

Prifysgol Cymru
Y Ddrws Dewi Sant
University of Wales
Trinity Saint David

THERAPEUTIC PAIN MANAGEMENT

SHSS6065
Semester 1 - Week 5

*Trawsnewid Addysg; Trawsnewid Bywydau
Transforming Education; Transforming Lives*

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How Pain Works ©2007 HowStuffWorks

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Pain Physiology – Revisited

- Pain is debilitating and pervasive obstacle to effective injury rehabilitation in athletes (Taylor and Taylor, 1998).
- Experience of pain and the way pain is communicated on behaviour varies immensely from person to person
- Measurement and quantification of pain is difficult, at best it can be relatively scaled, qualified or described

Mechanism of Pain

- International Association of the Study of Pain (IASP)
 - Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage (IASP, 1986)

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Pain Transmission - Nociceptors

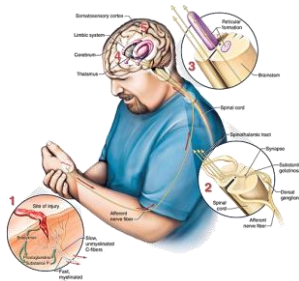
- Pain receptors?
- Danger receptors!
- Nociceptive system of the nervous network
- Sensory nerves
- Threshold of excitation: too high to be stimulated by non-noxious stimuli but high enough to be stimulated by potentially damaging stimuli

Pain Transmission - Nociceptors

- Noxious, potentially damaging stimuli are carried predominantly by small myelinated alpha-delta fibres (A- δ) and larger unmyelinated C fibres.
 - **A δ (A delta) fibres**
 - Medium diameter with some myelination
 - Sharp, acute pain (4-30m/s)
 - Mechano/Thermosensitive (>45°)
 - **C fibres**
 - Small diameter, non myelinated
 - Transmit dull, slow, achy pain (0.5-2m/s)
 - Mechano/Thermo/Chemosensitive

Pain Transmission – Pathway Overview

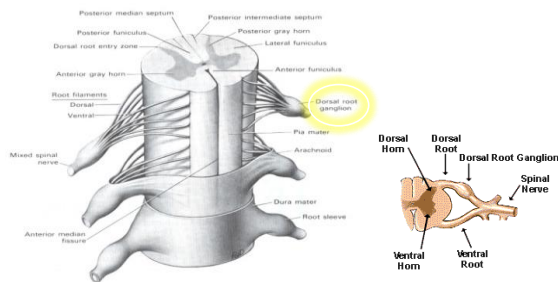
- Pain stimuli travel quickly to the *substantia gelatinosa* in the dorsal horn of the spinal cord where the "gating" mechanism occurs.
- Pain impulses then cross over to the opposite side of the spinal cord and ascend to the higher centres in the brain via the *spinothalamic tracts* and on to the *thalamus* and higher centres of the brain, including the *reticular formation*, *limbic system* and *somatosensory cortex*.



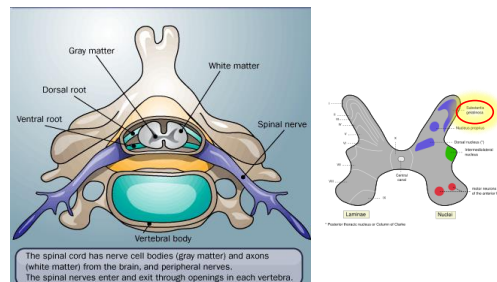
Pain Transmission – Spinal Cord

- The unmyelinated C fibres unite forming a single nerve fibre that enters the peripheral nerve sheath before reaching the DORSAL ROOT GANGLION
- Alpha delta fibres travel as individual myelinated fibres to the dorsal root ganglion.
- Once they reach the DRG they synapse with the dorsal horns (substantia gelatinosa) of the spinal cord
- Spinal cord connects to the brain

Dorsal Root Ganglion



Spinal Cord Anatomy



Spinal Cord Anatomy

- Dorsal Horn: Grey Matter
- Substantia Gelatinosa
 - The apex of the posterior horn of the gray matter of the spinal cord is capped by a V-shaped or crescentic mass of translucent, gelatinous neuroglia,
 - Aka **Substantia Gelatinosa of Rolando** (or SGR)
 - contains both neuroglia cells, and small nerve cells.
 - The gelatinous appearance is due to a very low concentration of myelinated fibers.

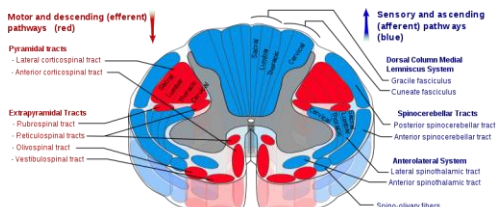
Substantia Gelatinosa



- **Function**
 - The **Substantia Gelatinosa** is one point (the nucleus proprius being the other) where first order neurons of the **Spinothalamic Tract** synapse.
 - Many opioid receptors are found on these nerve cells; they can be targeted to manage pain of distal origin.
 - C fibre's terminate at this layer. Cell bodies located here are part of the neural pathway conveying slowly conducting, poorly localized pain sensation.
 - However, some A-Delta fibers (carrying fast, localized pain sensation) also terminate in the Substantia Gelatinosa.

Brain Anatomy

- The nociceptors also synapse with an area of the **white matter** in the spinal cord called the **Spinothalamic Tract**

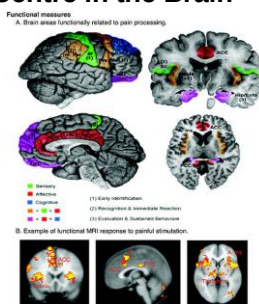


Brain Anatomy

- Spinothalamic tract is like a superhighway where traffic from all of the lower segments rides up the spinal cord.
- The signals of the **spinothalamic tract** travel up the spinal cord
- through the **medulla** (brain stem)
- synapse on neurons in the **thalamus** (the brain's relay center)
- Some neurons also synapse in the medulla's **reticular formation**, which controls physical behaviors
- Nerves from the thalamus then relay the signal to various areas of the brain's **somatosensory cortex**
- there is no single pain center in the brain.

There is NO Pain Centre in the Brain

- Areas displayed include insula, anterior cingulate cortex (ACC), posterior cingulate cortex (PCC), primary somatosensory cortex (SI), secondary somatosensory cortex (SII), inferior parietal lobe (Inf. Par), dorsolateral prefrontal cortex (DLPFC), pre-motor cortex (Pre-Mot), orbitofrontal cortex (OFC), medial prefrontal cortex (Med. PFC), posterior insula (P. Ins), anterior insula (A. Ins), hippocampus (Hip), entorhinal cortex (Ento).



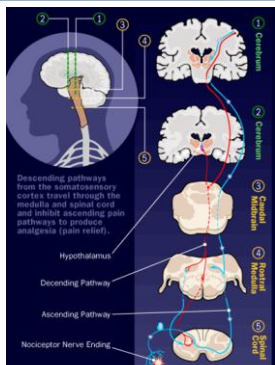
Borsook D, Moulton EA, Schmidt KF, Becerra LR. (2007). Neuroimaging revolutionizes therapeutic approaches to chronic pain. *Molecular Pain*. 3 (25).

Pain is Interpreted..Then what?

- Detected pain**
- Act!**
 - Remove or leave the noxious stimuli
 - Change behaviour
 - Protect/splint/treat the painful area
 - Learn to recognise the noxious stimuli in future/avoid future pain
 - Reduce pain

Descending Pain Pathway

- Information arrives in brain
- Processed?
- Motor cortex → spinal cord → motor nerves
- Muscle contraction
- Eventually pain subsides or goes away if you don't think about it – BUT HOW?
- Pain-influencing neural pathways must exist from the brain downward...
- Descending pain pathways inhibit 'pain signals'



Descending Pathways

- Descending pathways originate in the **somatosensory cortex** (which relays to the **thalamus**) and the **hypothalamus**.
- **Thalamic neurons** descend to the midbrain.
- There, they synapse on ascending pathways in the **medulla** and **spinal cord** and inhibit ascending nerve signals.
- This produces pain relief (analgesia).
- Some of this relief comes from the stimulation of natural pain-relieving opiate neurotransmitters called **endorphins**, **dynorphins** and **enkephalins**.
- Opioid release is an alternative method of pain relief (as well as pain gate)

History of Pain Theory

Descartes' pain pathway:

- "Particles of heat" (A)
- Activate a spot of skin (B)
- Attached by a fine thread (cc)
- To a valve in the brain (de)
- Where this activity opens the valve, allowing the animal spirits to flow from a cavity (F)
- Into the muscles causing them to flinch from the stimulus,
- Turn the head and eyes toward the affected body part,
- And move the hand and turn the body protectively.



Descartes, R. (1664). *Treatise of Man*

But....you already knew all of that, right?

You must know the physiology of pain to pass this exam!



PAIN GATE CONTROL THEORY

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Reducing Pain

- Pain is often the main reason an athlete visits a therapist.
- Sports Therapy has a role to play in the treatment of pain in 2 ways
 - Neurophysiologically reducing pain levels
 - Providing a 'window' of reduced pain for a therapist to work with the athlete on other treatment/rehabilitation.



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Who tells the brain/SC?

Skin Surface

A- β afferent Sensory Fibres

A- δ afferent Nociceptors (1st pain)

C-fibre afferent Nociceptors (2nd Pain)



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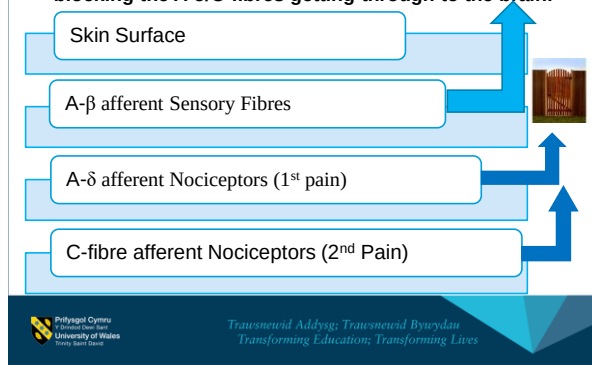
Pain Gate Control Theory (gate control theory of pain)

- Ronald Melzack and Patrick David Wall in 1962 and again in 1965,
- The perception of physical pain is not a direct result of activation of Nociceptors, but instead is modulated by interaction between different neurons, both pain-transmitting and non-pain-transmitting.
- The theory asserts that activation of nerves that do not transmit pain signals can interfere with signals from pain fibers and inhibit an individual's perception of pain.



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By rubbing the skin, your A- β fibres were stimulated, blocking the A- δ /C fibres getting through to the brain!



Gate Control theory of Pain

- A more in-depth look at pain gate....

Pain Gate Theory

- Melzack and Wall (1965)
- Described a neurophysiological mechanism which involved the concept of peripheral and central "gating".
- The concept is that when several sensory stimuli reach the spinal cord at the same location and time one of them becomes dominant.

Sensory Transmission

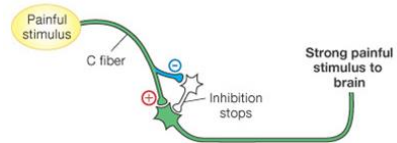
- Mechanical pressure/movement is transmitted by
 - A β (A Beta) fibres
 - Large diameter with myelin
 - Myelin increases conduction
 - Larger diameter increases conduction
 - Up to 80m/s
 - **$\therefore$ A β fibres transmit sensory input more rapidly than A δ or C fibres**

Gating Mechanism



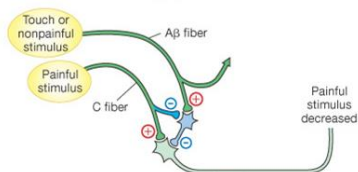
- **T-cell inhibitory neuron** in substantia gelatinosa of dorsal horn
 - “tonically active”
 - Has a base rate of activation
- *Suppresses* the ascending pain pathway

Gating Mechanism



- Painful stimulus leads to **T-cell** activity
- *Allows* transmission of pain stimulus to brain

Gating Mechanism



- **Aβ fibres** stimulate **inhibitory T-cells**
 - Counters inhibition from nociceptor fibres
- Inhibitory T-cells block the transmission of pain signals to the brain

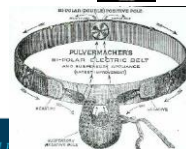
Transcutaneous Electrical Nerve Stimulation

So what is TENS?

- **TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION**
- Non invasive
- Peripheral stimulation technique
- Used to relieve pain
- Pulsed electrical currents are delivered across an intact skin surface to activate underlying nerves

History of using electricity for pain relief

- Ancient Egyptians (2,500 BC) electrogenic fish to painful body parts
- Dioscorides : 76AD Greek physician. Hemorrhoids
- Pulvermacher's bi-polar electric belt (1840's Guys Hospital)
- Dr Karshner's Electric Bath: inflamed uterus
- 18th century; electrostatic generators popularised electrotherapy, but advances in pharmacology preferable
- 1965: Melzack and Wall's Pain Gate Theory



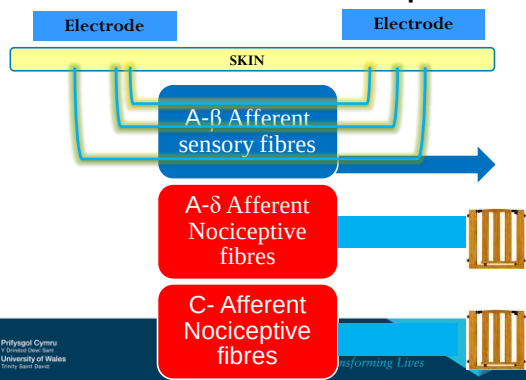
TENS as a Peripheral Stimulation Technique

- Standard TENS device
- Battery powered, hand-held device
- Generates pulsed electrical currents delivered via electrodes placed on the skin
- Conventional TENS
 - High frequency (50-100Hz), low-intensity, with small pulse widths (50-200µs)

TENS as a Peripheral Stimulation Technique

- Stimulate A-β fibres in the dermatomes related to the pain
- Thus stimulating inhibitory T-Cells in SG and inhibiting Nociceptors (1st and 2nd pain) transmission in to the spinothalamic tract
- Generating STRONG, COMFORTABLE, NON-PAINFUL, paraesthesia beneath the electrodes

How TENS works to block pain



Contraindications

- **Undiagnosed pain**
- **Pacemakers**
- **Epilepsy (?)**
 - Avoid head, neck and shoulders: few case studies reported TENS induced seizures in post stroke Pts
- **Pregnancy (?)**
 - C1 in 1st trimester,
 - After 1st Trimester, avoid abdomen and lower back (no evidence of -ve effect)
- **Cardiac conditions**
 - AngioTENS
 - Persistent chest pain from chronic refractory angina
 - David Trenbath
- **Carotid Sinus**
 - Monitors BP
 - Hypotensive responsive crisis
 - Larynx spasm
- **Broken skin**
 - Careful: increased BF may start bleeding
- **Dysaesthetic skin**
 - Thermal skin test and pin-prick (sharp/blunt) test
 - Can put proximal to paralysed limb
- **Internally (!)**
- **Cognitively impaired**
 - Safety U4's?
 - Parent/guardian

TENS: other safety precautions

- **Direct reaction to electric currents**
 - Mike Cummings personal communication
- **TENS induced Epileptic seizure**
 - Rosted (2001) – post stroke pain
 - Scherder (1999) – psychomotor impairment with epilepsy
- **Respiratory Compromise**
 - Mann (1996) – TENS for unstable angina
- **Interference with Cardiac Monitoring Equipment**
 - Many reports of ECG artifacts (!)
 - Inappropriate shock given by Implantable Cardioverter Defibrillator when using TENS - Philbin (1998) comments by Vlay (1998) Glotzer et al (1998)
- **Contact Dermatitis**
 - Many minor reports

TENS – other safety precautions

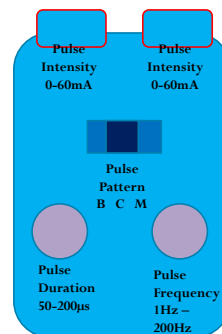
- **Electrode care and hygiene**
 - Electrodes should be Pt specific
 - Vary electrode placement if worn every day
 - Take electrodes off at night 'let skin breath'
- **Hypoanaesthesia**
 - Nerve fatigue due to decreases in neurotransmitters

Skin Sensation Testing: Pin Prick/Sharp-Blunt

- A test of a person's ability to detect a cutaneous pain sensation and to differentiate such sensations from pressure stimuli.
- The test is performed with a pin or needle gently applied to a skin area where it cannot be observed by the subject (point of safety pin).
- The application of the pin is alternated with the pressing of a dull object against the skin (blunt point).
- Care is taken to prevent penetration of the dermis, and the sharp object used should be sterilized or discarded after the test. Under NO circumstance should you draw blood!
- Ask Pt 'is this sharp or dull?' or 'does this feel the same as this?'
- Leave approx. 2 seconds between each stimulus to avoid summation

Mosby's Medical Dictionary, 8th edition (2009)

Standard TENS Device



A Standard TENS Device

Pulse Intensity

- Low to High
- 0-60mA
- Usually numbered 1-10

Pulse Pattern

- B: Burst Pattern
- C: Continuous
- M: Modulated

A Standard TENS Device

Pulse Duration

- Short (50 µs)
 - May send impulses deeper
- Long (150-250 µs)
 - Recommend start at 120-150µs increase up to 200µs for therapeutic effects

Pulse Frequency

- Range from low, med to high
- Low: 1 Hz
- Med: 80Hz
- High: up to 200Hz

A Standard TENS Machine

Practical Application

1. Make sure the stimulator is switched off!
2. Adjust the dials and buttons to the following settings
 1. Mode/pattern to C (Continuous) or N (Normal)
 2. Frequency to mid range (80Hz)
 3. Pulse Duration to mid range (120-150 μ s)
 4. Timer (if available) to continuous
3. Make sure that all other dials are set to zero (Pulse Intensity!)
4. Connect the electrode wires to the TENS device and place the electrodes to the skin on the arm.

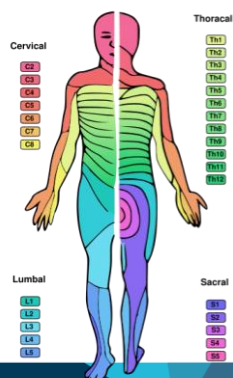
A Standard TENS Machine

5. Now switch the TENS device ON by turning the INTENSITY DIAL
6. SLOWLY INCREASE the intensity dial until you feel the first tingling sensation from the TENS
7. SLOWLY INCREASE intensity further until you feel:
 - A Strong but comfortable tingling sensation
 - This should NOT be painful OR cause a contraction
8. Adjust the frequency dial to experience the 'high' and 'low' frequency end of ranges

You may need to adjust 'intensity' to maintain a strong but comfortable sensation

Placement of Electrodes according to Dermatomes

- A **dermatome** is an area of skin that is mainly supplied by a single spinal nerve
- You should try to keep the electrodes within the same dermatome to ensure effective use of the A- β fibres
- Use to dictate areas of skin that feed in to correct spinal segments
- Close correct pain gate!



Electrode Placement

Choices you have:

- 2 electrodes or 4?
 - TENS comes with 4 pads and 2 intensity switches
 - Think size of painful area: e.g. Lower back may need 4?
- If unilateral side is too painful, sensitive or has broken skin..what are the options?
 - Place TENS above site
 - Place TENS within same dermatome but away from injured site
 - Place TENS on the Contralateral side (used in phantom limb pain)
 - Place TENS either side of surgical scar for Rx post operative pain

Electrode Placement

Apply electrodes to 'tingle' ...

- The pain @ site
- The main nerve trunk @ side of vertebrae of nerve root
- Sites proximal to pain
- Dermatomes: spinal segments of pain origin
- Contralaterally



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TENS Rx prescription

Frequency and duration of TENS

- General advice (NHS, LBP, Chronic pain Pts)
- Trial session supervised by you
 - Educate Pt on its use
 - Continue to supervise up to 1hr post application (!) to monitor for side effects
- Small Rx sessions
 - First 3 sessions wear for 1hour per day
 - Check for effects
 - Use as much as needed (as and when pain becomes inhibitory)
 - Advise not to use when driving or sleeping!



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What is TENS Recommended for?

- **Acute Post Operative Pain**
 - TENS found to reduce analgesic consumption
 - Bjordal, Johnson et al (2003)
- **Labour Pain**
 - Johnson (1997)
 - 91% would use TENS in future delivery
- **Chronic Pain**
 - TENS use 7+ hours per day
 - 50% + use TENS for several years
 - Johnson et al (1991)
- **Chronic Musculoskeletal Pain**
- **Osteoarthritic Pain**
 - Especially of knee
- **Rheumatoid Arthritis**
- **Lack of Empirical Research**
 - Randomised Controlled Trials
 - Clinical Trials
- **A lot of**
 - Meta-analysis
 - Systematic Reviews



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Box 17.1 Common medical conditions that TENS has been used to treat

Analgesic effects of TENS

Relief of acute pain

- Postoperative pain
- Labour pain
- Dysmenorrhoea
- Musculoskeletal pain
- Bone fractures
- Dental procedures

Relief of chronic pain

- Low back
- Arthritis
- Stump and phantom
- Postherpetic neuralgia
- Trigeminal neuralgia
- Causalgia
- Peripheral nerve injuries
- Angina pectoris
- Facial pain
- Metastatic bone pain

Non-analgesic effects of TENS

Antiemetic effects

- Postoperative nausea associated with opioid medication
- Nausea associated with chemotherapy
- Morning sickness
- Motion/travel sickness

Improving blood flow

- Reduction in ischaemia due to reconstructive surgery
- Reduction of symptoms associated with Raynaud's disease and diabetic neuropathy
- Improved healing of wounds and ulcers



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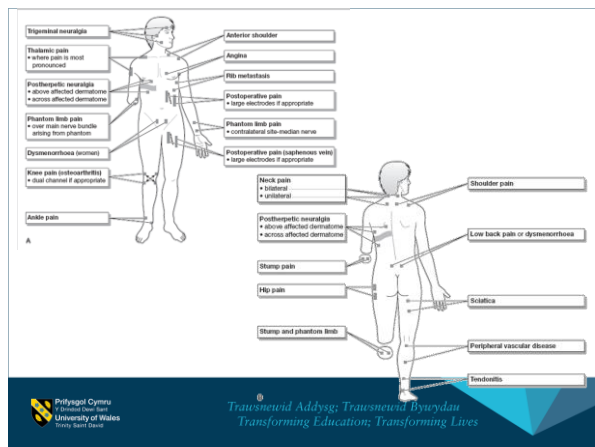


Table 17.5 Suggested characteristics to use for a patient trying TENS for the first time

Conventional TENS	
Electrode placement	Straddling site of pain or over main nerve bundle proximal to pain
Pulse pattern	Continuous
Pulse frequency	80–100 p.p.s.
Pulse duration	100–200 μ s
Pulse amplitude (intensity)	Increase intensity to produce a strong but comfortable tingling
Duration of stimulation in first instance	At least 30 minutes

Box 17.3 Safety protocols for TENS

Protocol for the safe application of TENS

- Check contraindications with patient.
- Test skin for normal sensation using blunt/sharp test.
- TENS device should be switched off and electrode leads disconnected.
- Set electrical characteristics of TENS while device is switched off (see Tables 17.5 and 17.6).
- Connect electrodes to pins on lead wire and position electrodes on patient's skin.
- Ensure TENS device is still switched off and connect the electrode wire to the TENS device.
- Switch the TENS device ON.
- Gradually (slowly) increase the intensity until the patient experiences the first 'tingling' sensation from the stimulator.
- Gradually (slowly) increase the intensity further until the patient experiences a 'strong but comfortable' tingling sensation.
- This intensity should not be painful or cause muscle contraction (unless intense TENS or AL-TENS are being used).

Protocol for the safe termination of TENS

- Gradually (slowly) decrease the intensity until the patient experiences no tingling sensation.
- Switch the TENS device OFF.
- Disconnect the electrode wire from the TENS device.
- Disconnect electrodes from the pins on lead wire.
- Remove the electrodes from the patient's skin.

Table 17.6 Suggested advice following the initial trial

Conventional TENS	
Electrode positions	Straddle site of pain but if not successful try main nerve bundle, across spinal cord or contralateral positions—dermatomal
Pulse pattern	Patient preference
Pulse frequency	Patient preference, usually 10–200 p.p.s.
Pulse duration	Patient preference, usually 100–250 μ s
Pulse amplitude (intensity)	Strong but comfortable sensation without visible muscle contraction
Dosage	As much and as often as is required—have a break every hour or so
Analgesic effects	Occur when stimulator on
General advice	Experiment with settings to maintain strong comfortable sensation

References

- Melzack, R. Wall. P. D. (1965). Pain mechanisms: A new theory. *Science*, 150. Pp. 171-9.
- Johnson, M. I. (2003). A critical review of the analgesic effects of TENS-like devices. *Physical Therapy Reviews*. 6. Pp. 153-173.

SPECIFICATIONS

Interfer™ Mobile Combo

WAVEFORM SPECIFICATIONS (continued)

TENS - Asymmetrical Biphasic

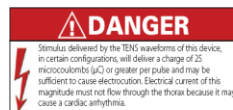
The Asymmetrical Biphasic waveform has a short pulse duration and is capable of strong stimulation of nerve fibers in the skin and in muscle tissue. This waveform is often used in TENS devices. Because of its short pulse, the patient typically tolerates the current well, even at relatively high intensities.

Output Intensity.....	0-110 mA
Phase Duration.....	Adjustable 20-1000 μ sec
Frequency.....	1-250 Hz
Mode Selection.....	CC or CV*
Burst Frequency.....	0-10 bps
Frequency Modulation.....	0-250 Hz
Amplitude Modulation.....	Off, 40%, 60%, 80%, and 100%
Treatment Time.....	1-60 min

TENS - Symmetrical Biphasic

The Symmetrical Biphasic waveform has a short pulse duration and is capable of strong stimulation of nerve fibers in the skin and in muscle tissue. This waveform is often used in portable muscle stimulation units, and some TENS devices.

Output Intensity.....	0-80 mA
Phase Duration.....	Adjustable 20-1000 μ sec
Frequency.....	1-250 Hz
Mode Selection.....	CC or CV*
Burst Frequency.....	0-10 bps
Frequency Modulation.....	0-250 Hz
Amplitude Modulation.....	Off, 40%, 60%, 80%, and 100%
Treatment Time.....	1-60 min



*CC= Constant Current
CV= Constant Voltage

27

Interferential Therapy

Interferential Therapy

- Developed in the 1950s in Vienna
- "Transcutaneous application of alternating medium-frequency electrical currents, amplitude modulated at low frequency for therapeutic purposes"
- Form of TENS

Interferential Current

- Current applied approx 4000 Hz (medium frequency)
- This current rhythmically increases and decreases in amplitude at low frequency (0-250Hz)
- IFC produced by mixing two slightly out of phase medium frequency currents



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Interferential Current

- One current fixed and other is adjustable (4000-4200Hz)
- Two currents summate or cancel each other out producing:
 'amplitude modulated interferential current'
- The frequency of the current equal to the mean of the two original currents and will vary in amplitude at a frequency equal to the difference between these two currents
- Latter known as amplitude modulate frequency (AMF) or beat frequency



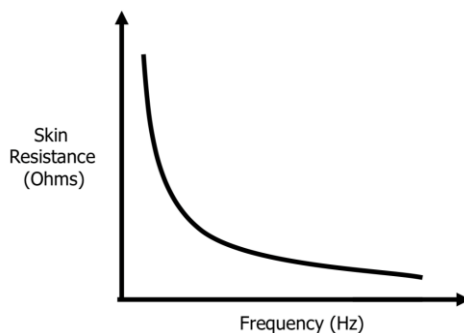
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Why Choose ITF as a Treatment Modality?

- Based on knowledge of therapeutic benefits of low intensity current.
- Based on knowledge of electrical stimulation and resistance
- When current is applied to the skin, skin resistance decreases as pulse frequency increases.
- OK – but what does that mean?



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Resistance

- Impedance of skin is inversely proportional to the frequency of stimulation
- Skin resistance is greater for lower resistances
- When current is applied to the skin, capacitive skin resistance decreases as pulse frequency increases.
- At 50Hz = 3200 Ω
- At 4000Hz = 40 Ω



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The Dilemma

- Human skin has a very high resistance to the passage of low frequency current $\therefore$ painful
- BUT it is low frequency electrical stimulation of muscle and nerve tissues that has the *therapeutic effect*.
- So what is the best way to get low intensity current to the target tissue?



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Delivery

- IFT delivers 2 medium frequency currents
- Medium frequency = $\downarrow$ skin resistance
- 2 medium currents mix and interfere or 'summate' (ie cancel each other out)



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Frequency

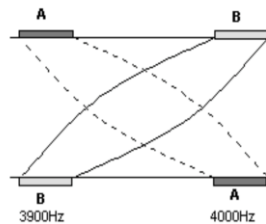
- Frequency = mean of 2 original currents
- Amplitude = frequency range between carrier and interference currents
- One current is fixed at e.g. 4000Hz = '**Carrier Frequency**'
- The other is adjustable e.g. 4001-4150Hz = '**Interference Frequency**'



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AMF

- AMF = 'Amplitude-modulated frequency' = 'Beat Frequency'
- $4000\text{Hz} + 4100\text{ Hz} = 4050\text{ Hz}$ of medium frequency current that is amplitude modulated at a 100Hz frequency
- Deliver low frequency AMF into tissues



If current A - A is at 4000Hz
And current B - B is at 3900Hz
then the interference current will
have a 'beat frequency' of 100Hz

Interference Frequency

- By careful manipulation of the input currents, different beat frequencies can be achieved
- Modern machines 1-150Hz
- It is thought that different tissues will have 'optimal stimulation bands'
- Estimated by the conduction velocity of the tissue, its latency and refractory period

Stimulation Values – Beat Frequency Selection

- Sympathetic nerve **1-5Hz**
- Parasympathetic nerve **10-150Hz**
- Motor nerve **10-50Hz**
- Sensory nerve **90-100Hz**
- Nociceptive fibres **90-150Hz**
- Smooth muscle **0-10Hz**

Physiological Effects - Pain Relief

- Pain relief - **90-150Hz** to stimulate **pain gate** mechanisms
- Stimulation at lower frequencies, **1-5Hz**, can activate **opiate** mechanisms.
- Pain relief may be achieved by stimulation of the **reticular formation** at frequencies of **10-25Hz** or by blocking **C fibre** transmission at **>50Hz**



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ITF - Clinical Application

- Widely used treatment modality
- 91% of therapists use ITF to treat pain
- ITF reduces skin resistance
- Less discomfort than traditional low frequency currents
- Perfuse to greater depths & over a larger volume of tissue than other forms of electrotherapy.
- Used for acute and chronic pain
- ↓ swelling



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Clinical Application

- Involves the crossing of 2 medium frequency currents within the tissues
- Amplitude modulated current that behaves like a low frequency direct current
- The peak amplitudes within each 'beat' stimulate the excitable tissue



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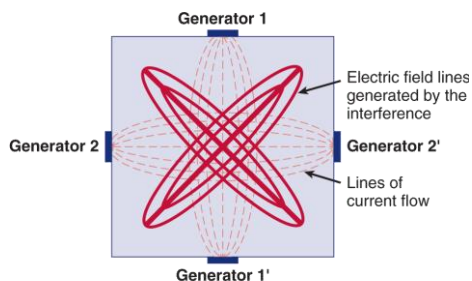
Four Pole Application

- 4-pole ITF employs 2 circuits that are at right angles to each other
- Alternating currents enter the tissues and 'interfere'
- Where current 'crosses over' = delivery of treatment
- More effective than 2-pole?
- Can treat a larger area of the body than 2-pole
- Deeper tissues and large areas e.g. joints and back



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Clover Leaf Pattern



Source: William E. Prentice, William Quillen, Frank Underwood: Therapeutic Modalities in Rehabilitation, 5e Copyright © McGraw-Hill Education. All rights reserved.

Two Pole Application

- The IF machine will combine the 2 medium frequency currents within the machine - the resultant alternating current is modulated more efficiently
- Amplitude is 100% modulated: can only be obtained using the 2 pole IF
- Beat frequencies are perfectly formed
- Stimulatory effect (0 → beat peak)
- Superficial
- Most common (79% of treatments) carried out by physiotherapists (Tabasam and Johnson 2000)
- 4 pole used more for lower back pain

ITF Settings

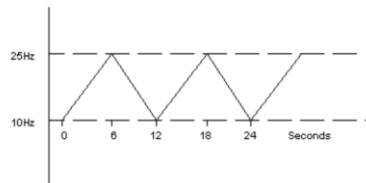
- Constant/variable beat frequency
- Control for time of beat frequencies
- Intensity control
- Vector setting
- Control of total time (10-20 mins)
- 2/4 pole

Sweep

- Sweep prevents accommodation
- Should be appropriate to physiological affects
- Excessive range may minimise clinical effect

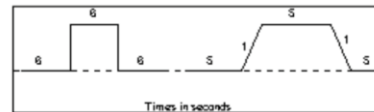
Sweep

- Sweep: e.g. 10-25-10Hz



Sweep Times and Ratios

- Rate of change of sweep



- Chronic = fast rise/fast fall
- Acute = Slow rise/slow fall

Intensity

- Turn to 'maximum comfort level'
- Monitor for accommodation
- Leave for 1 min then turn up

Grade/Intensity	Physiological response
5/ Very High	Severe pain, very strong muscle contraction, tingling
4/ High	Pain, strong muscle contraction
3/ Medium	Muscle action, tingling, weak contractions
2/ Low	Fine tingling
1/ Very low	Threshold tingling
0/ zero	No effect!

Contraindications

- Tumours
- Recent bleeding or haemorrhage
- Thrombosis
- Pacemakers
- Bacterial infections
- Rapidly dividing tissue
- Implants
- Inability to comprehend treatment

Contraindications

- Over the anterior aspect of the neck
- Significant impairment in the circulation /sensory loss of the area to be Rx
- Where there are local skin conditions e.g. eczema, dermatitis
- Epilepsy
- Avoid active epiphyseal regions in children



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Contraindications/Dangers

- Increase in bleeding - warfarin
- Pregnancy
- Suction pressure if too high - bruising
- Unknown effect on developing foetus
- Sudden surge → excessive contraction of muscle/stimulation of nerve



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Precautions

- Observe contraindications - Common sense!
- Wash skin
- Test machine prior to use
- Check connections/leads etc
- Sharp/blunt skin sensation
- Good electrode contact
- Clear instructions/warnings



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Proposed Patient Benefits

- **Reduces painful symptoms**
- Decreases local swelling
- Promotes muscle tone
- Restores normal movements
- **Releases the body's natural pain killers**
- Accelerates the healing process



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Common Use of ITF

- Pre and post-orthopaedic surgery
- Joint injury
- To increase circulation
- **Pain control**
- To ↑ range of motion
- To ↓ oedema and muscle spasms.



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ITF Issues

- Placebo
- 'Putting machine on'
- Clinic based
- Dependence
- Treatment time
- Evidence base



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Clinical Choices

- Contraindications
- Treatment aim
- Objective marker
- Target tissue
 - Nature
 - Location
- Beat frequency section
- 2 pole, 4 pole or suction
- Sweep time/ratio
- Intensity
- Treatment time



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Clinical Choices

- Acute
 - fairly stationary frequency
 - small sweep
 - 10 mins
- Chronic
 - increase sweep
 - 20 mins (up to 30 mins max)



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**“Remember it is not a
cookery book – you need
to use clinical reasoning”**



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Pain Relief Choices

- Pain Gate
- Opioid Release



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Pain Relief Choices – Pain Gate

- Peripheral Nerve – Nociceptive Stimulus
- Dorsal Root Ganglion
- Dorsal Horn
- Substantia Gelatinosa (in grey matter)
- Spinothalamic Tract (in white matter)
- Medulla
- Thalamus
- Multiple Centres of the Brain

Settings

- Acute Pain
- 90-150Hz
- 2p or 4p ITF
- 5-10



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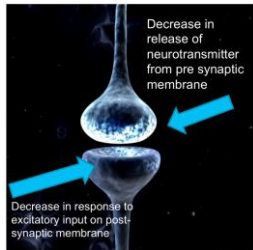
Pain Relief Choices – Opioid Release

- Descending pathway
- Endogenous opioids
 - Endorphins
 - Enkephalins
 - Dynorphine
 - Endomorphines
- Inhibit nociceptive transmission in Spinal Cord and Brain
- Inhibits pre-synaptic and post synaptic membranes
- Opioids bind on pre and post synaptic membranes
- Hyperpolarisation
- Decrease in release of neurotransmitter from pre synaptic membrane
- Decrease in response to excitatory input on post-synaptic membrane



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Pain Relief Choices – Opioid Release



Settings

- Chronic Pain
- 1-5Hz or 2-4Hz
- 2p or 4p ITF

Interferential	
Competency	Comments
Equipment Checks (test machine, check connections/leads)	Test connection 4P test for strong but comfortable tingling
Client Communication (clear explanation of benefits & dangers, IC)	Language, aim of Rx, dangers, 3 key IC questions
Safety Checks (Contraindications, Sharp & Blunt)	Sharp and Blunt, CI's
Identify Rx aim & Set objective markers	Anatomy!
Identify target tissue (inc palpation; nature & location)	Anatomy!
Prepare client (positioning, skin)	Clean skin, wash to increase conduction. Get them comfortable.
Beat frequency selection	machine setting: what are your aims?
2/4 pole selection	Size of Rx area? Clover leaf pattern
Sweep Ratio	Already set on this unit!
Intensity	INCREASE SLOWLY AND GENTLY BEFORE PRESSING START! Strong but comfortable tingling!
Rx time	Acute 5 mins +, chronic 10-30mins (neurotransmitter fatigue!)