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## AN EVIDENCE-BASED NEW INSIGHT INTO TREATMENT OF DISEASES BY HYDROTHERAPY

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**ABSTRACT:** Hydrotherapy or hydrophathy is nothing but external or internal use of any form of water (*i.e.*, water, ice, steam) for health promotion or treatment of various diseases with varying temperatures, pressure, duration, and site of application. It is one of the well known naturopathic treatments used widely in ancient cultures including India, Egypt, China, and other Asian countries. Many studies were conducted to understand the physiological and therapeutic effects of hydrotherapy on different organs, but the effect of hydrotherapy was not explored in many organs till. The main objective of this review is to report the scientific evidence-based effects of hydrotherapy on various physiological systems which are not reported yet. The review was conducted and found that hydrophathy has therapeutic value and capacity to improve various physiological functions in some diseases and disorders. Diseases like rheumatoid arthritis, osteoarthritis, and ankylosing spondylitis required a long period of treatment to cure by using allopathic medicine, whereas using hydrotherapy can reduce the duration of treatment. Moreover, if the combination of both medication and hydrophathy is given to the patient, it will be more beneficial. The main advantages of hydrotherapy over allopathic treatment are nontoxic as well as economic. Based on the available literature this review suggested that the hydrotherapy has a scientific evidence-based effect on various systems of the body. It also revealed the fact that hydrophathy was not explored clinically much and there is a huge scope for the researchers to establish the cellular level mechanism of hydrophathy.

**INTRODUCTION:** Hydrotherapy or hydrophathy is the use of water (hot, cold, steam, or ice) to improve various physiological conditions or to treat disease. Water can be used therapeutically in some ways. Common forms of hydrotherapy include: Whirlpools, Jacuzzis, and hot tubs are commonly used by a physiotherapist to improve the condition of a patient affected by muscle and joint pain. An obstetrician suggests the use of hot tubs to soothe the labor pain.

A set of the aquatic program has been established by experimental evidence by the arthritis foundation to improve various kinds of arthritis (RA, OA, *etc.*). Use of essential oils has found to a variety of role in relaxation and stress reduction.

Epsom salts (magnesium sulfate) or Dead Sea salts to a bath promote relaxation and soothing effect in rheumatism and arthritis. Burn patients are exposed to showers for treatment. A headache, fever, and inflammation of an injury can be reduced by cold compressions. Hot or warm compresses are useful for soothing muscle aches and treating abscesses. Detoxification and cleansing of the body can be achieved by steam treatments and sauna that helps in opening of skin pores. Patients with respiratory tract infections are prescribed steam

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inhalation with adding some botanicals in the therapy. Colonic irrigation is an enema that is designed to cleanse the entire bowel. Proponents of the therapy say it can cure some digestive problems. Douching directs a stream of water into the vagina for cleansing purposes that can be self-administered with kits available at most drug stores as douches.

Herbs and essential oils that can be beneficial in steam inhalation include:

- Tea tree oil (*Melaleuca alternifolia*) for bronchitis and sinus infections.
- Sandalwood (*Santalum album*), Virginian cedarwood (*Juniperus virginiana*), and

frankincense (*Boswellia carteri*) for a sore throat.

- Lavender (*Lavandula angustifolia*) and thyme (*Thymus vulgaris*) for a cough.

Hydrotherapy relieves from inflamed muscles and joints, lower fevers, soothe headaches, promote relaxation, treat burns and frostbite, ease labor pains, and clear up skin problems. It stimulates the immune system.

- Hot water- used for relaxation effect.
- Tepid water- used for stress reduction.
- Cold water- reduce inflammation and nerve injuries.



FIG. 1: HYDROTHERAPY EFFECTS

### Effects of Hydrotherapy on Different Biological Systems:

**Cardiovascular System:** Cold exposure to small surface area produces vasodilation in the deeper vascular system and increases blood flow at that exposed area<sup>2</sup>. Patients suffering from chronic heart failure when treated with thermal vasodilation following warm water bathing and low-temperature sauna bathing at 60 °C for 15 min improves cardiac function<sup>5</sup>. Repeated sauna-therapy (ST) increases left ventricular ejection fraction. Increased 6 min walk distance in association with improvement in flow-mediated dilation increases the number of circulating CD34 (+) cells reduces plasma levels of norepinephrine and brain natriuretic peptide. These indicate that ST improves exercise tolerance in association with improvement in endothelial function<sup>6</sup>.

Sauna therapy reduces the level of LDL and increases HDL that prevents from ischemic heart disease<sup>7</sup> sauna therapy also increases the level of endothelial nitric oxide synthase resulting in improved cardiac function in heart failure. When

myocardial infarction (MI) was induced in Wistar rats followed by sauna therapy increases myocardial endothelial nitric oxide synthase. It diminishes cardiac remodeling after MI through improving coronary vascularity<sup>8</sup>.

Thus, sauna therapy might serve as a novel noninvasive therapy for patients with MI. Sauna bath is generally followed by a cold water bath, patients with acute MI, when treated with sauna followed by rapid cooling during cold water bath, shows the danger for them because they are more susceptible to coronary risk factor result from thrombosis or plaque rupture because of coronary artery spasm<sup>9</sup>. Use of sauna therapy in early pregnancy is a potential concern because of evidence is suggesting that hyperthermia might be teratogenic<sup>10</sup>. Cold water immersion (CWI) induces an increase in HR, BP, metabolism, and peripheral catecholamine concentration; and a decrease in cerebral blood flow<sup>11</sup>. Increase in HR and a decrease in systolic blood pressure and diastolic blood pressure were observed in 30 min of head-out WI (38.41 ± 0.04 °C)<sup>13</sup>.

WI up-to shoulder levels at different temperatures (25 °C, 34 °C, and 40 °C) showed no significant effect on cardiac output in 25 °C compared with 34 °C, but in 40 °C a considerable increase in cardiac output was observed<sup>16</sup>. Carbon dioxide (CO<sub>2</sub>) enriched WI reduces free radical plasma levels, raised antioxidants levels, and induce peripheral

vasodilatation suggests improvement in micro-circulation<sup>17, 18</sup>. The three main effects of CO<sub>2</sub> enriched WI are a decline in core temperature, increase in cutaneous blood flow, and elevation of the score on thermal sensation, which were analyzed<sup>19</sup>.



**FIG. 2: (A) SAUNA BATH FOR CARDIOVASCULAR SYSTEM (B) COLD IMMERSION FOR CARDIOVASCULAR SYSTEM**

**Respiratory System:** WI up-to shoulder levels at different temperatures (25 °C, 34 °C, and 40 °C) showed increased metabolic rate, oxygen (O<sub>2</sub>) consumption only at 25 °C. Hydrostatic pressure and temperature two main factors affecting oxygen transport during immersion. The combined action of hydrostatic counter pressure and body heating improves O<sub>2</sub> transport above the neutral temperature. Below neutral temperature, O<sub>2</sub> transport is altered. The pulmonary tissue volume and arterial blood gases were not significantly affected at any of the temperature tested<sup>16</sup>.

A significant decrease in vital capacity (VC) with bath temperature was observed (*i.e.*, VC at 40 °C > 34 °C > 25 °C). A significant increase in tidal

volume (VT) in cold or hot water compared with thermoneutral water (*i.e.*, VT 40 °C > 34 °C < 25 °C). Alterations in respiratory muscles functioning might produce variations of the pulmonary volumes as a function of water temperature<sup>20</sup>.

Cold water immersion as shown in **Fig. 3** was associated with an increase in respiratory minute volume and a decrease at the end-tidal CO<sub>2</sub> partial pressure<sup>11</sup>. Repeated cold water stimulations reduced the frequency of infections; increased peak expiratory flow, lymphocyte counts, and expression of gamma - interferon; modulated interleukin expression; and improved quality of life (QOL) in patients with chronic obstructive pulmonary disease<sup>21</sup>.



**FIG. 3: HYDROTHERAPY FOR RESPIRATORY SYSTEM**

**Nervous System:** When the back portion of the lower leg is exposed to three cold modalities such as ice massage, ice pack, and CWI applied for 15 min reduced skin temperature (mean 18.2 °C);

reduced amplitude and increased latency and duration of the compound action potential. It also reduced sensory nerve signal velocity by 20.4, 16.7, and 22.6 m/s and motor nerve signal velocity

by 2.5, 2.1, and 8.3 m/s, respectively. Even though all three modalities effectively reduced temperature and sensory conduction at a physiological level, cold water immersion is the most indicated, effective modality for inducing therapeutic effects associated with the reduction of motor nerve conduction<sup>25</sup>. The mechanism of hydrotherapy lies in blocking of nociceptors by acting on mechanoreceptors and thermal receptors and shows its effect on a spinal segment of CNS which is helpful in relieving pain<sup>26</sup>. Forty sessions of Ai Chi aquatic exercise (AE) program improves pain, spasms, disability, fatigue, depression, and autonomy in the patient with multiple sclerosis<sup>27</sup>.

Both physiotherapy and hydrotherapy have found to improve the functional reach test in Parkinson's disease, but Berg Balance Scale (BBS) and Unified Parkinson's Disease Rating Scale (UPDRS) were improved only in an aquatic therapy group. It indicates improvement in postural stability in Parkinson's disease was significantly larger after aquatic therapy<sup>28</sup>. Ten minutes of immersions in whirlpools produced increases in pulse and finger temperature with increased feelings of well-being and decreased state anxiety. CO<sub>2</sub>-WI activates parasympathetic nerve activity in humans<sup>18</sup>. An adapted cold shower might have an antipsychotic effect similar to that of electroconvulsive therapy because it could work as mild electroshock applied to sensory cortex<sup>31</sup>. Reticular activating system such as locus ceruleans and raphe nuclei can be activated by CE, which can result in activation of behavior and increased the capacity of the central nervous system (CNS) to recruit motor neurons<sup>32</sup>. Anti-depressive effect of cold shower attributed to the presence of high density of cold receptors in skin expected to send an overwhelming amount of electrical impulses from peripheral nerve endings to the brain. It does not cause dependence and has noticeable analgesic activity<sup>33</sup>. Most narcotics administered rectally can cause intoxication.



FIG. 4: WHIRLPOOL FOR NERVOUS SYSTEM

**Musculo Skeletal System:** Walking in water at umbilical level increases the activity of erector spinae and activates rectus femoris to levels near to or higher than walking on dry ground<sup>34</sup>. CWI <15°C is one of the most popular intervention used after exercise,<sup>11, 35</sup> which significantly lowered ratings of fatigue and potentially improved ratings of physical recovery immediately after immersion with reduction in delayed onset muscle soreness at 24, 48, 72, and 96 h follow-ups after exercise compared with passive interventions involving rest or no intervention<sup>35</sup>.

The rate of decrease in plasma lactate concentration over 30 min recovery period after intense anaerobic exercise was significantly higher in contrast-WI [hot (36 °C) and cold (12 °C)] compared with passive recovery on the bed for both genders<sup>36</sup>. Leg immersion in warm water (44 ± 1 °C) for 45 min before stretch-shortening exercise reduced most of the indirect markers of exercise-induced muscle damage, including muscle soreness, creatine kinase activity in the blood, maximal voluntary contraction force, and jump height. Decreasing muscle damage did not improve voluntary performance; therefore the clinical application of muscle pre-warming may be limited<sup>37</sup>.

Contrast water therapy (CWT) [alternating 1-min hot (38 °C) and 1-min cold (15 °C)] for 6/12/18 min lowered subjective measures of thermal sensation and muscle soreness compared with control (seated rest) but no consistent differences were observed in whole body fatigue. It indicates CWT for 6 min assisted acute recovery from high-intensity running and CWT duration did not have a dose-response effect on running performance recovery<sup>38</sup>. Contrast baths have been suggested for reducing pain; hand volume; and stiffness in affected extremities but it had no significant effect on pre- and postoperative hand volume in carpal tunnel syndrome<sup>39</sup>.

Cold water or cold/thermoneutral water did not induce modifications of inflammatory and hematological markers. CWI or CWT did not negatively influence the performances of athletes. Reduced perception of fatigue after the training session was the principal effect of CWI<sup>45</sup> because CE increases opioid tone and high MR, which could diminish fatigue by reducing muscle pain and

accelerating recovery of fatigued muscle, respectively,<sup>32</sup> which can improve training and competitions in young soccer players<sup>40</sup>.

A systematic review on management of fibromyalgia syndrome (FMS) through hydrotherapy described as “there is strong evidence for the use of hydrotherapy in the management of FMS,” and it showed positive outcomes for pain; tender point count; and health-status<sup>41</sup>. Combination of ST (once daily for 3 days/week) and underwater exercise (once daily for 2 days/week) for 12 weeks significantly reduced pain and symptoms (both short- and long-term); and improved QOL in patients with FMS<sup>42</sup>. Pool-based exercise using deep water running three times/week for 8 weeks is a safe and effective intervention for FMS because it showed significant improvement in general health and QOL compared with control; and significant improvement in fibromyalgia impact questionnaire score, incorporating pain; fatigue; physical function; stiffness; and psychological variables<sup>43</sup>.

Hydrotherapy may have some short-term benefit to a passive range of movement in rehabilitation after rotator cuff repair<sup>44</sup>. Spa water (37 °C) and tap water heated to 37 °C for 20 min/day for 5 days/week for 2 weeks with home-based exercise program improved the clinical symptoms and QOL in a patient with osteoarthritis of the knee (OAK). However, pain and tenderness statistically improved in spa water<sup>45</sup>. It may be due to that spa waters are not only naturally warm, but their mineral content is also significant. Spa water has mechanical, thermal, and chemical effects.

In ankylosing spondylitis (AS) patients, balneotherapy statistically improved pain; physical activity; tiredness and sleep score; Bath Ankylosing Spondylitis Disease Activity Index (BASDAI); Nottingham Health Profile (NHP); patient's global evaluation and physician's global evaluation at 3 weeks, but only on modified Shober test and patient's global evaluation parameters at 24 weeks. It showcases the effect of balneotherapy in functional parameters of as patients<sup>46</sup>. Infrared sauna, a form of total-body hyperthermia was well tolerated; no adverse effects; and no exacerbation of disease were reported in patients with rheumatoid arthritis (RA) and AS in whom pain,

stiffness, and fatigue showed clinical improvements during the 4 weeks treatment period but these did not reach statistical significance<sup>47</sup>. Aqua-jogging without caloric restrictions in obese persons for 6 weeks was associated with reductions in waist circumference and body fat; improvement of aerobic fitness and QOL<sup>48</sup>.

AE may be an excellent alternative to land exercise for individuals who lack confidence, have a high risk of falling, or have joint pain<sup>49</sup>. Water buoyancy reduces the weight that joints, bones, and muscles have to bear<sup>50</sup>. Warmth and pressure of water also reduce swelling and reduces the load on painful joints, remotes muscle relaxation<sup>51</sup>. AE has significant effects on pain relief and related outcome measurements for locomotor diseases. Patients may become more active and improve their QOL as a result of AE<sup>52</sup>. Water-based and land-based exercises reduced pain, and improved function in patients with OAK and that water-based exercise was superior to land-based exercise for relieving pain before and after walking<sup>53</sup>.

Hydrotherapy is highly valued by RA patients who were treated with hydrotherapy (30 min session/week) reported feeling much better/very much better than those treated with land exercises (similar exercises on land) immediately on completion of the treatment program (6 weeks). But this benefit was not reflected on 10 m walk times, functional scores, QOL measures, and pain scores by differences between groups<sup>51</sup>. Hot compress (HC) with surrounding electro-acupuncture needling was significantly effective on rear thigh muscles strain, and it was superior to conventional needling method and cupping in improving symptoms and physical signs as well as recovery of walking function of athletes<sup>54</sup>.



**FIG. 5: HYDROPATHY CYCLING FOR MUSCULO-SKELETAL SYSTEM**

**Gastrointestinal System:** Drinking water significantly elevates the resting energy expenditure (REE) in adults but in overweight children transient decrease in REE was observed immediately after drinking 10 ml/kg cold water (4°C). Then a subsequent rise in REE was observed, which was significant after 24 min and the maximal mean REE values were seen after 57 min, which was 25% higher than baseline. The recommended daily amount of water consumption in children could result in an energy expenditure equivalent to additional weight loss of about 1.2 kg/year suggesting that water drinking could assist overweight children in weight loss or maintenance<sup>55</sup>.

Exposure to cold increases MR, for example, head out immersion in the cold water of 20 °C almost doubles MR, while at 14 °C it is more than quadrupled<sup>3</sup>. When very HC applied to the lumbar region of a healthy female for 10 min blood flow to the back increased to 156% with increased blood flow to the upper arm. Immediately after HC, bowel sounds increased 1.7 times compared with before application, which suggests that a very HC can be useful to promote flatus or defecation<sup>56</sup>. Low mineral water intake normalizes the intestinal permeability of patients with atopic dermatitis<sup>57</sup>.

Warm water is effective for colonic spasm in which significantly less discomfort was reported compared with control group, and this may be useful as an alternative for glucagon (expensive) and hyoscyamine (has side effects) because it has no side effects and costs practically nothing<sup>58</sup>. In patients with acute anal pain due to hemorrhoids or anal fissures, neither cold water (30 °C) sitz bath (SB) did control pain statistically<sup>59</sup>. Similarly, after sphincterotomy for anal fissure, SB produced no significant difference in pain, but significant relief in anal burning and better satisfaction score with no adverse effects were observed compared with control group<sup>60</sup>. Healing and pain relief was not significant in SB, but it improved patient satisfaction in acute anal fissures<sup>61</sup>. Though, there was no strong evidence to support the use of SB for pain relief and to accelerate fissure or wound healing among adult patients with anorectal disorders (ARDs), patients were satisfied with using SB, and no severe complications were reported<sup>62</sup>.

In contrast, warm water SB (40 °C, 45 °C, and 50 °C for 10 min each time) in ARD, was more evident and lasted longer at higher bath temperatures. Pain relief after SB might attribute to internal anal sphincter relaxation, which might be due to thermo sphincteric reflex, resulting in diminution of the rectal neck pressure. In post-hemorrhoidectomy care, water spray method could provide a safe and reliable alternative to SB as a more convenient and satisfactory form of treatment<sup>64</sup>.

Spa treatment with mineral water Nizhnevinskaya (sulfate calcium) induced clinical remission of the disease, normalization of the echoscopic picture of stomach and gallbladder, their motor function, tesiocystalloscopic characteristics of saliva suggest its effectiveness in the rehabilitation of patients with gastric and gallbladder motorevacuatory dysfunction<sup>65</sup>. Intake of sulfatechloridesodium mineral water activates regulation of carbohydrate metabolism by insulin and cortisol due to the formation of adaptive reactions. It promoted trophic effects of insulin and gastrin in animals with a significant reduction in peptic ulcer size and enhanced resistance to stressful factors<sup>66</sup>.

Immersion in Dead Sea water produced a significant reduction in blood glucose in type 2 diabetes mellitus (DM) and no significant differences in insulin, cortisol, and cpeptide levels were observed between DM pain relief patients and healthy volunteer's immersion<sup>67</sup>.

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produced a significant reduction in blood glucose in type 2 diabetes mellitus (DM) and no significant differences in insulin, cortisol, and cpeptide levels were observed between DM patients and healthy volunteers following immersion<sup>67</sup>.

Genitourinary system mean labor pain scores were significantly higher in control group than immersion bath (IB) group suggest that use of IB as an alternative form of pain relief during labor<sup>68</sup>. WI in primipara at any stage of labor, from 2 cm external opening of the uterine cervix, significantly decreased parturition duration compared with traditional delivery. It raised both the amplitude and frequency of uterine contractions proportional to uterine cervix gaping with no disturbances in contraction activity of the uterus. A 3 cm gaping of the uterine cervix is the optimal timing for WI in the primipara because earlier WI at 2 cm uterine cervix gaping also accelerated the labor but required repetitions of WI or use of oxytocin for correcting weakened uterine contraction<sup>69</sup>.

In contrast, IB did not influence the length of labor and uterine contractions frequency. However, contractions length was statistically shorter in IB, and it can be an alternative for woman's comfort during labor since it provides relief to her without interfering on labor progression or jeopardizing the baby<sup>70</sup>.

WI during the first stage of labor reduces the use of epidural/spinal/ paracervical analgesia /anesthesia compared with controls, and there is no evidence of increased adverse effects to fetus/neonate or woman from laboring in water or water birth<sup>71</sup>. Neonatal swimming can accelerate babies growth in early stage<sup>72</sup>. In a microbiological study, comparing neonatal bacterial colonization after water birth to conventional bed deliveries with or without relaxation bath showed no significant difference between three groups in the neonatal outcome, infant's and maternal infection rate<sup>73</sup>.

ColdSB but not warm SB, significantly reduced edema during postepisiotomy period<sup>74</sup> and perineal pain, which was greatest immediately after the bath<sup>75</sup>. Bakera, a steam bath prepared with various plants (commonly the essential oil plants) is traditionally used in Minahasa (Indonesia) mainly for recuperation after childbirth.

It is based on thermotherapy with aromatherapy which attributes for its therapeutic effects. Thermotherapy soothes symptoms such as heaviness in limbs, edema, muscular strain, loss of appetite, and constipation. Essential oils of the plants used have antiseptic, antiphlogistic, and immunostimulant effect. Hence, it can be an effective and safe method for recuperation after childbirth<sup>76</sup>. In postnatal mothers, alternate (hot and cold) compress and cold cabbage leaves were equally effective in reducing breast engorgement, but in relieving breast engorgement pain, alternate compresses were more effective than cold cabbage leaves<sup>77</sup>. Warm SB (40-45 °C) for 10 min, for at least 5 days immediately after the removal of Foley urethral catheter in patient undergone transurethral resection of prostate, significantly reduced urethral stricture compared with no SB group who had 1.13 fold increased risk of rehospitalization within 1 month after surgery due to postoperative complications compared with warm SB group<sup>78</sup>.

Thirty healthy volunteers and 21 patients with urinary retention after hemorrhoidectomy underwent SB at 40 °C, 45 °C, and 50 °C where the number of spontaneous micturitions increased with higher temperature baths, and it seems to be initiated by reflex (thermosphincter reflex) internal urethral sphincter relaxation<sup>79</sup>.

**Hematology / Immunology:** Subsequent CE induced increase of leukocytes, granulocytes, circulating levels of interleukin (IL) 6, and natural killer (NK) cells and its activity. Leukocytes, granulocyte, and monocyte responses were augmented by pretreatment with exercise in water (18 °C) and thus acute CE has immune stimulating effects<sup>80</sup>. Daily brief cold stress can increase both numbers and activity of peripheral cytotoxic T-lymphocytes and NK cells, the major effectors of adaptive and innate tumor immunity, respectively. It (for 8 days) improved survival of intracellular parasite *Toxoplasma gondii* infected mice, with consistent enhancement in cell-mediated immunity.

The sustained/long term effects of cold stress repeated daily for 5 days to 6 weeks increased plasma levels of tumor necrosis factor  $\alpha$ , IL2, IL6. According to a hypothesis if coldwater stress is given for many months, then it can potentiate antitumor immunity and improve nonlymphoid

cancer survival rate. The possible mechanism of nonspecific stimulation of cellular immunity might attribute to transient activation of SNS, hypothalamic pituitary adrenal (HPA) and hypothalamic pituitary thyroid axes. Sudden cold WI can produce transient pulmonary edema and increase blood brain barrier permeability, thereby increasing mortality of neuro virulent infections. Studies are required to warrant this hypothesis for immunotherapy development for some (non lymphoid) cancers, including those caused by viral infections<sup>81</sup>.

Warm water (28°C) treatment could not only cure bacterial coldwater disease but also immunize against causative agent *Flavobacterium psychrophilum*<sup>82</sup>. Head out WI (38.41  $\pm$  0.04 °C) for 30 min decreased blood viscosity; red blood cells count; and mean hematocrit without significant changes in leukocytes and platelets count; mean corpuscular volume; plasma viscosity; erythrocyte filtration time and red cell deformability index<sup>13</sup>. Application of hyperthermic water bath produced a significant reduction of relative  $\beta$ -lymphocyte. Whole body hyperthermic water bath reduced relative total T-lymphocyte counts; increased relative CD8+ lymphocyte; NK cell counts and its activity, which were probably dependent on increased somatotrophic hormone production<sup>83</sup>.

**Endocrine / Hormonal System:** During CE increase levels of circulating nor-epinephrine was observed<sup>80</sup> and exercising HPA system by repeated CE could potentially restore its normal function in chronic fatigue syndrome, or at least increase net HPA activity (without changing baseline activity)<sup>84</sup>. It produces a temporary increase in plasma levels of adrenocorticotropic hormone (ACTH), beta endorphin, and cortisol<sup>32</sup>. The sustained / longer term effects of cold stress repeated daily produced an increase in ACTH, corticosterone, and a decrease in  $\alpha$ 1antitrypsin and testosterone<sup>81</sup>. Cold stress reduces the level of serotonin in most regions of the brain (except brainstem)<sup>32</sup>. Cold stress induced analgesia might be mediated by increased production of opioid peptide beta-endorphin (an endogenous painkiller)<sup>85, 86</sup>. Exposure to the sauna and ice WI significantly elevated epinephrine levels in winter swimmer<sup>87</sup>. Steam bath produced an increase in blood serum concentrations of gastric and aldosterone, with a



decrease in concentrations of cortisol in athlete - fighters<sup>88</sup>. Whole body hyperthermic bath increased STH activity in 8 out of 10 volunteers<sup>83</sup>.

**Eye, Skin, and Hair:** Warm moist air device seemed to be safe and produced improvement in tear stability and symptomatic relief in ocular fatigue in patients with meibomian gland dysfunction<sup>89</sup>. Sauna (80 °C) produced stable epidermal barrier function, increases ionic concentration in sweat, increase hydration of stratum corneum, faster recovery of elevated water and pH levels, decreases skin and forehead oil (sebum) and increases epidermal blood perfusion in volunteers. It suggests a protective effect of ST on skin physiology<sup>90</sup>.

Clinical remission of atopic dermatitis has been reported after intake of low salt water<sup>57</sup>. Application of heated mustard compress produced second degree, partial thickness burn followed by hyperpigmentation and hypertrophic scarring<sup>91</sup>. Persistent use of cold pillow compress could reduce hair follicles inhibition or damage caused by chemotherapeutic agents. So, alopecia can be decreased or prevented<sup>92</sup>.

**Temperature Regulation:** Very HC applied to the lumbar region of a healthy female for 10 min increased back Tsk to 41.143.1 °C under HC, followed by decreased rapidly but no changes observed in BT<sup>56</sup>. A case of 20% of 2-degree burns and severe heat stroke followed by temperature rose up to 40.5 °C and patient developed severe multi-organ failure, and critical polyneuropathy was reported after exposure to extreme heat in the sauna for an unknown period<sup>93</sup>.

The most effective method of reducing body core temperature appears to be immersion in iced water, the main predictor of outcome in exertional heatstroke is the duration and degree of hyperthermia where possible patients should be cooled using iced WI, but if it is not possible, combination of other techniques may be used to facilitate rapid cooling<sup>94</sup> such as fan therapy, CWI, iced baths, and evaporative cooling<sup>95</sup>. Wet ice, dry ice, and cryogen packs applied to the skin overlying right triceps sure muscle for 15 min on 10 females decreased mean temp. 12 °C, 9.9 °C, and 7.3 °C, respectively.

None of the modalities produced temperature cooling below 17 °C, and no cooling was demonstrated 1 cm proximal or distal to any modalities after 15 min of application. Significant mean Tsk reduction in between pretreatment rest interval (time 0) and 15 min after removal of modality (time 30) was observed only in wetice. It suggests wetice was significantly more efficient in reducing Tsk than dry ice and cryogen packs<sup>96</sup>.

After exercise at 65% maximal oxygen consumption at ambient temperature of 39 °C until Tre increased to 40 °C produced no difference in cooling rate between WI at 8 °C, 14 °C, and 20 °C but cooling rate was significantly greater during 2 °C, which was almost twice as much as other conditions.

It suggests that 2 °C WI is the most effective treatment for exercise induced hyperthermia<sup>97</sup>. When hyper-thermic individuals are immersed in 2 °C water for approximately 9 min to Tre cooling limit of 38.6 °C negated any risk associated with overcooling<sup>98</sup>. Whole body immersion in moderately cold water is effective cooling maneuver for lowering BT and body heat content of approximately 545 kJ at the end of immersion in the absence of severe physiological responses generally associated with sudden cold stress<sup>99</sup>. Significant less BT variability and an overall higher BT were observed in late preterm infants following tub bathing procedure<sup>100</sup>.

**Precautions:** Individuals with paralysis, frostbite, or other conditions that impair the nerve endings and cause reduced sensation should take hydrotherapy treatments only under the guidance of a trained hydrotherapist. As the temperature sensor cannot be done inside water, there are probable chances of being burnt. People with diabetes and people with hypertension should also consult their healthcare professional.

**Side Effects:** Most forms of hydrotherapy are well tolerated. Patients using herbs or essential oils in their water during treatment can develop dermatitis. These individuals may want to test for allergic sensitization to herbs by performing a skin patch test (*i.e.*, rubbing a small amount of diluted herb on the inside of their elbow and waiting for any irritation or redness).

**CONCLUSION:** Based on available literature, this review suggests that hydrotherapy was widely used to improve immunity and for the management of pain, CHF, MI, chronic obstructive pulmonary diseases, asthma, AS, RA, OA, fibromyalgia syndrome, anorectal disorders, fatigue, anxiety, obesity, hypercholesterolemia, hyperthermia, labor, etc. It produces different effects on various systems of the body depending on the temperature of water and though these effects are scientifically evidence-based, there is lack of evidence for the mechanism on how hydrotherapy improves these diseases, which is one of the limitations of hydrotherapy, and further studies are required to find the mechanism of hydrotherapy on various diseases.

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