

# Summary of Published Findings from Use of the WS Far Infrared Therapy Unit with References

1. “FIR therapy, a non-invasive and convenient therapeutic modality, can improve Qa [access flow] and survival of the AVF [arteriovenous fistula] in HD [hemodialysis] patients through both its thermal and its nonthermal [biological] effects.” (Lin CC et al, 2007)
2. Re: Newly created AV fistulas in HD patients: “We enrolled 122 patients who were randomly allocated to the intervention (n\_ 60) and control (n\_ 62) groups. In comparison to controls, patients in the intervention group had higher Qa [blood flow] values at 1, 2, 3, and 12 months; a higher rate of physiologic maturation (90% vs 76%; *P* \_ 0.04) at 3 months; and a lower rate of AVF malfunction (12% vs 29%; *P* \_ 0.02) but higher rates of AVF cumulative unassisted patency (87% vs 70%; *P* \_ 0.01) and clinical maturation (82% vs 60%; *P* \_ 0.008) within 12 months. **Conclusions:** 40 minutes of far infrared therapy [3 times weekly for a year] improves the access flow, maturation, and patency of newly created AVFs in patients with chronic kidney disease stages 4 and 5.” (Lin CC et al, 2013 AJKD)
3. Of 216 participants analyzed, including 97 with arteriovenous grafts (AVG) (49 FIR-radiated participants and 48 control participants) and 119 with arteriovenous fistulas (AVF) (69 FIR-radiated participants and 50 control participants), the FIR-radiated therapy compared with free-radiated usual therapy significantly enhanced PTA-unassisted patency at 1 year in the AVG subgroup (16.3% vs. 2.1%; *p* < .01), but not the AVF subgroup (25.0% vs. 18.4%; *p* ¼ .50), and this accounted for the overall improved patency rates (21.4% vs. 10.3%; *p* ¼ .02).  
**Conclusions:** This study suggests FIR-radiated therapy improves PTA-unassisted patency in patients with AVG who have undergone previous PTA. (Lai CC et al, 2013)
4. “Four RCTs (666 patients) were included. Unassisted patency assessed in 610 patients, and was significantly better among those who received FIR (228/311) compared to (185/299) controls (pooled risk ratio of 1.23 [1.12–1.35], *p* = 0.00001). In addition, the two studies which reported secondary patency rates showed significant difference in favour of FIR therapy -160/168 patients - compared to 140/163 controls (pooled risk ratio of 1.11 [1.04–1.19], *p* = 0.003).” ... “The meta-analysis showed overwhelming support for regular use of FIR therapy, however there were limitations that need to be considered. Finally, this review may serve to guide future advances in using repeated thermal therapy in postconditioning of AVFs. Results from four RCTs suggest that regular use of FIR therapy in haemodialysis and pre-haemodialysis patients, in particular those with AVFs, can positively influence AVF function. However, more blinded randomised controlled, multicentre and international clinical trials are required.” (Bashar K et al, 2014)
5. “FIR therapy improves Qa and patency of AVF in HD patients, with the best protective effect in those with S/S genotype of HO-1” (Lin CC et al, 2013 NDT)

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6. “Patients have objectively recorded a reduced pain score on needling an AVF under the influence of FIR, as well as improvement in haematoma resolution. We surveyed 40 patients on our HD unit who underwent FIR of their AVF because of associated with needling (see Figure 3). Patient testimonials have been integral to developing our service further” ...“At CHSFT, we have shown that it is possible to set up a dedicated, nurse-led FIR service within a busy dialysis unit, which is available to all patients with CKD who have AVFs. Our experience and feedback from patients informs us that it is a well tolerated treatment that reduces pain for patients during needling, and has the potential to improve patient outcomes by optimizing their HD treatment through better vascular access.” (Shipley T et al, 2013)
7. Patch-enlarged brachial artery for hemodialysis access: Far infrared therapy was used “to promote wound healing (both for the blood drawing port and the dialyzed blood infusion vein) and to increase the arterial diameter and flow...” “Far-infrared irradiation is good for prevention of phlebitis of needled veins and is good for increasing the speed of blood flow through the arterial system.” (Chiang JC et al, 2007)
8. Far infrared therapy inhibits vascular endothelial inflammation via the induction of heme oxygenase-1 “These results demonstrate that FIR therapy exerts a potent anti-inflammatory effect via the induction of HO-1. The ability of FIR therapy to inhibit inflammation may play a critical role in preserving blood flow and patency.” (Lin CC et al, 2008)
9. Far infrared therapy upregulates NF-E2-related factor-2 leading to inhibition of the expression of inflammatory factors E-selectin, vascular cell adhesion molecule-1, and intercellular adhesion molecule-1: “Our recent study also demonstrated that far-infrared therapy, a noninvasive and convenient therapeutic modality, can improve access flow, inflammatory status and survival of the AVF in HD patients through both its thermal and non-thermal (endothelial-improving, anti-inflammatory, anti-proliferative, anti-oxidative) effects by upregulating NF-E2-related factor-2-dependent HO-1 expression, leading to the inhibition of expression of E-selectin, vascular cell adhesion molecule-1, and intercellular adhesion molecule-1.” (Lin and Yang 2009)
10. “We found that FIR ranging 3~10  $\mu\text{m}$  significantly inhibited VEGF-induced proliferation in HUVECs. According to intensity and time course analyses, the inhibitory effect of FIR peaked at an effective intensity of 0.13  $\text{mW}/\text{cm}^2$  at 30 min.... These data suggest that FIR induces the nuclear translocation of PLZF which inhibits VEGF-induced proliferation in HUVECs.” (Hsu Y-H et al, 2012)

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11. "A TY301N therapy unit (WS Far-Infrared Medical Technology Co., Ltd., Taiwan) was used for the FIR therapy. This study employed a rat model of sciatic nerve injury to investigate the effects of postoperative low-power far-infrared (FIR) radiation therapy in nerve repair following end-to-end neurorrhaphy. Walking-track analysis results showed that the NI/FIR group exhibited significantly higher sciatic functional indices at 8 weeks after surgery ( $P < 0.05$ ) compared with the NI/sham group. The decreased expression of CD4 and CD8 in the NI/FIR group indicated that FIR irradiation modulated the inflammatory process during recovery. Compared with the NI/sham group, the NI/FIR group exhibited a significant reduction in muscle atrophy ( $P < 0.05$ ). Furthermore, histomorphometric assessment indicated that the nerves regenerated more rapidly in the NI/FIR group than in the NI/sham group; furthermore, the NI/FIR group regenerated neural tissue over a larger area, as well as nerve fibers of greater diameter and with thicker myelin sheaths. Functional recovery, inflammatory response, muscular reinnervation, and histomorphometric assessment all indicated that FIR radiation therapy can accelerate nerve repair following end-to-end neurorrhaphy of the sciatic nerve" (Chen TY et al, 2015)
12. Biological effect of far-infrared therapy on increasing skin microcirculation in rats: "A WS TY301 FIR emitter was placed 20 cm above the rats .... There was no significant change of skin blood flow during FIR treatment. Skin blood flow increased significantly soon after the removal of the FIR emitter. The stimulating effect on skin blood flow was more significant in the rats treated with FIR for 45 min and could be sustained as long as 60 min. These findings suggested a non-thermic biological effect of FIR on skin microcirculation "In conclusion, FIR therapy exerts a NO elated biological effect to increase skin microcirculation in rats. This might bring into perspective the clinical application of FIR to treat ischemic disease by augmenting L-arginine/NO pathway." (Yu SY et al, 2006)
13. Clinical effects of far-infrared therapy in patients with allergic rhinitis (AR): "Thirty-one patients with AR...symptoms of eye itching, nasal itching, nasal stuffiness, rhinorrhea and sneezing were all significantly improved." "No obvious adverse effect was observed .... We concluded that FIR therapy could improve the symptoms of AR and might serve as a novel treatment modality for AR." (Hu KH and Li WT 2007)
14. Phantom limb pain treated by far infrared ray: A patient with severe phantom limb pain was treated by far infrared therapy. "The patient has suffered persistent and progressively worsening phantom limb pain after amputation ten years ago. He also experienced severe muscle spasm. His phantom limb pain was excruciating and was rated up to 9 by the Visual Analog Pain Scale." "One month after the FIR treatment ... rated his phantom pain at 4, and down to 2-3 after two months of treatment. The duration of each phantom limb pain

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attack has significantly reduced from over 24 hours to only a few minutes or seconds after five months of FIR treatment. During a six-month post-treatment follow-up, his phantom limb pain occurred seldom for only a few seconds at a low 1-2 rating on the pain scale. The analgesic effect of FIR treatment has prevented him from the scheduled third sympathectomy. It also reduced his risk of heart attack and severe twitching in his stump. The results of this study demonstrate an easy, non-invasive and effective treatment modality for phantom limb pain.” (Huang TY et al, 2009).

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15. Far-Infrared Radiation Promotes Angiogenesis in Human Microvascular Endothelial Cells via Extracellular Signal-Regulated Kinase Activation: “The results revealed that FIR radiation from a WS(TM) TY301 FIR emitter activated p38 and extracellular signal-regulated kinase (ERK), but not Akt or c-Jun N-terminal protein kinases (JNK), and significantly promoted angiogenesis by increasing tube formation in Matrigel and the migration of cells across an eight micron polyester filter.” “This study revealed that FIR radiation possesses in vitro angiogenic activity via the activation of the MEK/ERK but not the VEGF/Akt/eNOS-dependent signaling pathways.” (Rau CS et al, 2010)
16. “By using FIR therapy, we have reduced our vascular access failure rate and have also minimized surgical intervention and consequent patient co-morbidity. We have been able to demonstrate that FIR therapy is cost effective and reduces effort and resources in vascular access management. Over the last 12 months due to overwhelmingly positive feedback from our patient group we have expanded our FIR programme to cover our central unit and satellite units. We believe this is the first systematic use of this effective, patient-centred innovation in the UK.” (Moore I et al, 2011)

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