INTERFERENTIAL THERAPY (IFT)

INTRODUCTION

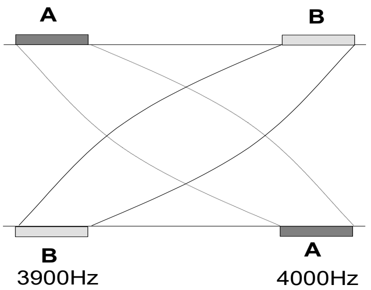
The basic principle of Interferential Therapy (IFT) is to utilise the significant physiological effects of low frequency (≅<250pps) electrical stimulation of nerves without the associated painful and somewhat unpleasant side effects sometimes associated with low frequency stimulation. Recently, numerous 'portable' interferential devices have become easily available. Despite their size, they are perfectly capable of delivering 'proper' interferential therapy, though some have limited functionality and ability for the practitioner to 'set' all parameters. Most multifunction stimulators include all interferential modes, so the practitioner has several machine types to select from (examples below).

		
Dedicated Interferential Therapy Unit (EMS Physio)	Portable Interferential Unit (TENSCare)	Multi function device which includes Interferential (DJO)

Interferential Therapy (IFT / IFC) has been widely used in therapy for many years (usage reviewed in Pope et al, 1995 and more recently Shah and Farrow, 2012; Ladeira et al, 2015; Phadke et al 2015), Its use is probably disproportionate to both the volume and the quality of the published evidence, though it is strongly supported on an anecdotal evidence level, and several reviews are indicating an overall supportive evidence base, especially for pain based management (e.g. Fuentes et al, 2010). There has been a recent increased flow of Interferential research material with additional supportive evidence (2016- 2021) and the topic is usefully reviewed in Fuentes (2020).

PRINCIPLES

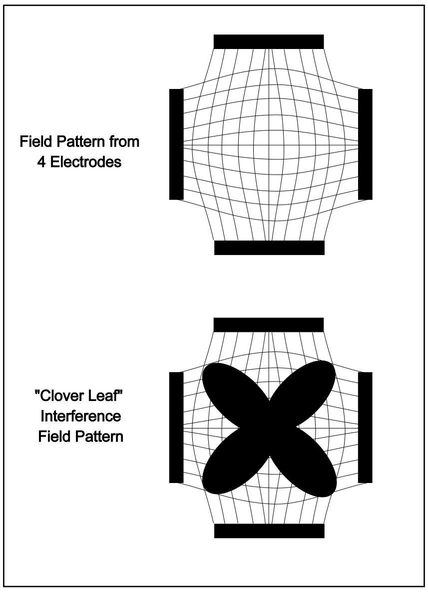
To produce low frequency effects at sufficient intensity and at sufficient depth, patients can experience considerable discomfort in the superficial tissues (i.e. the skin). This is due to the impedance of the skin being inversely proportional to the frequency of the stimulation. [The barrier presented by the skin to the passage of an electric current is more complex than just impedance, or resistance, but will be regarded as such for the purpose of this explanation] In other words, the lower the stimulation frequency, the greater the impedance to the passage of the current & so, more discomfort is experienced as the current is 'pushed' into the tissues against this barrier. The skin impedance at 50Hz is approximately 3200Ω whilst at 4000Hz it is reduced to approximately 40Ω. The result of applying a higher frequency is that it will pass more easily through the skin, requiring less electrical energy input to reach the deeper tissues & giving rise to less discomfort.



**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**

The effects of tissue stimulation with these 'medium frequency' currents (medium frequency in electromedical terms is usually considered to be 1KHz-100KHz) has yet to be established. It is unlikely to do nothing at all, but in terms of current practice, little is known of its physiological effects. It is not capable of direct stimulation of nerve in the common context of such stimulation, though some researchers are currently investigating this area.

Interferential therapy utilises two of these medium frequency currents, passed through the tissues simultaneously, where they are set up so that their paths cross & they literally interfere with each other – hence another term that has been used in the past but appears to be out of favour at the moment – Interference Current Therapy. This interaction gives rise to an interference current (or beat frequency) which has the characteristics of low frequency stimulation – in effect ***the interference mimics a low frequency stimulation***.



The exact frequency of the resultant beat frequency can be controlled by the input frequencies. If for example, one current was at 4000Hz and its companion current at 3900Hz, the resultant beat frequency would be at 100Hz, carried on a medium frequency 3950Hz amplitude modulated current.

By careful manipulation of the input currents it is possible to achieve any beat frequency that you might wish to use clinically. Modern machines usually offer frequencies of 1-150Hz, though some offer a choice of up to 250Hz or more. To a greater extent, the therapist does not have to concern themselves with the input frequencies, but simply with the appropriate beat frequency which is selected directly from the machine.

The magnitude of the low frequency interference current is (in theory) approximately equivalent to the sum of the input amplitudes. It is difficult to show categorically that this is the case in the tissues but it is reasonable to suggest that the resultant current will be stronger than either of the 2 input currents.

Numerous researchers have evaluated the effect of varying the medium frequency carrier sine wave current (e.g. Ward et al 2002; Ward, 2009; Venancio et al, 2013; Correa et al, 2013, 2016; Fuentes 2020). There is a general trend in the results that the lower the carrier frequency, the more uncomfortable the resulting stimulation. If there is a choice of carrier frequency on a clinical machine, higher carrier frequencies will be perceived as more comfortable by the patient, and thus it is suggested that they would be able to tolerate a stronger current before discomfort, increasing the effectiveness of the intervention.

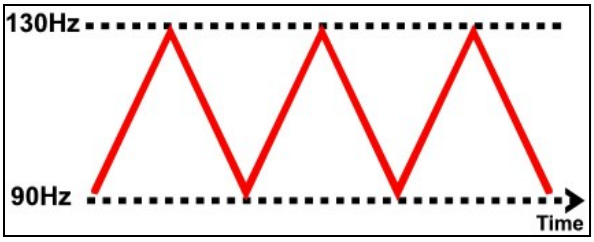
The use of 2 pole IFT stimulation is made possible by electronic manipulation of the currents - the interference occurs within the machine rather than in the tissues. There is no known physiological difference between the effects of IFT produced with 2 or 4 electrode systems. The key difference is that with a 4 pole application the interference is generated in the tissues and with a 2 pole treatment, the current is 'pre modulated' i.e. the interference is generated within the machine unit (Ozcan et al, 2004). Fiori et al (2014) provide some evidence of a differential effect, in favour of a 4 pole application, but this was lab based work on healthy individuals and thus may not transfer to the clinical environment.

Whichever way it is generated, the treatment effect is generated from low frequency stimulation, primarily involving the peripheral nerves. There may indeed be significant effect on tissue other than nerves, but they have not as yet been unequivocally demonstrated. Low frequency nerve stimulation is physiologically effective (as with TENS and NMES) and this is the key to IFT intervention.

FREQUENCY SWEEP

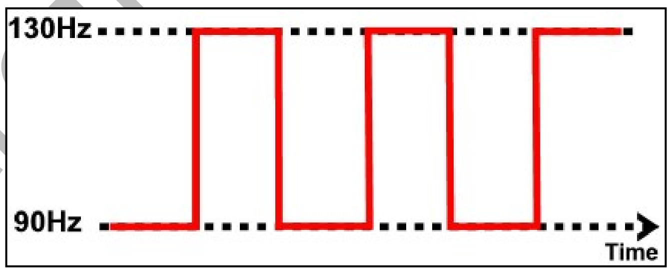
Nerves will accommodate to a constant signal & a sweep (or gradually changing frequency) is often used to overcome this problem. The principle of using the sweep is that the machine is set to automatically vary the effective stimulation frequency using either pre-set or user set sweep ranges. The sweep range employed should be appropriate to the desired physiological effects (see below). It has been repeatedly demonstrated that 'wide' sweep ranges are ineffective whenever they have been tested or evaluated in the clinical environment

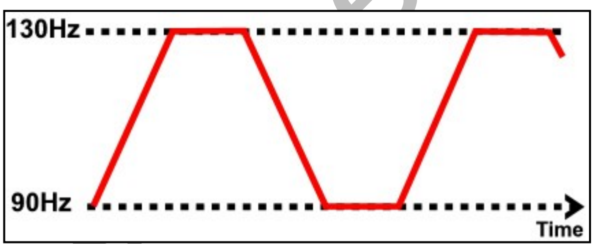
Note : Care needs to be taken when setting the sweep on a machine in that with some devices, the user sets the actual base and top frequencies (e.g. 10 and 25Hz) and with other machines the user sets the base frequency and then how much needs to be added for the sweep (e.g. 10 and 15Hz). Knowing which was round your machine works is critical to effective treatment.



The pattern of the sweep makes a significant difference to the stimulation received by the patient. Most machines offer several sweep patterns, though there is very limited 'evidence' to justify some of these options. In the classic '***triangular***' sweep pattern, the machine gradually changes from the base to the top frequency, usually over a time period of 6 seconds – though some machines offer 1 or 3 second options. In the example illustrated, the machine is set to sweep from 90 to 130Hz employing a triangular sweep pattern. All frequencies between the base and top frequencies are delivered in equal proportion.

Other patterns of sweep can be produced on many machines, for example a rectangular (or step) sweep. This produces a very different stimulation pattern in that the base and top frequencies are set, but the machine then 'switches' between these two specific frequencies rather than gradually changing from one to the other. The adjacent diagram illustrates the effect of setting a 90 – 130Hz rectangular sweep.





There is a clear difference between these examples – even though the same 'numbers' are set. One will deliver a full range of stimulation frequencies between the set frequency levels and the other will switch from one frequency to the other. There are numerous other variations on this theme, and the 'trapeziodal' sweep is effectively a combination of these two.

The only sweep pattern for which 'evidence' appears to exist is the triangular sweep. The others are perfectly safe to use, but whether they are clinically effective or not remains to be shown.

PHYSIOLOGICAL EFFECTS & CLINICAL APPLICATIONS :

It has been suggested that IFT works in a 'special way' because it is 'interferential' as opposed to 'normal' stimulation. The evidence for this special effect is lacking and it is most likely that IFT is just another means by which peripheral nerves can be stimulated. It is rather a generic means of stimulation – the machine can be set up to act more like a TENS type device or can be set up to behave more like a muscle stimulator – by adjusting the stimulating (beat) frequency. It is often regarded (by patients) to be more acceptable as it generates less discomfort than some other forms of electrical stimulation.

The clinical application of IFT therapy is based on peripheral nerve stimulation (frequency) data, though it is important to note that much of this information has been generated from research with other modalities, and its transfer to IFT is assumed rather than proven. There is a lack of IFT specific research compared with other modalities (e.g. TENS).

Selection of a wide frequency sweeps has been considered less efficient than a smaller selective range in that by treating with a frequency range of say 1-100Hz, the effective treatment frequencies can be covered, but only for a relatively small percentage of the total treatment time. Additionally, some parts of the range might be counterproductive for the primary aims of the treatment.

CLINICAL APPLICATION

There are 4 main clinical applications for which IFT appears to be used:

- Pain relief
- Muscle stimulation
- Increased local blood flow
- Reduction of oedema

In addition, claims are made for its role in stimulating healing and repair and for various specialised application – e.g. stress incontinence, though for the former examples (healing and repair) there is a dearth of quality research information available.

As IFT acts primarily on the excitable (nerve) tissues, the strongest effects are likely to be those which are a direct result of such stimulation (i.e. pain relief and muscle stimulation). The other effects are more likely to be secondary consequences of these.

PAIN RELIEF:

Electrical stimulation for pain relief has widespread clinical use, thought the direct research evidence for the use of IFT in this role is limited. Logically one could use the higher frequencies (90-130Hz) to stimulate the pain gate mechanisms & thereby mask the pain symptoms. Alternatively, stimulation with lower frequencies (2-5Hz) can be used to activate the opioid mechanisms, again providing a degree of relief. These two different modes of action can be explained physiologically & will have different latent periods & varying duration of effect. It remains possible that relief of pain may be achieved by stimulation of the reticular formation at frequencies of 10-25Hz or by blocking C fibre transmission at >50Hz. Although both of these latter mechanisms have been proposed (theoretically) with IFT, neither have been categorically demonstrated.

A good number of studies (e.g. Johnson and Tabasam 2003; Hurley et al 2004; McManus et al 2006; Jorge et al 2006; Walker et al 2006; Fuentes et al, 2011; Atamaz et al 2012; Gundog et al 2012; Rocha 2012; Lara-Palomo et al 2013; Fuentes et al, 2014; Suriya-Amarit et al 2014; Eftekharsadat et al 2015; Samuel and Maiya, 2015; Youn et al 2016; Albornoz-Cabello et al, 2017, 2019; Eslamain et al 2020) provide substantive evidence for a pain relief effect of IFT. Numerous studies have evaluated the capacity of IFT to influence various pain thresholds in healthy subjects. The results are somewhat mixed, and whilst of interest, may not transfer to a clinical environment (e.g. Beatti et al 2012; Venancio et al, 2013; Bae and Lee, 2014; Claro et al, 2014). The clinical situation is usefully reviewed in Fuentes 2020.

MUSCLE STIMULATION:

Stimulation of the motor nerves can be achieved with a wide range of frequencies. Clearly, stimulation at low frequency (e.g. 1Hz) will result in a series of twitches, whist stimulation at 50Hz will result in a tetanic contraction. There is limited evidence at present for the 'strengthening' effect of IFT (though this evidence exists for some other forms of electrical stimulation), though the paper by Bircan et al (2002) suggests that it might be a possibility. On the basis of the current evidence, the contraction brought about by IFT is no 'better' than would be achieved by active exercise, though there are clinical circumstances where assisted contraction is beneficial. For example to assist the patient to appreciate the muscle work required (similar to surged Faradism used previously – but much less uncomfortable). For patients who can not generate useful voluntary contraction, IFT may be beneficial as it would be for those who, for whatever reason, find active exercise difficult. There is no evidence that has demonstrated a significant benefit of IFT over active exercise. Bellew et al (2012) evaluated the stimulatory effects of IFT and various Burst Mode currents in terms of their capacity to generate significant quality muscle contraction, the results were supportive of IFT as a treatment option.

The choice of treatment parameters will depend on the desired effect. The most effective motor nerve stimulation range with IFT appears to lie between approximately 10 and 20, maybe 10 and 25Hz. Stimulation below 10Hz results in a series of coarse twitches which may be of clinical benefit, though it has yet to be unequivocally demonstrated with IFT. Stimulation at higher frequencies than that needed to bring about a partial tetany (usually around 20 or 25Hz) can generate a strong tetanic contraction, which might be considered beneficial to assist patient appreciation of the required muscle work, but again, in terms of IFT intervention, it has yet to be demonstrated that this contraction level is needed over and above a partial tetany.

Youn et al (2016) evaluated the effect of IFT on muscle fatigue, demonstrating some (potential) benefits over a control comparison.

Da Silva et al (2015) reviewed the literature which compared pulsed current and kilohertz frequency stimulation with regards their potential benefits in generating peak muscle torque. There were no significant differences in outcome identified.

Caution should be exercised when employing IFT as a means to generate clinical levels of muscle contraction in that the muscle will continue to work for the duration of the stimulation period (assuming sufficient current strength is applied). It is possible to continue to stimulate the muscle beyond its point of fatigue – the contractions are forced via the motor nerve – and short stimulation periods with adequate rest might be a preferable option. Some IFT devices are capable of generating a 'surged' stimulation mode which might be advantageous in that fatigue would be minimised – this surged intervention would be similar, but more comfortable than Faradism.

BLOOD FLOW

There is very little, if any quality evidence demonstrating a direct effect if IFT on local blood flow changes. Most of the work that has been done involves laboratory experimentation on asymptomatic subjects, and most blood flow measurements are superficial i.e. skin blood flow. Whether IFT is actually capable of generating a change (increase) in blood flow at depth remains questionable. The elegant experimentation by Noble et al (2000) demonstrated vascular changes at 10–20Hz, though was unable to clearly identify the mechanism for this change. The stimulation was applied via suction electrodes, and the outcome could therefore be as a result of the suction rather than the stimulation, though this is largely negated by virtue of the fact that other stimulation frequencies were also delivered with the suction electrodes without the blood flow changes. The most likely mechanism is via muscle stimulation effects (IFT causing muscle contraction which brings about a local metabolic and thus vascular change). The possibility that the IFT is acting as an inhibitor or sympathetic activity remains a theoretical possibility rather than an established mechanism.

Based on current available evidence, the most likely option for IFT use as a means to increase local blood flow remains via the muscle stimulation mode, and thus the 10-20 or 10-25Hz frequency sweep options appears to be the most likely beneficial option.

OEDEMA

IFT has been claimed to be effective as a treatment to promote the reabsorption of oedema in the tissues. Again, the evidence is very limited in this respect and the physiological mechanism by which is could be achieved as a direct effect of the IFT remains to be established. The preferable clinical option in the light of the available evidence is to use the IFT to bring about local muscle contraction(s) which combined with the local vascular changes that will result (see above) could be effective in encouraging the reabsorption of tissue fluid. The use of suction electrodes may be beneficial, but also remains unproven in this respect.

A study by Jarit et al (2003) demonstrated a change in oedema following knee surgery in an IFT group, though the patients did the circumferential knee measures (rather than the therapist) and circumferential knee measurement is not an especially reliable method for identifying oedema as such. The Christie and Willoughby study (1990) failed to demonstrate a significant benefit on ankle oedema following fracture and surgery. The treatment parameters employed are unlikely to be effective given the information now available. If IFT has a capacity to influence oedema, the current evidence and physiological knowledge would suggest that a combination of pain relief (allowing more movement), muscle stimulation (above) and enhanced local blood flow (above) is the most likely combination to be most effective.

A recent study (Kadi et al 2019) failed to demonstrate significant benefit when compared with sham stimulation for patients post arthroplasty, though stimulation was delivered at 100Hz which would not be expected to influence oedema – thus their results should be treated with a degree of caution.

OTHER CLINICAL APPLICATIONS

In addition to the 4 key areas identified above, there are several other specialist application for which IFT has been employed. These include stimulation as part of the management of **incontinence** and **pelvic floor training** (e.g. Parkkinen et al, 2004; Yazdanpanah et al 2012), **Fibromyalgia** (e.g. Almedia et al, 2003; Raimundo et al, 2004; Moretti et al 2012), **Trigger Point** intervention (e.g. Hou, 2002; Jenson et al, 2002), **Myofascial Pain Syndrome** (Galasso et al 2020) and **Psoriasis** (Philipp et al 2000). A limited, but potentially interesting development is the employment of IFT in neurology as a means to influence **spasticity, gait and function post stroke** (Suriya-Amarit et al 2014). Enhancement of fracture healing has also been investigated with mixed results (e.g. Ganne, 1988; Fourie and Bowerbank, 1997)

Acedo et al (2015) compared TENS and IFT for patients with **chronic (non specific) neck discomfort**. They compared muscle (trapezius) relaxation and reported pain. Whilst both interventions provided pain relief, that associated with the IFT reached a clinically important level whilst the TENS did not (as employed in this study). The IFT additionally provided a significant change in muscle relaxation which was beneficial.

Hasegawa et al (2016) evaluated the benefits of IFT for patients with **dry mouth syndrome**, demonstrating some benefits with minimal discomfort or pain compared with other options. Elnaggar and Elshafey used IFT with hydrotherapy compared with a standard treatment protocol for patients with **juvenile idiopathic arthritis**, showing that the IFT contributed to a useful treatment effect.

Wound healing with electrical stimulation is a widely explored intervention. Shahrokhi et al (2014) have extended the normal range of stim modalities to include IFT with interesting preliminary results.

Samhan (2014) reports the effect of IFT on **hand function** in patients with psoriatic arthritis using an underwater technique (which is valid, but unusual) – demonstrating useful results.

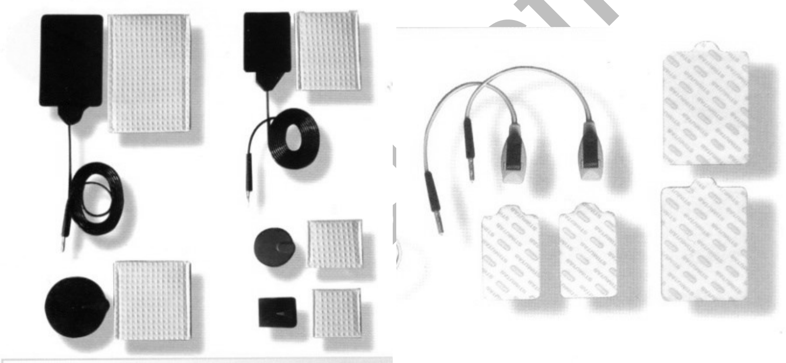
There have been several studies in which the use (home based) of IFT as a means of helping bowel function in children with **chronic constipation** have been reported (e.g. Chase et al, 2005, Ismail et al, 2009; Leong et al, 2011; Yik et al 2012 a,b; Queratto et al 2013; Southwell, 2013; Kajbafzadeh, et al 2015; Ladi et al 2017, 2020). This research is currently being extended in the UK as a multi centered study. A high percentage of the interferential related publications in the last 5 years have been devoted to this and associated topics (including treatment of adults) – giving rise to an increase in the use of IFT in the clinical environment (e.g. Southwell 2020; Sharif-Rad et al 2020; Samhan et al, 2020; Moore et al 2020; Lee et al 2020; Penfold et al 2019)

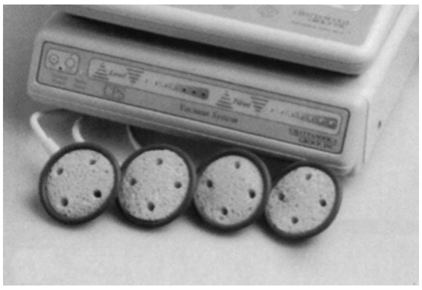
Interferential Compared with TENS

There have been numerous studies in recent years which have compared the efficacy of iFT and TENS, primarily with regard to pain relief. A significant proportion of these studies have been lab based, though some are more clinically oriented. Overall, these studies indicate that TENS generally provides higher (stronger) levels of pain relief (or some associated outcome), though IFT is generally identified as being more comfortable from the perspective of the recipient. If a patient dislikes the sensation associated with TENS, IFT would constitute a useful fallback stimulation modality on the basis of reported comfort.

Treatment Parameters:

Stimulation can be applied using pad electrodes and sponge covers (which when wet provide a reasonable conductive path), though electroconductive gel is an effective alternative. The sponges should be thoroughly wet to ensure even current distribution. Self adhesive pad electrodes are also available (similar to the newer TENS electrodes) and make the IFT application easier in the view of many practitioners. The suction electrode application method has been in use for several years, and whilst it is useful, especially for larger body areas like the shoulder girdle, trunk, hip, knee, it does not appear to provide any therapeutic advantage over pad electrodes (in other words, the suction component of the treatment does not appear to have a measurable therapeutic effect). Care should be taken with regards maintenance of electrodes, electrode covers and associated infection risks (Lambert et al 2000; Koh et al, 2010).





Whichever electrode system is employed, electrode positioning should ensure adequate coverage of the area for stimulation. Using larger electrodes will minimise patient discomfort whilst small, closely spaced electrodes increase the risk of superficial tissue irritation and possible damage / skin burn.

The bipolar (2 pole) application method is perfectly acceptable, and there is no physiological difference in treatment outcome despite several anecdotal stories to the contrary. Recent research evidence supports the benefit of 2 pole application (e.g. Ozcan et al 2004).

Treatment times vary widely according to the usual clinical parameters of acute/chronic conditions & the type of physiological effect desired. In acute conditions, shorter treatment times of 5-10 minutes may be sufficient to achieve the effect. In other circumstances, it may be necessary to stimulate the tissues for 20-30 minutes. It is suggested that short treatment times are initially adopted especially with the acute case in case of symptom exacerbation. These can be progressed if the aim has not been achieved and no untoward side effects have been produced. There is no research evidence to support the continuous progression of a treatment dose in order to increase or maintain its effect.

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INTERFERENTIAL CONTRAINDICATIONS

- Patients who do not comprehend the physiotherapist's instructions or are unable to co-operate should not be treated
- Patients with Pacemakers – some pacemakers are relatively immune to interference from electrical stimulation whilst others can demonstrate serious adverse behaviour. It is suggested that as a general rule, if the patient has a pacemaker, it is best to avoid all electrical stimulation, but like TENS, if it is a treatment that is needed. The stimulation should be tried in a carefully controlled environment where appropriate equipment is available to correct any pacing problems should they arise.
- Patients who are taking anticoagulation therapy or have a history of pulmonary embolism or deep vein thrombosis should not be treated with the vacuum electrode applications
- Similarly, patients whose skin may be easily damaged or bruised
- Application over :
  - The trunk or pelvis during pregnancy (though this MAY be modified in time in line with the TENS advice. At the present time, it is suggested that it is best avoided in these regions)
  - Active or suspected malignancy except in hospice/palliative/terminal care
  - The eyes
  - The anterior aspect of the neck
  - The carotid sinuses
- Dermatological conditions e.g. dermatitis, broken skin
- Danger of haemorrhage or current tissue bleeding (e.g. recent soft tissue injury)
- Avoid active epiphyseal regions in children
- Transthoracic electrode application is considered to be 'risky' by many authorities

INTERFERENTIAL PRECAUTIONS

- Care should be taken to maintain the suction at a level below that which causes damage / discomfort to the patient
- If there is abnormal skin sensation, electrodes should be positioned in a site other than this area to ensure effective stimulation
- Patients who have (marked) abnormal circulation
- For patients who have febrile conditions, the outcome of the first treatment should be monitored
- Patients who have epilepsy, advanced cardiovascular conditions or cardiac arrhythmias should be treated at the discretion of the physiotherapist in consultation with the appropriate medical practitioner
- Treatment which involves placement of electrodes over the anterior chest wall
- Satter (2008) reports an electrical burn following IFT treatment – correct application methods are therefore strongly encouraged
- Keramat and Gaughran (2012) report and unusual range of untoward effects following IFT treatment

INTERFERENTIAL TREATMENT RECORD

- Electrode number (2 pole, 4 pole) and positions
- Frequency applied
- Sweep settings employed (if applicable)
- Current intensity applied (or patient reported sensation)
- Treatment duration