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Appendix 10: Neurotechnology Descriptions

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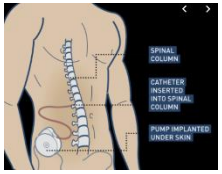
Appendix 10

Neurotechnologies

Neurotechnology	Medical term	Description	Benefits	Risks
NON-INVASIVE PROCEDURES				
E1. Electrical stimulation over the surface of the arm or hand  https://www.strokengine.ca/en/patient-info/functional-electrical-stimulation-upper-extremity-info/	Electrical stimulation (E-stim) OR Transcutaneous Electrical Nerve Stimulation (TENS) OR Neuromuscular Electrical Stimulation (NMES) OR Functional Electrical Stimulation (FES)	Electrical stimulation uses surface electrodes (adhesive pads or stickers) over the skin which are attached to a machine. The machine sends a small amount of electrical current to weak or paralyzed muscles. Tingling sensation is experienced over the skin in the area of stimulation.	-Increase in muscle contraction[1] -Increase in blood circulation[2] -Reduces spasticity[3] -Reduce pain[4] -Increase aerobic fitness[5]	-Skin irritation[6] -Burning sensation[4] -Muscle tears -Pain[4] -Tingling below application site[4]
E2. Electrical stimulation over the surface of the spine  http://depts.washington.edu/moritlab/?page_id=718	Transcutaneous Spinal Cord Stimulation	Electrical stimulation uses surface electrodes (adhesive pads or stickers) over the skin of the lower back and abdomen that are attached to a machine. The machine sends small amount of electrical current that can stimulate nerves in the spinal cord from outside the body.	-Immediate effect while the stimulator is on[3] -Controlling locomotion[7] -Long-lasting effects (up to a week)[3] -Reduced pain[4] -Reduced spasticity[3]	-Skin irritation[6] -Burning sensation[4] -Pain[4] -Tingling below application site[4]

E3. Electrical stimulation over the surface of the head  https://www-ncbi-nlm-nih-gov.proxy1.lib.tju.edu/pmc/articles/PMC5702643/ Stroke, Depression, anxiety, pain, Parkinson's disease	Transcranial Direct Current Stimulation (TDCS)	Electrodes are placed over the scalp directly over the brain area to be stimulated. A small amount of electric current is passed through.	-Temporary improvement in emotion and mental functioning[8] -Fatigue[9] -Improvement of language in aphasia[10]	-Tickling or burning sensation over the head[11] -Headache[11,12] -Skin lesions or burns[11] -Nausea[11,12] -Difficulty concentrating[12] -Fatigue[11] -Redness[12] -Mood changes[11,12]
E4. Magnetic stimulation over the surface of the head  https://www.medpagetoday.com/psychiatry/depression/56168 Cost: $200 to $300 per session (20 min) – Needs 5 sessions/wk for 4-6 wks	Transcranial Magnetic Stimulation (TMS), Repetitive TMS (rTMS)	A magnetic coil is placed over the head, creating changing magnetic fields over the surface of the brain. It is used to create electric current at a specific area in the brain. (FDA approved)	-Improves mood[13]	-Cannot be used with metal objects near the head -Headache[14] -Pain over scalp -Loud machine noise -Crying -Seizure[14]
E5. Braces that are powered to amplify movements  https://myomo.com/what-is-a-myopro-orthosis/	Myoelectric brace	The electrical signals from weak muscles are converted into large movement of the brace to allow improved movement.	-Improved movement[15, 16, 17] -Allows the patient to perform movement they otherwise are unable to complete[15, 16, 17] -Effective in improving motor control[15, 16, 17] -Improvement in self-reported function and	-Pressure sores -Chafing of the skin -Mechanical irritation

			perception of recovery[15, 16, 17]	
E6. Brain computer interface with a cap  https://www.odtmag.com/contents/view_breaking-news/2017-08-30/stroke-patients-motor-function-improved-with-brain-computer-interface/	EEG driven brain computer interface	Brain computer interfaces or brain machine interfaces are hardware and software systems that allow brain activity to control a hand brace to move the hand. Some brain computer interfaces are implanted in the brain and others use an external cap.	-Communication[19] -Movement control[19] -Control of external devices[19] -Improved motor function[19]	-BCIs placed outside of the skull have a limited ability to read brain signals[20] -Signal connection problems[20] -Quality of electroencephalography signals is affected by scalp, skull, and many other layers as well as background noise[20] -Skin irritation or hair loss secondary to cap pulling on hair follicles[21]
INVASIVE PROCEDURES				
 E7. Baclofen pump http://www.emdocs.net/core-em-intrathecal-baclofen-withdrawal/	Intrathecal Baclofen Therapy (ITB)	The medicine Baclofen is placed in a round metal disc under the skin of the abdomen and delivered by a pump and a catheter directly into the spine. Refills are done every 1 to 6 months and battery is changed every 5 to 7 years. (FDA approved)	-Reduces spasticity[22] -Improved ambulation/wheelchair seating -Reduced spasticity-related pain -Improved sleep	-Dosing errors -Weakness[23] -Sleepiness[23] -Upset stomach[23] -Nausea[23] -Vomiting -Headache -Dizziness -Confusion -Catheter, Battery or pump malfunction (CSF leakages)[23] -Hypotonia[23] -Infection -ITB withdrawal syndrome (rare)[23]

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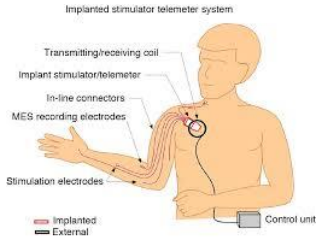
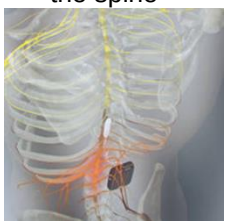
E8. Implanted stimulators for the nerves of the arm and hand  https://connect.springerpub.com/content/book/978-0-8261-3775-3/part/part05/chapter/ch48	Peripheral nerve and field stimulators (PNFS)	Peripheral nerve and field stimulation involves placing the electrodes directly on nerves or under the skin in the painful region. It is a minimally invasive procedure, requiring a small incision over the targeted area.	-Pain reduction for chronic pain[24]	30 to 40% rate of complications -Hardware complication: movement, breaking or malfunction of the electrode -Infection, pain over electrode -Rare: headache, neurological damage
E9. Implanted stimulators for the spine  https://www.spinalcord.com/blog/what-to-know-epidural-stimulation-spinal-cord-injury Spinal cord injury – traumatic and non-traumatic: Cost: $15 - 50K without insurance, Covered by some insurance such as Medicare and Blue Cross and Blue Shield	Epidural Electrical stimulation (EES) or Epi-stim	Stimulators for the spinal cord are surgically placed directly on the cord for continuous electrical current.	-Increases muscle contraction[25, 26]	-Programming issues for the device -Movement, leakage of current, & failure of electrode -Nerve injury [27,28] -Infection[28] -Pain at the site[28] -Equipment failure [27,28]

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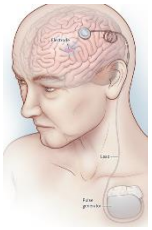
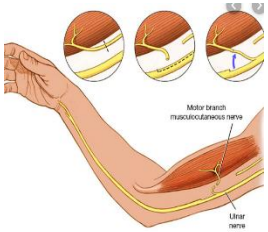
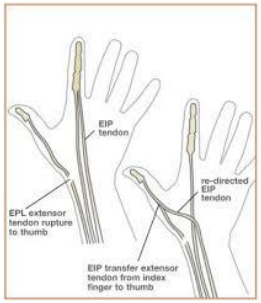
E10. Braces powered by implanted sensors in the brain  https://www.extremetech.com/extreme/102927-brain-computer-interfaces-creep-closer-to-bionic-mecha-dream	Brain computer interface (BCI), Neural-control interface (NCI), Direct neural interface (DNI), Brain machine interface (BMI)	A small chip is surgically placed in the brain and connects to an external brace that can move the arm or hand.	-Increased movement Communication[29] -Increased perception[29] -Increased motor activity[29] -Increased sensation[29]	-Infection -Anesthesia risk -Scarring over brain -Pain at location site, headaches
 E11. Deep Brain Stimulation for Parkinson's disease https://www.nejm.org/doi/full/10.1056/NEJMct1208070	Deep Brain Stimulation	A brain pacemaker is placed surgically on specific areas of the brain. (FDA approved)	-Reduces tremor[30] and epilepsy -Reduced dyskinesia[31] -Increased control with movements	-Infection -Electrode movement, damage or malfunction -Scarring over brain -Worsening of gait, balance, and/or speech[31]
E12. Nerve transfers  https://www.mayoclinic.org/diseases-conditions/brachial-plexus-injury/diagnosis-treatment/drc-20350241	Nerve transfer	A nerve transfer is a surgical procedure where a nerve with a less important role is transferred surgically to another more important nerve that is not functioning.	Regain important movement [32, 33, 34]	-Anesthesia risk -Infection

E13. Tendon transfers  http://blog.handcare.org/blog/2017/04/26/4-reasons-you-may-need-tendon-transfer-surgery/	Tendon transfer	A tendon transfer is a surgical procedure where a tendon with a less important role is transferred to serve the function of a weak tendon with a crucial role.	Regain important movement[32]	-Anesthesia risk -Infection

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