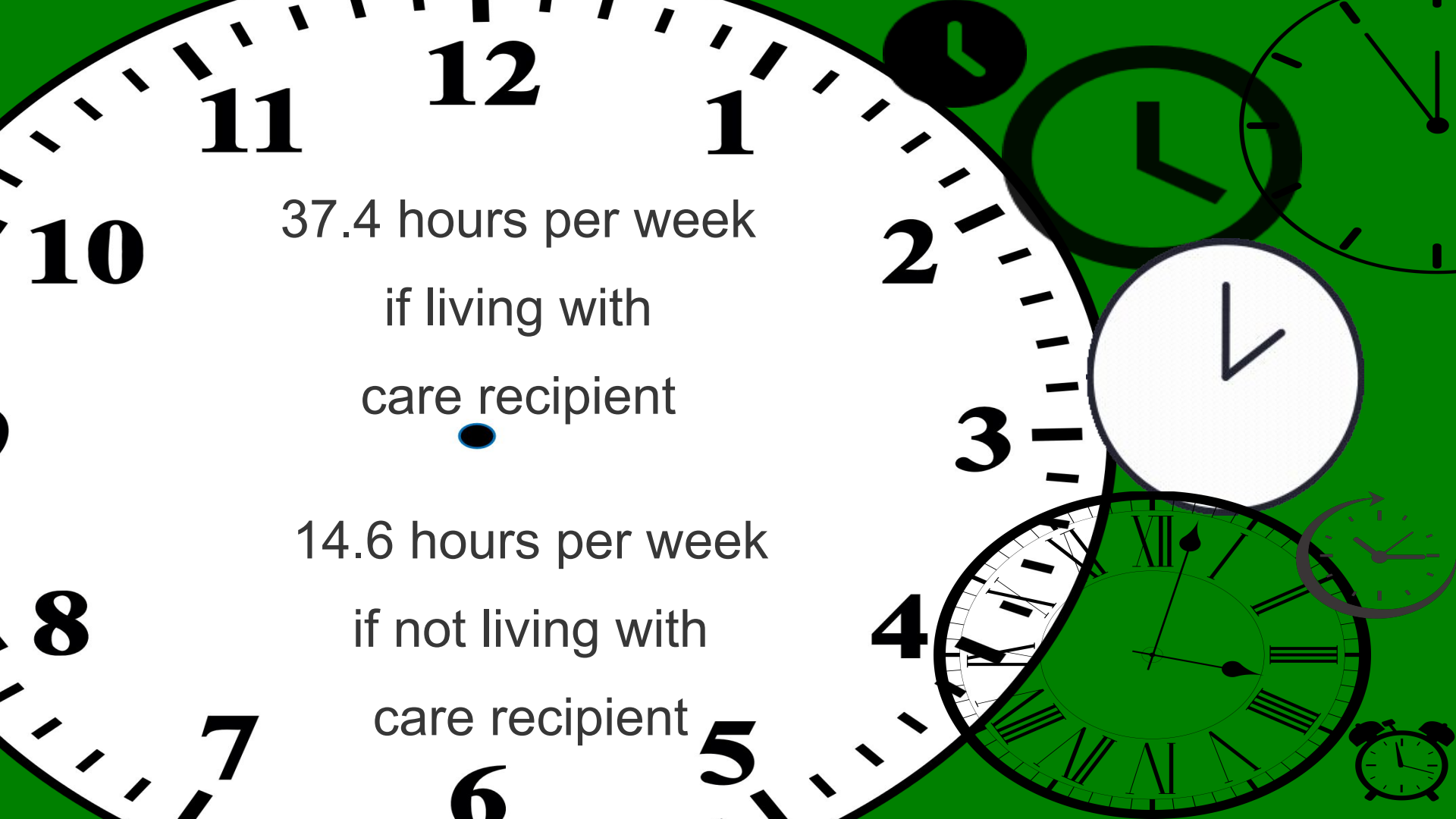
Family Caregivers

- **53 million in US**
- **3 out of 5 are women**
- **89% caring for relative**
- **72% caring for parent or spouse**



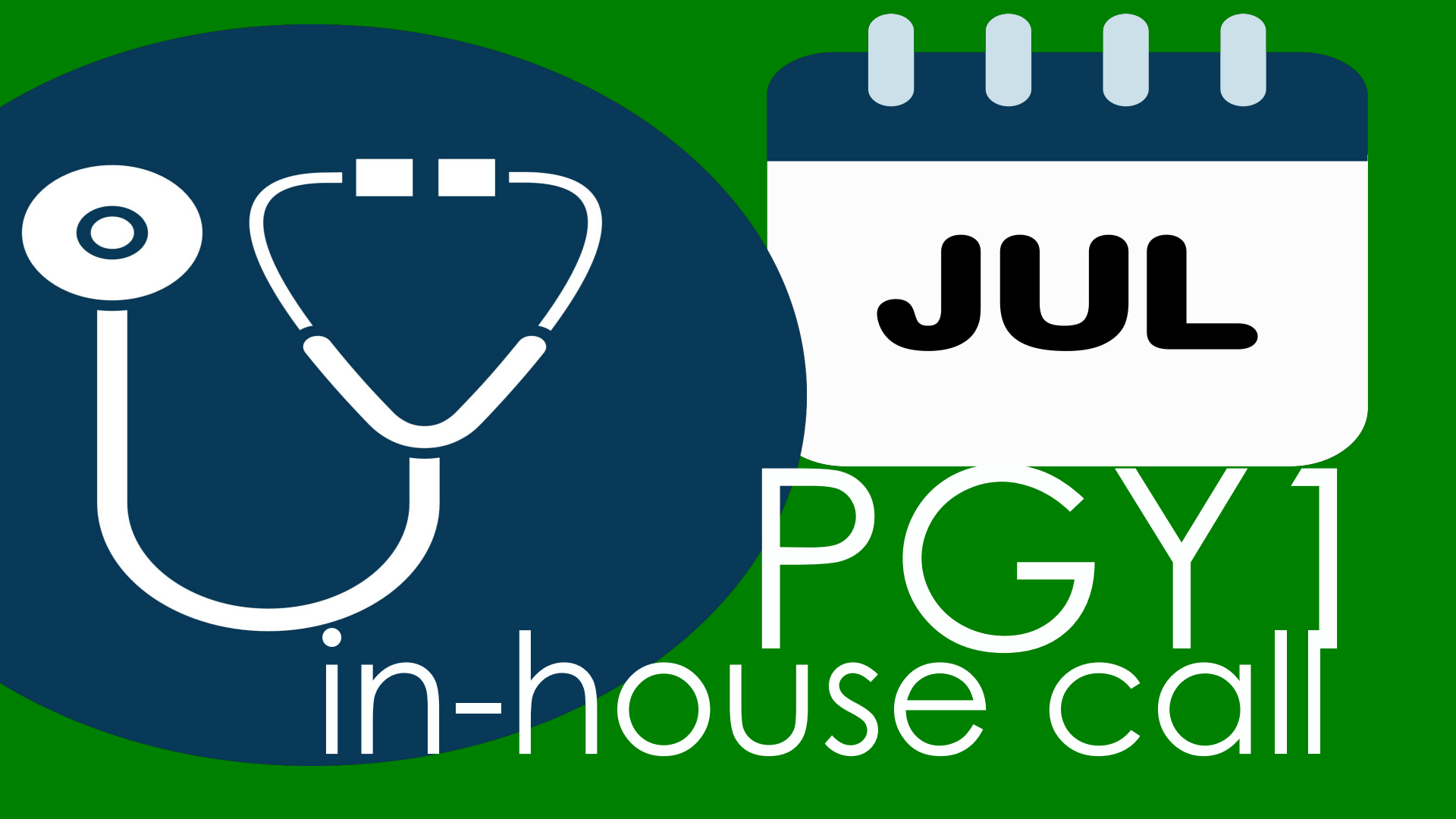
2020 Base: Caregivers of Recipient Age 18+ (n=1,392)

Note: Results are rounded; results may not add to 100 percent.


37.4 hours per week
if living with
care recipient
14.6 hours per week
if not living with
care recipient

2

Stressors & Challenges


JUL
PGY1
in-house call

Family Caregivers

- 56% have clinical anxiety or depression
- X10 more likely to experience suicidal ideation
- Increase substance use X5 rate

"This book is remarkable and should be a required read for everyone facing the mortality
-- James Wolfe, MD Clinical Professor of Medicine, Stanford University School of

the

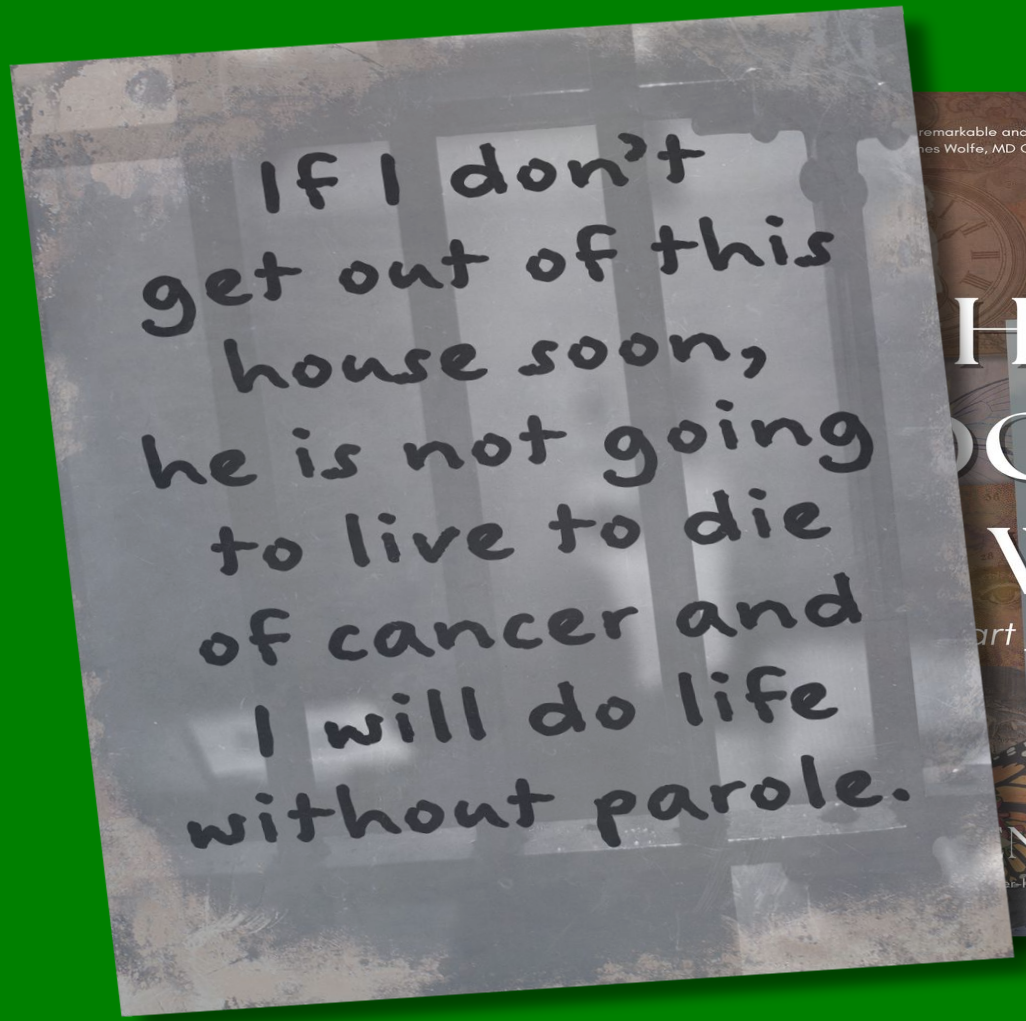
HOSPIC
DOCTOR
WIDOV

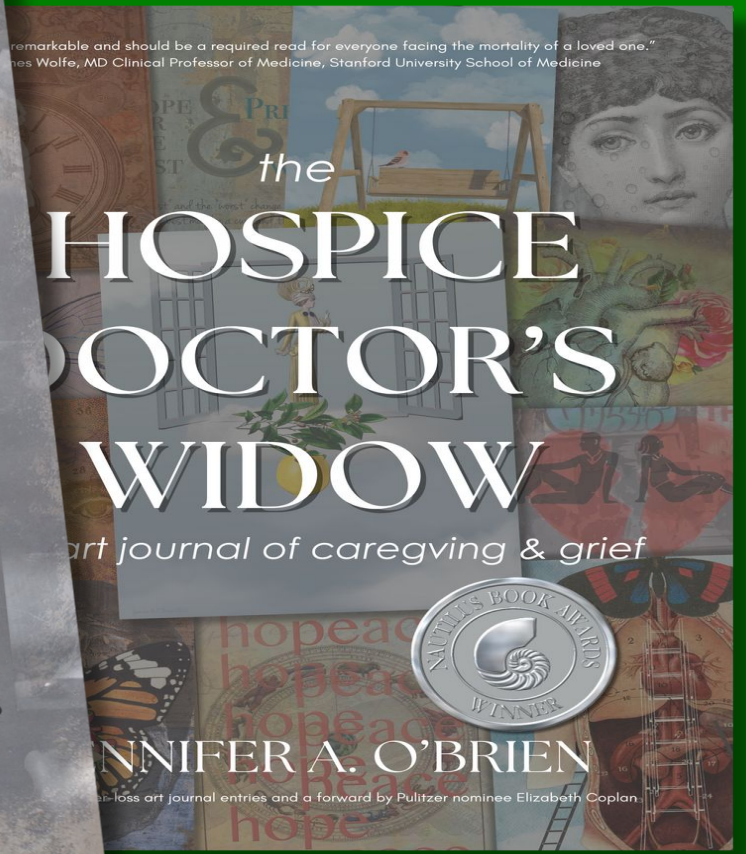
an art journal of caregvi

JENNIFER A. O

With nine new after-loss art journal entries and a forward by Pu

Sometimes
I wish
I would be
diagnosed
with cancer
and beat him
to the finish line.


If I don't
get out of this
house soon,
he is not going
to live to die
of cancer and
I will do life
without parole.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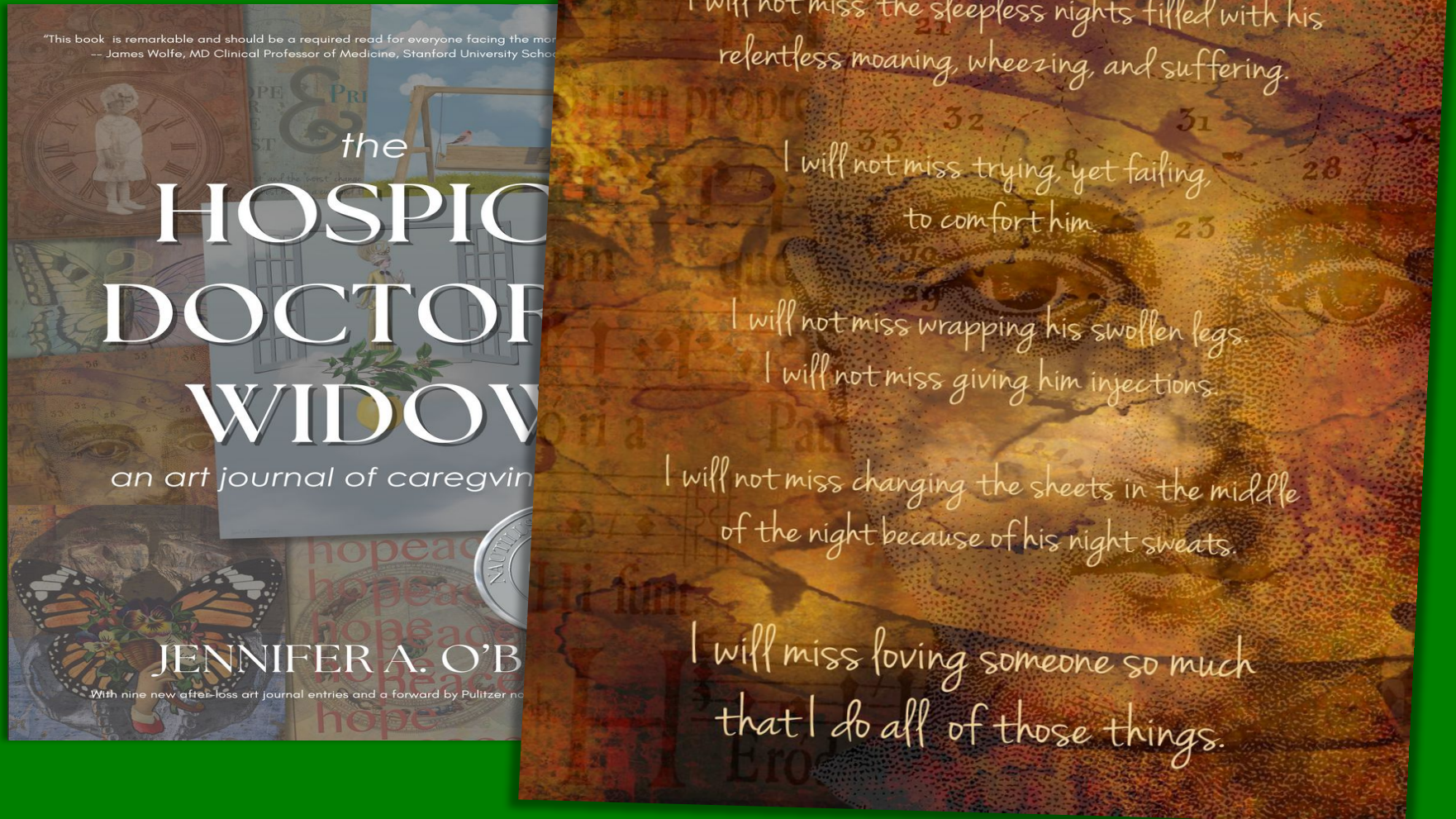
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HOSPIC
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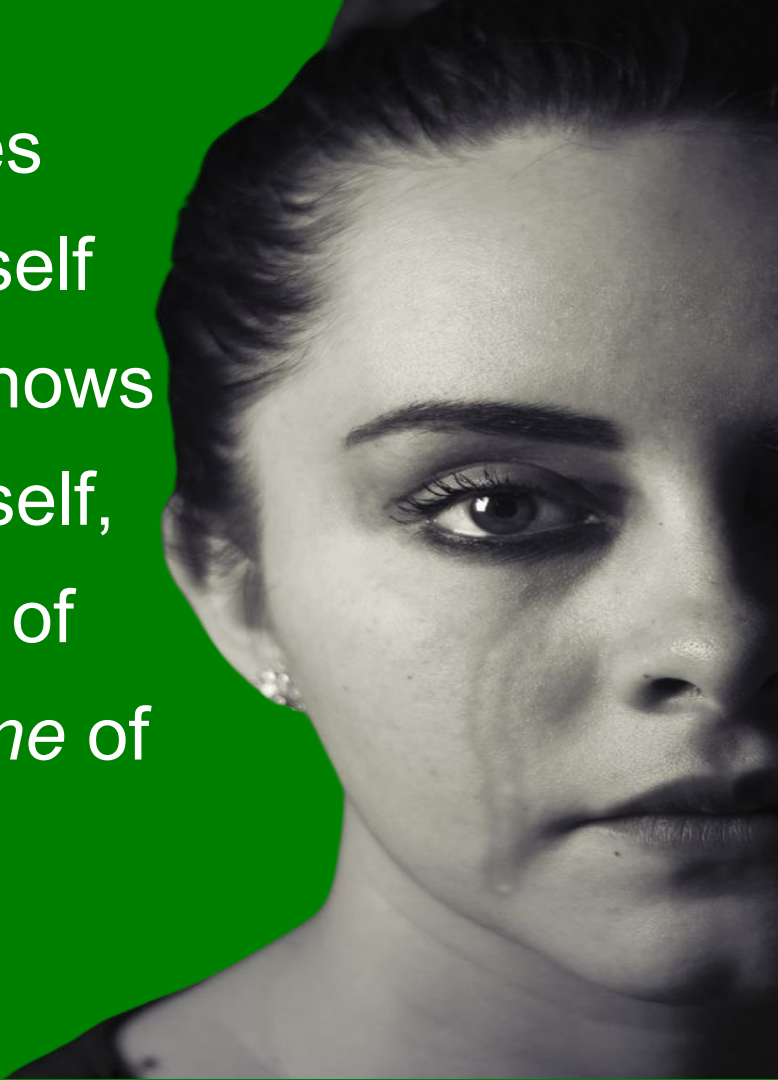
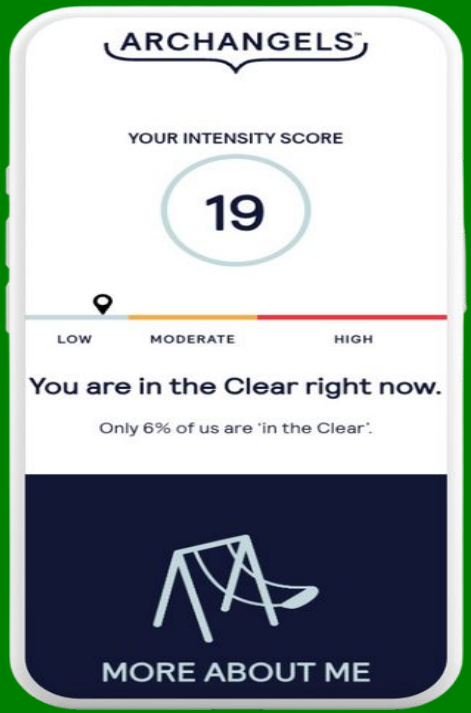
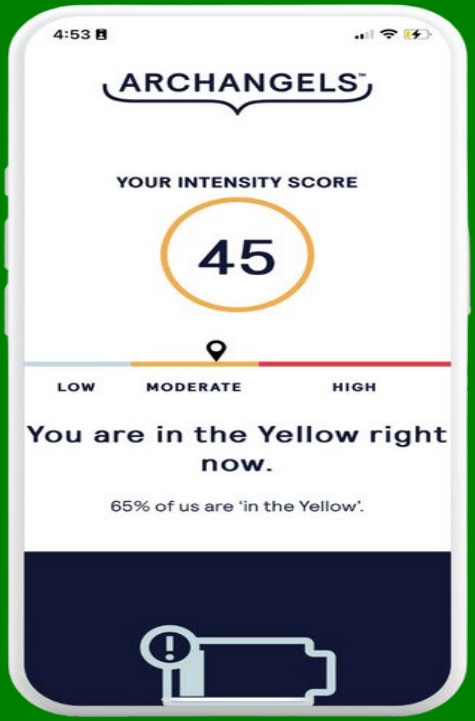
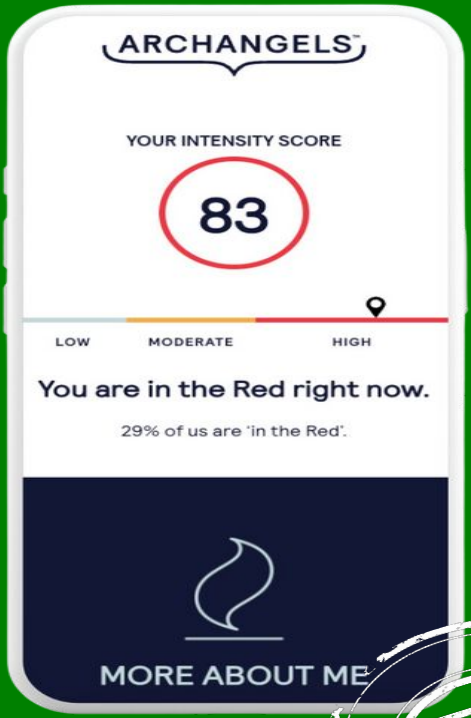
WIDOV
an art journal of caregivin
JENNIFER A. O'B
With nine new after-loss art journal entries and a forward by Pulitzer no
I will not miss the sleepless nights filled with his relentless moaning, wheezing, and suffering.
I will not miss trying, yet failing, to comfort him.
I will not miss wrapping his swollen legs.
I will not miss giving him injections.
I will not miss changing the sheets in the middle of the night because of his night sweats.
I will miss loving someone so much that I do all of those things.

When the family caregiver cries during a visit, a lecture about self care is contraindicated. She knows if she doesn't take care of herself, she won't be able to take care of her person, that's likely *only one* of the reasons she is crying.




ARCHANGELS
YOUR INTENSITY SCORE
19
LOW
MODERATE
HIGH
You are in the Clear right now.
Only 6% of us are 'in the Clear'.
MORE ABOUT ME


4:53
ARCHANGELS
YOUR INTENSITY SCORE
45
LOW
MODERATE
HIGH
You are in the Yellow right now.
65% of us are 'in the Yellow'.


ARCHANGELS
YOUR INTENSITY SCORE
83
LOW
MODERATE
HIGH
You are in the Red right now.
29% of us are 'in the Red'.
MORE ABOUT ME


RESOURCE

3

Fund of Knowledge, Sense of Fulfillment, and Resilience

The New York Times

March 25, 2019

My Friend's Cancer Taught Me About a Hole in Our Health System

Caregivers aren't supported, and America overlooks their importance.

By Aaron E. Carroll, MD, MS

"What seems more important is recognizing that the efforts of caregivers are probably just as important to health as the drugs and procedures the medical system provides. Rides to the hospital are care. Time spent at home with those recuperating after procedures is care. Watching and monitoring and caring for the ill in their home is just as much care as doing the same in the hospital. We are willing to pay a fortune for the former, and almost nothing for the latter."

84% need more help and information.

The top three (3) topics of concern to caregivers are the following:

- Keeping their loved one safe (42%)
- Managing their own stress (42%)
- Making end-of-life decisions (22%)

Caregiver Statistics: Health, Technology, and Caregiving Resources, National Caregiving Alliance , 2016

the

S-T-R-O-N-G METHOD

FOR PARTNERING WITH A FAMILY CAREGIVER

S - SHARE

We lead a team best when we share the goals, vision and take time to explain the "why."

Family caregivers are key members of the team. Share with them the treatment goals and confirm they understand them. Share details of signs and symptoms to look out for. Engage them in the maintenance and management of factors such as regular bowel movements, significant, rapid weight gain/loss, etc.

S-T-R-O-N-G

T - Training & Tools

You were not born knowing how to fill a syringe, change a colostomy bag or administer wound care and neither were Family Caregivers.

Create a resource list of YouTube videos, helpful apps, books and podcasts. Know the local training and resources available to family caregivers including support groups.

S-T-R-O-N-G

R - ROLE

Recognize the role of the Family Caregiver. It's a big job with far more access and, in some ways, responsibility for the patient than yours. What does the Position Description look like for a Family Caregiver?

S-T-R-O-N-G

FREE DOWNLOAD

Family Caregiver Position Description

RESOURCE

Family Caregiver Position Description

Provide 24/7 (in person or “on call”) all-round support to loved one, including but not limited to: personal and hygiene needs, health care, food preparation, mobility assistance, emotional support, personal supervision, transportation, record keeping, household organization and management, coordination of appointments and external commitments, communicating updates and developments, crisis management, mediation, end-of-life planning and preparation.

O - OBSERVE

Pay close attention to the relationship between the Family Caregiver and the Care Recipient.

Help the Caregiver to understand that alternatives to default love languages (food, sex) may need to be found. Be certain the Care Recipient understands that the Caregiver is a partner. Tend to their relationship. Their relationship needs to stay in tact and relatively healthy.

S-T-R-O-N-G

N - NURTURE

- Welcome questions with, "I am so glad you asked."
- Listen without interruption.
- Learn the Caregiver's name and call them by it.
- Proactively check in especially on weekends and holidays.
- Don't leave it to, "Call us if you need anything."
- Offer only pin-pointed positive feedback.
- Acknowledge and support their "gut feelings."

S-T-R-O-N-G

G - GIVE

Patients with serious illness describe profound isolation, yet every visit and hospitalization all the providers and staff focus on *the patient*. Friends periodically check in on *the patient*. *No one checks in on the Family Caregiver*.

Give care, attention, support and respect. Give permission not to listen to friends and family full of "shoulds" and advice. Give guidance that they will need help and support from others.

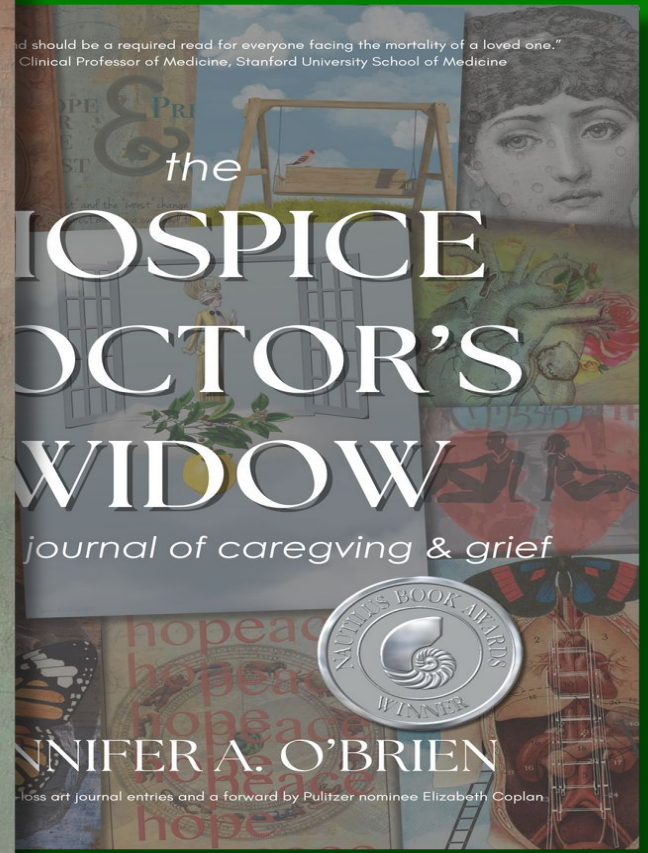
S-T-R-O-N-G

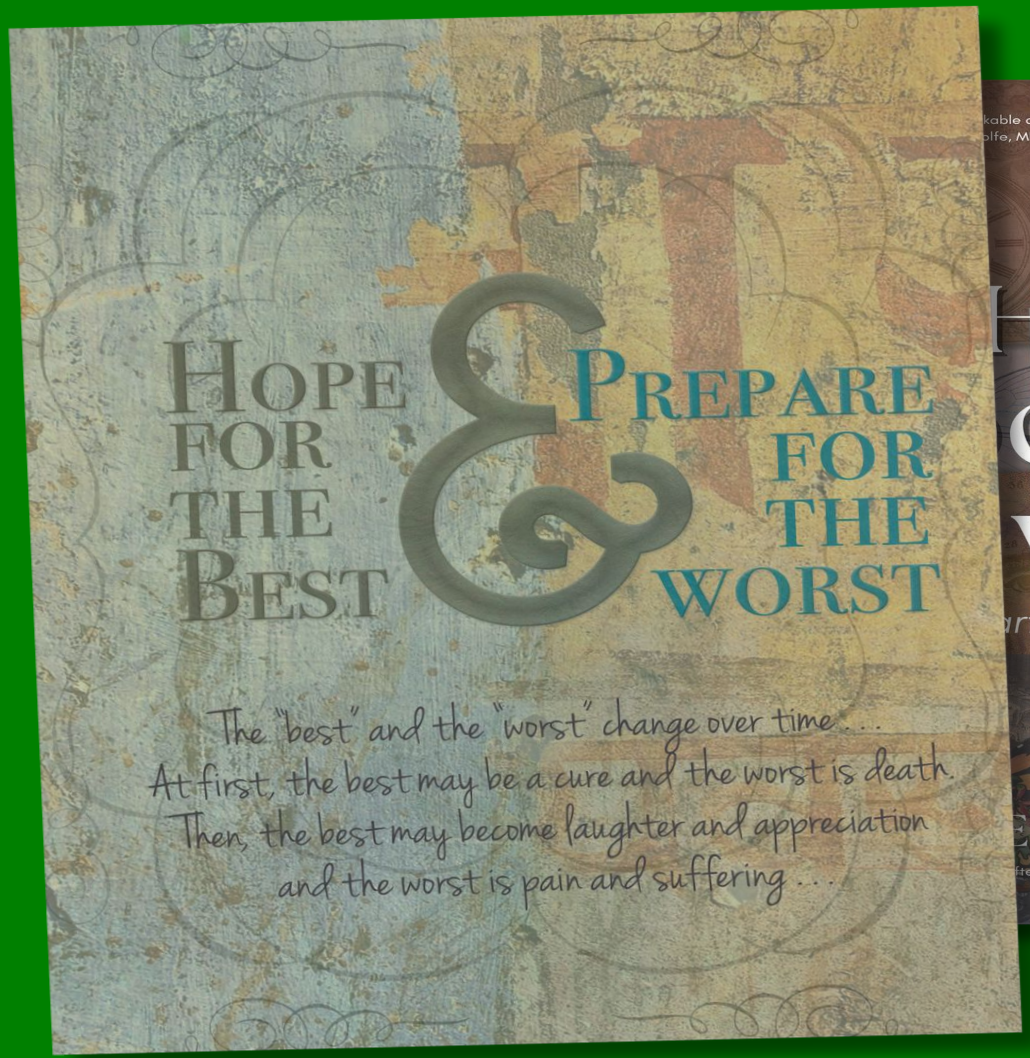
Yesterday, we cried together about how much we will miss each other when he dies.

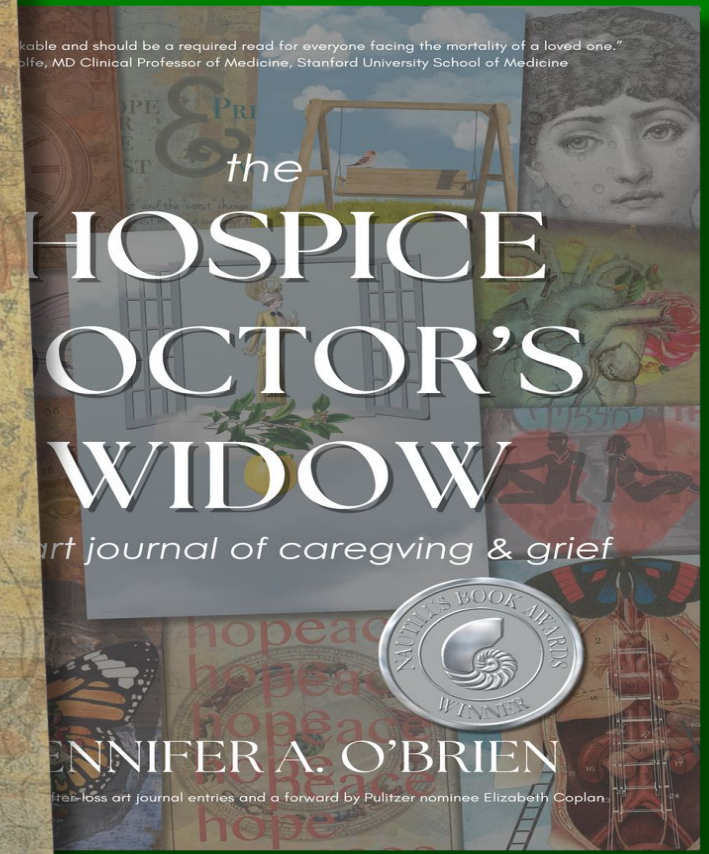
We are becoming closer and closer and it feels so good. I must have faith. What other choice do I have?

I can't pull away. . . The regret after he dies will be unbearable. I want to KNOW that I loved him thoroughly. That's my goal from now until he is gone.

And when he is gone,
I'll be alone.




HOPE FOR THE BEST
&
PREPARE FOR THE WORST
The "best" and the "worst" change over time . . .
At first, the best may be a cure and the worst is death.
Then, the best may become laughter and appreciation
and the worst is pain and suffering . . .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4

Access and make available resources for both family and professional caregivers.

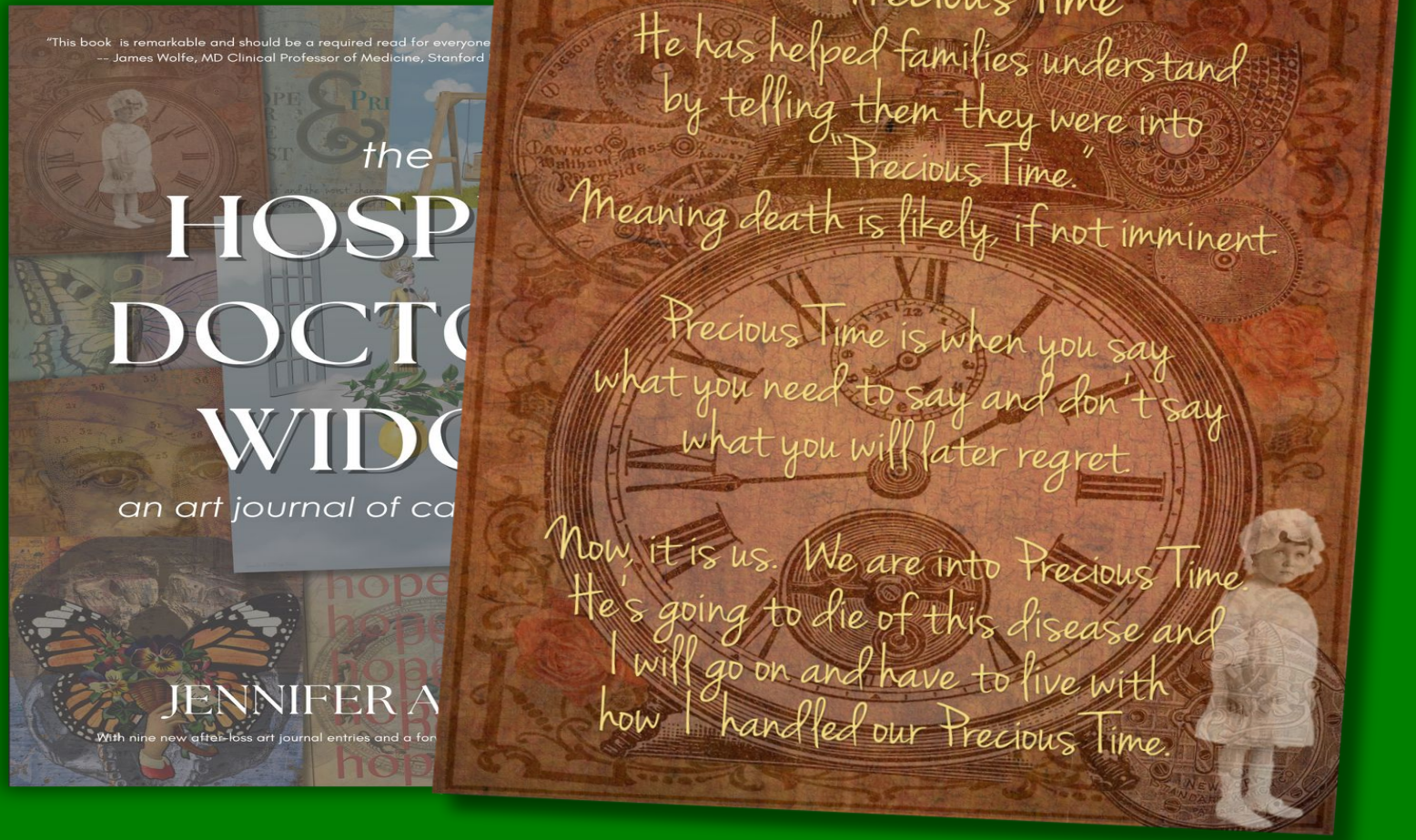

“life support”


“feeding tube”

Two Biggest Changes

Life Sustaining > >> End-of-Life/Hospice

Caregiver >>> Griever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JENNIFER A
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Precious Time
He has helped families understand
by telling them they were into
"Precious Time."
Meaning death is likely, if not imminent.
Precious Time is when you say
what you need to say and don't say
what you will later regret.
Now, it is us. We are into Precious Time.
He's going to die of this disease and
I will go on and have to live with
how I handled our Precious Time.

precious time™

free download

Implementation Guide for Healthcare Professionals

Making Difficult Conversations Easier

RESOURCE

precious time™

- Reconciliations
- Apologies
- I love yous
- Thank yous
- Good-byes

Social Media Accounts

Family Caregiving General

· Aisha Adkins
· Aging with a Plan – Jenna Rumberger
· Archangels
· Badass Advocate – Erin Mulqueen Gaylean
· Barry Jacobs (with AARP)
· Career & Caregiving Collide – Jessica C. Guthrie
· Caregiver Coach
· Caregiver Talks
· Caregiver Warrior
· Caregiving Advice – Michelle Seitzer
· The Caregiving Circle – Ayanna Swain
· The Caregiving Crew
· Caregiving Philosophy – Lani
· The Caregiving Space
· Caregiving Support
· Caring Across Generations
· Credit for Caring
· Finding a Foothold – Consuela Marshall
· Happy Healthy Caregiver – Elizabeth Miller
· Help.Texts
· The Reluctant Caregiver
· Support Now
· Will Gather – Nicole Will
· Whole Care Network

Dementia Care

· Be Light Care – Adria Thompson
· Blamb.md - Brittany Lamb, MD
· Career Caregiving Collide – Jessica C. Guthrie
· Dementia Darling – Carrie Aalberts
· Dementia Care Blazers – Natali Edmonds, PsyD
· Dementia Nutrition – Molly
· Dementia Spring – not for profit organization
· Dementia Success Path – Krista Montague, CDP
· Mom of My Mom – Jacqueline Revere
· A Sweeter Course – Rebecca Wellner
· Teepa Snow
· Your Dementia Therapist – Mary Osborne

Palliative Care

· C. Elizabeth Dougherty
· End Well
· Jared Rubenstein, MD
· Matthew Tyler, MD
· Nathan Gray, MD
· Pallimed
· Sammy Winemaker, MD
· Your Palliative PA – Tracey Piparo, PA
· The Waiting Room Revolution

Thank you

JenniferAOBrien.com

Baptist Health

FOR YOU. FOR LIFE.

Baptist Health

Next year's plan?

October 2nd-3rd here at Oaklawn

FOR YOU. FOR LIFE.

To Claim Credit

Complete the Credit Claim/Evaluation:
https://www.surveymonkey.com/r/bhneuroscience24

The evaluation will close on 10/20/24 at midnight.
Please complete the evaluation as soon as possible because after the evaluation closes, you will not be able to claim credit.

A certificate will be emailed to the address provided within 60 days of the activity end date.

Evaluation QR Code

Baptist Health

Thank You!

See you next year!

FOR YOU. FOR LIFE.