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Cautery Looked through the Prisms of Shapes, Types and Methods: A Critical Appraisal

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Traditional cautery (in Arabic Kai) is an ancient practice and used in a variety of diseases with variable efficacy around the world.
Objective: This review aimed to describe critically and synthesise the literature on shapes, types and methods of cautery therapy.
Methods: Electronic searches of four databases (PubMed, MEDLINE, Google Scholar, and OvidSP) using the Boolean operators and keywords were conducted, and some pertinent articles and abstracts (N=10256) were retrieved for extensive appraisal by two independent reviewers. Finally, 90 articles were included in this paper.
Results: Cautery is described in the literature having multiple shapes, types, application marks, precautions and methods and efficacy supported by single case reports and case series with evidence level 4 & 5. Traditional cautery with specific shape and type is used in particular diseases together with a precise procedure, but the underlying mechanism of actions and effects are not well elucidated.

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Conclusion: Cautery a recognised complementary and integrative therapy having different instrument shapes, types, application marks, methods and procedures and anatomical sites is used in many recommended diseases. Cautery is a safe therapy when used cautiously by an expert trained complementary and alternative medicine (CAM) practitioners and trained health professionals around the world. Unlike modern cautery, traditional cautery is mostly recommended as the last choice in the management of difficult-to-treat medico-surgical conditions, but this rule is not followed by health seekers characterised by low education, rural background, parental influence and strong religious convictions. This study calls for continuous cautery training programs directed towards CAM practitioners and conducting rigour basic research and randomised clinical trials for elucidating the underlying mechanism of actions and effects and effectiveness of cautery therapy in various indicated diseases around the world.

Keywords: Traditional cautery; Kai; instrument shapes; types; procedures and application marks.

1. INTRODUCTION

The historic use of traditional cautery therapy is recognised in diverse ancient cultures. However, the earliest reference is found in Surgical Papyrus (1550BC) in Egyptian culture [1-4]. Cautery is reported to have a checkered history and was partially diminished in early 1800 century but revived in late 1800-1900 AD across the world [5]. Several ancient cultures around the world have recognised fire as a powerful remedy, its multiple therapeutic advantages in numerous diseases and worshipped it as their rituals [5,6]. A range of diseases which are treated by cautery therapy include warts, wounds, infections, bleeding, fatigue, stress disorders, gastrointestinal tract (GIT) diseases, fibromyalgia, musculoskeletal pains, eye diseases, ear, nose and throat conditions, neurological conditions, children diseases, women health conditions and diverse cancers [6-10].

1.1 Local Scenario of Cautery Use

The prevalence of cautery therapy is variable globally. In a study from Saudi Arabia, honey was the most used CAM treatment among the participants (39.0%) followed by herbs use (31.8%), bloodletting (13.5%) and cautery (3.4%). Nearly 76.6% CAM users were satisfied with alternative treatments to help control their disease. CAM use was significantly associated with family traditions [11]. In another study from Riyadh city, participants (n=1408) selected randomly reported to use Quranic therapies most (50%), followed by honey (40%), black seed (39%), myrrh (35%), fenugreek (25%), herbs (19%) and cautery (7%) [12]. Females were the largest users of traditional therapies (59% to 8% versus 37% to 5%), and this trend was attributed to the perceived failure of modern treatment and success of CAM, a choice of natural products and long appointment intervals to see a physician [12]. Further details of cautery and other traditional therapies are available here [13]. Overall cautery therapy has been used safely in many diseases with therapeutic benefits in the Eastern world.

1.2 Aim of the Study

This review aimed to critically analyse and synthesise the pertinent literature on multiple bio-clinical perspectives of cautery especially contributions of ancient healers, types, shapes, application marks and sites, mechanisms, case reports and efficacy, care-seeking pathways, treatment of scabs, significance and research. The significance of this study is that it will support and scale up the precise practice of cautery along with a focus both on relevant research and training directed towards patients, traditional healers and health professionals. Furthermore, this review will bridge the knowledge and treatment gap of traditional healers and health professionals along with the application of safety measures, a proper treatment requiring suitable shape, type and aseptic procedures concerning cautery. Another important point is that this critical review of bio-clinical perspectives of cautery from Saudi Arabia will fully update the knowledge of concerned complementary and integrative medicine (CIM) practitioners around the world.

2. METHODS

2.1 Search Strategy

The relevant literature published in English prior to 2018 was searched in PubMed, MEDLINE, Google Scholar, and OvidSP databases. The Boolean operators and keywords used in multiple

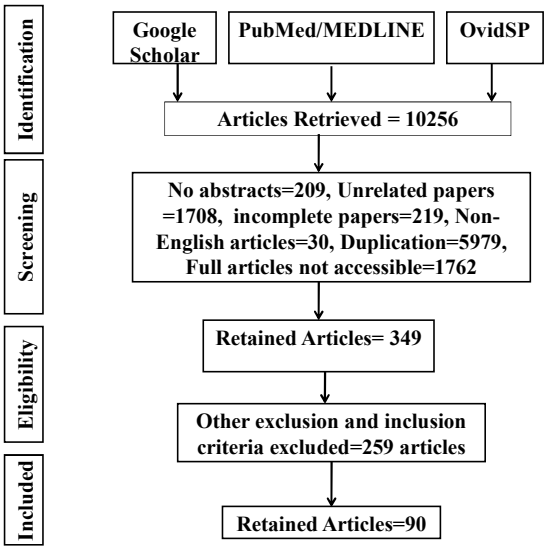


Fig. 1. The flowchart of selected articles

electronic searches were "Cautery AND cauterization sites OR Kaiy OR Amal-i-Kaiyy OR ancient healers OR types OR shapes OR application marks OR methods OR precautions OR mechanism of action OR research OR modern cautery OR reasons for seeking cautery OR case reports OR use of catheter OR efficacy OR significance". The search strategy and the keywords were modified as appropriate according to the searched database. Also, references included in full-text articles, some traditional medicine (cautery) books and treatises on cautery were reviewed for inclusion in this review.

2.2 Search Results

More than 10256 articles were retrieved and reviewed by two independent researchers (NAQ & SMS). Our focus was on full articles describing multiple clinical perspectives of cautery therapy. However, we also reviewed articles that gave specific descriptions of ancient contributors to the development of cautery, mechanisms of action, case reports and efficacy, seeking pathways to cautery, its significance, sites of cauterisation, types, shapes, application marks, procedures and precautions in various diseases and modern cautery. These brief snapshots were reviewed critically, and their important contents were incorporated in this review. The additional inclusion criteria were free to access to full articles, papers containing aforesaid salient detailed related to multiple perspectives of cautery therapy. Furthermore, all types of studies, such as systematic reviews and meta-analyses, randomised clinical trials, prospective and retrospective observational studies, case series and single case reports along with professorial opinions were included in this narrative review. After removal of duplications (n=5979), unrelated articles (n=1708), no abstract (n=209), non-English articles (n=30), incomplete papers (n=219) and full articles not accessible (n=1762), only 349 papers were left for further assessment and eligibility. A number of articles (n=259) were excluded because of duplications of clinical information (n=194) and containing irrelevant information (n=65). Finally, both reviewers agreed to include 90 published studies, including some traditional books on cautery in the present narrative review. Finally, the total number of included studies is 90 (Fig. 1).

3. RESULTS

3.1 Contributions of Ancient Healers

There were progressive improvements in cautery therapy since ancient times and many physicians and surgeons contributed to this accomplishment. Hippocrates (Buqrat) around the 4th century BC recommended the use of cautery in many health conditions including haemorrhoids, abscess, dropsy, enlarged lymph nodes in plague, trachoma and sciatica [1,14-16]. Later Albucasis, Marcus Aurelius Seven'nus, and

Ambroise Parry, and Percy in his book (Pyrotechnia Chirurgicale) supported the use of fire and cautery in various diseases with good benefits [9]. Aulus Cornelius Celsus significantly contributed to the achievements of cautery, and he advised its use in the management of gangrene, fistulas, inward grown eyelashes (Trichiasis), droopy eyelids, and discharge from eyes, blood and pus exuding ulcers. Celsus also introduced a cauterising knife in the treatment of abscess [17,18].

In the Indian System of Medicine, Sushruta (800 BC) used Agni (means fire) therapy (called Agnikarma therapy) for cauterising the affected veins and tendons for various body ailments [1,19-21]. Agnikarma is still used in various health conditions in diverse cultures of India. Healing practitioners of Traditional Chinese Medicine (TCM) also practised cautery (moxibustion) for treating many diseases since antiquity. Later on, moxibustion (heating therapy using Moxa/Mugwort) disseminated from China to other neighbouring countries including Mongolia. The ancient Arab cautery is considered similar to moxibustion whereby moxa - a dried herb - is burned, either directly on the skin, or just above the skin, over specific acupuncture points related to a medical condition [5,6]. There is indirect moxibustion which uses moxa sticks resembling large cigars or incense sticks. Ancient Chinese teachings advise that the formation of a blister by moxibustion is essential for healing to take place in any disease [7]. Arab world healers also used this important religious therapy (cautery) for many medico-surgical health conditions including controlling bleeding [7] before and after arising Islam. Arab physician Hunain Ibne Ishāq contributed to cautery by writing a book ("Ikhtiyār-ul-Advia Al Muharriqā") that contained various herbs and non-herbal drugs used as cauterising agents in various diseases [1]. In the same vein, Ibn Sina (980-1037 AD) and Abul Qasim Al Zahrawi (Albucasis d. 1013 AD) in their famous books (Kitab al-Qanoon-The Canon & Al-Tasrif li-man 'ajaza' an al-ta'lif) recommended practice of cautery in health conditions. Notably, primitive cautery was mainly practised by Bedouins and laymen healers, but Moslem physicians had better scientific knowledge of human body and cautery therapy. Further detailed historical descriptions of aforesaid three Arab authors and their contributions to cautery therapy are provided here [7,22]. The editor of the book (Al-Tasrif li-man 'ajaza' an al-ta'lif by Zahrawi) stated that "The hot iron was one of the earliest and most popular means of treatment. Hippocrates speaks of it as a well-established way of opening a liver abscess; and every later writer gives plenty of room to the subject of the cautery therapy" [7]. Qasim Zahrawi comprehensively described cautery including its possible risks and illustrated diagrams of organs affected by diseases and necessary instrument for each disease. For example, for the treatment of ptosis, he devised crescent or semi-circular shaped instruments. Ibn Sina in *The Canon of Medicine* reported a number of advantages of cauterisation including prevention of destructive lesion, dissemination, rectification of cold temperament, breaking up putrefactive matters embedded in tissue, removing dead flesh and restraining bleeding along with a suggestion to healers not to expose nerves, fascia or ligaments. For controlling haemorrhage, immense heat is required to produce a firm, thick eschar which will not readily come off [23]. Unani scholars equally contributed to the development and sustainment of cautery therapy. Ibn al-Qaf Masiḫi (1233-1286 AD) and Ali Ibn Abbas Majusi (930-994 AD) and others practised and propagated cautery during ancient times. Furthermore, the Unani ancient surgeons provided antiseptic guidelines regarding cautery [14]. In sum, cautery therapy is developed progressively and sustained over centuries mainly attributed to the continuing efforts of traditional healers, professional practitioners and religious scholars of the Eastern world.

3.2 Defining Principles of Cautery

Cautery is termed as Amal-i-Kaiyy, Kai or wasm in Muslim world but elsewhere as cauterizare, kauteriazein, or cauterisation [1,14]. Kai is derived from Unani word Kaiein which means to burn [1]. Agnikarma (in traditional Indian system) and moxibustion (in Traditional Chinese Medicine) and Amal-i-Kaiyy (in Persia) reflect "burning or branding with a hot iron", "burning or branding iron", and "I burn" [24-26]. Amal-i-Kaiyy is the practice of burning the affected flesh, stopping bleeding or, removing unwanted skin or creating an entry point into the skin. Cautery is categorized under Ilaj-bit-Tadbir (regimental therapy) [1,14,27-29]. In another way, cautery is the application of hot metal or caustic drug over the affected site for treatment so that the heat in effect, may correct the deranged condition of the affected area [27]. In sum, cautery is defined in several ways since ancient times and was used for several purposes, such as a 'counter-irritant', or a haemostatic, or a bloodless knife, or a means of destroying tumors or to dry the

excessive fluid, to stop bleeding, and to remove the putrefied flesh [1,30].

3.3 Types of Cautery

Many types of cautery were developed by ancient healers for treating a variety of specific diseases in diverse cultures of the world. These cautery forms are based on materials used in heating the cautery instrument; fire cautery (heat by fire), oil cautery (heat by boiled oil), acidic and alkali cautery (heat by corrosive materials), herbal cautery (burn by herbal drugs), cupping-fire cautery (combined type) and currently electric current - electrocautery [1,5-7,10,14, 24,25,27]. Also, "Thermie" therapy a folk remedy in Japan has been used to relieve pain, common cold, ileus and its adverse effect include 'Thermie Dermatosis' characterised by pigmented lesions [31]. Traditional cautery, i.e., treatment by fire is a traditional practice by healers, and its use dates back to ancient times, possibly time after the discovery of fire [1]. Fire and cautery have an intangible relationship, and a lot is written about the therapeutic power of fire. Goldberg, an influential physician emphasised on the healing power of herbs, songs, prayers and fire [32]. Chemical cautery uses corrosive (medicinal) drugs or acidic or alkali materials for burning diseased body tissue [1,10]. Herbal cautery uses herbs to destroy the affected tissue on the body surface [5,7]. In Unani medicine, Amal-i-Kaiyy uses Kāvvi Mādda (corrosive matter), or red-hot metal rod, or electric current to burn a specific afflicted part of the body for therapeutic purposes. The instruments used for Amal-i-Kaiyy are called Mikwāt (Cautery), and the place of the body which is used for cauterisation is called Kaiyya. The performer of Amal-i-Kaiyy is a Kawwa (Cauterist) [1].

Actual cautery means the metal device heated in a flame and then applied to the damaged tissue [9,14,27]. Another form of cautery is the combination of cupping or Hijamah with cautery especially used for opening and sucking infected abscess followed by cauterisation of the bare vesicle [27]. This technique is underused at present because of increased cost, patient choice, and practitioners' skills. In specific cases like in bleed of the posterior nose, cautery is combined with cupping for better outcome [33]. Branding is another form of cautery that is used in humans, either recreational or forced purposes [32]. Silver nitrate cautery is used in the nosebleeds with good outcome in 13% to 54% of patients [34]. Other olden times cautery instruments include fire-drill and localised cranial vault burning [35] for the treatment of head tumours and hot lance-for cauterisation of injured vessels for controlling bleeding [36]. In short, cautery is known by different names corresponding to its types. Currently, traditional cautery with better techniques and procedures including aseptic means is used by healers and professionals for the treatment of a variety of diseases across the world [5,6].

3.4 Modern Cautery

Currently, many forms of cautery and cautery devices are used in medical sciences which are electrocautery- or thermal cautery-unipolar and bipolar [37] (Fig. 2), chemical cautery - uses silver nitrate, trichloroacetic acid and cantharidin, and electrosurgery - electrocoagulation, electrofulguration, electrodesiccation, radiofrequency and electrosection [38,39]. Now electrocautery has been widely used for cauterisation [40]. Radiofrequency is used for removing moles, skin tags, warts, seborrhoeic kerratosis called wisdom spots, syringoma-harmless tumours within sweat glands, facial telangiectasia, i.e., thread veins, and resurfacing chicken pox and acne scars, perioral lines, and rhinophyma, i.e., the bulbous appearance of the nose due to rosacea in men. Comprehensive details of electrocautery and other related advanced devices used in various local or systemic diseases are available here [38,39]. Furthermore, a comprehensive paper on modern cautery is forthcoming soon. Overall cautery is an authentic safe therapy in the armamentarium of complementary and integrative medicine around the world.

Fig. 2. Electrocautery [37]

3.5 Cautery Shapes

Since ancient times, cauteries with different shapes and tips (Fig. 3) are developed, and are reported to be used in various diseases [1,10,41-43]; however, each one for a specific disease and their details are summarised in Table 1.

Table 1. Shapes of cautery and corresponding recommended condition

S. no.	Shape of cautery	Used in recommended conditions
1.	Olive-shaped	Disease of phlegm, epilepsy, coxalgia, gout, sciatica, arterial bleeding
2.	Claviform-shaped	An acute migraine, nasal diseases, toothache, lungs diseases, cough, bronchial asthma, hoarseness of voice, stomach diseases, dislocation of joint, ascitis, anal fissure, diseases of kidney, urinary bladder &uterus, lumbago, hernia, boils
3.	Knife-shaped	Chronic migraine, facial paralysis, sciatica
4.	Crescent-shaped	Ptosis, entropion, and trichiasis
5.	Hollow-cautery	Bleeding/oozing ulcers, scrofulous tumors (enlarged neck lymph nodes)*
6.	Two-Prongs	Dislocation of shoulder, diseases of spleen
7.	Three-Prongs	Diseases of spleen
8	Solid- cautery	Diseases of joints
9.	Saw-shaped	Dislocation of shoulder
10.	Bowel-shaped	Coxalgia, sciatica
11.	Probe-shaped	After the operation of hemorrhoid to prevent fistula formation.
12.	Triangular- shaped	Hernia
13.	Punctate-shaped	Earache, low backache, gout, sprain, scoliosis
14.	Ring-shaped	Diseases of stomach, cancer
15.	Lenticular-shaped	Ulcers including oral, and hernia,
16.	Circular-shaped	Disc prolapse

**Tuberculous in nature*

Fig. 3. Traditional cautery (Wasm nail) [44]

3.6 Materials Used for Cautery

Different materials-metals and non-metals- were used progressively in the development of cautery since olden times. Unani scholars preferred gold for cauterization [40,45,46]. Razi in his Famous book 'Al-Hawi' stated that the use of cautery made of gold is better for the crushed wound. Silver or copper made cautery is preferred for the treatment of non-healing ulcers and different malignant growths. Razi quoted the statement of Jalinoos in Al-Hawi "gold is best in cautery and does not cause vesicle formation and heal rapidly" [40]. Overall iron cautery is most commonly used in numerous diseases since historic times, but other cauteries made of different materials such as medicinal herbs, chemicals (acidic and alkali), drugs and wood were also used for the purpose of cauterisation.

3.7 Why People Seek Cautery Therapy

It is believed that certain medical and surgical problems were not treated by available means in olden days and this is also true at present time. This trend drives patients to seek different modes of therapies. For example, parents supported by other senior close relatives take their children to first consult traditional practitioners for cautery therapy or vice-versa [47,48]. The parental belief system in folk therapy is an equally important reason to consult CAM professionals for cautery treatment [49]. More often parents also seek cautery therapy from traditional practitioners for their own ailments not cured by modern medicine. However, the parental understanding of their children diagnosis is unsurprisingly unscientific and rarely matches with hospital diagnostic formulation [47]. Patients with chronic diseases including cancers often search for integrative medicine treatment including cautery therapy [5,6]. Other factors underpinning traditional health seeking pathways include increasing use of CAM and integrative medicine therapies globally, cost-effectiveness, easy access, efficacy, no appointment required, and no waiting time, preserving once culture, values and beliefs, gender, socioeconomic status, rural background, illiteracy and low adverse consequences when cautery and other CAM therapies are used in indicated patients by trained and experienced CAM practitioners

[1,2,5,6,50]. Overall health seeking pathways are manifolds addressing biopsychosocial and cultural needs of children and adolescents, adults and the older population living with a variety of ailments [51-56] and their caregivers including family members. Parents who are less educated (70%) behave like an expert guide to their kids for cauterisation. Surprisingly mother or father tends to cauterise their children [47]. In sum, though cautery is recommended for the treatment of resistant cases since ancient times, yet its use in simple diseases by traditional healers is commonplace in villages.

3.8 Anatomy of Skin-Sites for Cauterisation

Skin, an important anatomical component of the integumentary system, is the largest organ of the body because of its surface area. We describe the anatomy of skin because it is of high importance for traditional and CAM practitioners of cautery. The skin consists of epidermis, dermis and subcutis (Fig. 4). Skin performs several important functions which are: protecting the internal organs from diseases, regulating the body temperature, moisture retention, removal of toxins and vitamin D production and providing a sense of touch [57]. Cautery practitioners need to know basic anatomical structures of skin because of its many implications in cautery practice. Concerning the structure of skin, the epidermis made up of keratinocytes, and melanocyte cells are the outermost layer which as a barrier between internal body parts and the external milieu prevents the entry of harmful foreign agents into the body. Melanocytes that contain melanin determine the colour of the skin. Lying beneath the epidermis is the dermis containing hair follicles, sweat and sebaceous glands, nerve endings, tiny blood capillaries and elastin and collagen proteins. Small blood capillaries and nerve endings provide a constant supply of oxygen and nutrients to the skin cells and touch sensations, respectively. The innermost layer of the skin is subcutis containing fat that acts as an energy store and insulator.

Cautery needs to be applied superficially without injuring nerve endings and tiny capillaries as far as possible (cutaneous cautery). However, this fundamental principle of cauterisation does not work at all times. If the most painful area in which nerves and capillaries are also affected and caged in an infected fluid, such as chronic wounds and ulcers, the cautery may be applied slightly deeper. However, it is much better to curettage the wound first and then applies cautery to burn the bleeding capillaries and to remove infected fluid and muscles. It is wise to know that there are many areas where cautery is done other than skin (deeper cautery) based on the nature of the ailments [45,46]. While performing cautery therapy, the practitioner must never puncture any internal organ. We have comprehensively described the indications and sites of cauterisation elsewhere [5,6], and we suggest that CAM practitioners must choose the exact site for cauterisation in a particular illness.

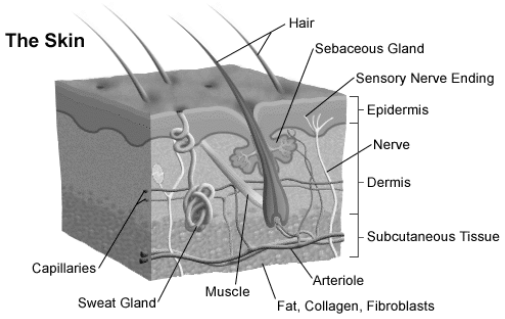


Fig. 4. Anatomical structure of skin [57]

3.9 Cautery Techniques and Procedures

There are many procedures concerning cautery use in specific health conditions. Prehistoric man discovered a variety of methods and medicaments for treating numerous types of wounds and diseases, though it is difficult to infer how such methods were developed at that time. Some of these wound healing techniques and medicinal therapies included various minerals such as clay, herbs and vegetables such as honey and animal materials such as egg white and milk, and cautery for stopping bleeding [58]. Cautery was considered as the last choice to burn the bleeding vessels in olden days. According to Forrest, cautery was substituted for suture in the Middle Ages [58]. Ibne Sina discussed in detail about the procedures and techniques of Amal-i-Kaiyy in his treatise "*Al-Qānoon fit Tibb*" [1]. Other Unani eminent physicians also documented their experiences about cautery and its procedures in their respective writings [14]. Maunoir also wrote about fire and cautery, its techniques, procedures, effectiveness in difficult-to-treat cases, and immensely helped in the revival of cautery practice [9].

For stopping haemorrhage, Celsus [First century AD] reported a procedure; if hot iron applications

are ineffective against the profuse bleeding, the vessels which are pouring out blood are to be seized, and round the wounded spot they are to be tied in two places and cut across between...." When circumstances do not even admit of this, the vessels can be burnt with red-hot iron" [59]. Aulus Cornelius Celsus [17,18] guided that "the place (of gangrene) should be burnt by cautery until no more Khilt (humour) escapes from it". In the case of hemorrhage, cauterisation is to be done extensively at an affected area that may cause high-grade fever. Cauterisation will be considered ineffective if the fever does not develop. Notably thick plaques with fever signify congestion of blood in the affected part which signifies an unsafe condition [40]. Therefore, extremely hot cautery instrument needs to be applied in hemorrhage to produce a very thick clot [40,46]. Hippocrates stated in'Kitabul Al-Ahwiya Wal-Baldaan' as quoted by Razi in"Al-Hawi" cauterisation is not advisable in extreme hot and cold weather [40].

The second-century physician Jālinūs (Galen, 131–199AD) described in his treatise "On Tumors Against Nature" the process of cauterisation for burning the roots of a tumour that is called Karkinos or karkinoma, which was infrequently associated with negative results including bleeding [1,60,61]. Buqrat (Hippocrates) around the 4th century BC also advised a technique in which "heat the iron rod red-hot for burning haemorrhoids until it becomes dried up and no part may be left behind". Buqrat (Hippocrates) also suggested the use of cautery for treating the abscess either by making a surgical incision or opening by heated cautery to let the infected material (pus) comes out or burn it. Buqrat also suggested the management of dropsies by opening fluid build-up under the skin by cautery therapy, in addition to treatment of sciatica where the bone has come out of its socket [1,10,14,59].

The traditional healers of Muslim world utilised cautery made of mostly metal sticks or iron nails. The cautery instrument is about 20 cm long which is either bent at the top or narrowed to a point [Fig. 2]. The procedure is like this: the stick is heated over hot charcoal until it becomes as red (or white) as the hot charcoal [7]. Then, the practitioner places the hot metal tip over a specified, most painful location over the affected skin for a few seconds depending on complaints, disease types, sex and age of the patient [29,62]. Iwasaki described the technique of "Thermie therapy" which is rubbing the skin with special instruments in Japanese culture [31].

The number of heated cautery application in one session varies between one to seven and even more, and this is because of several factors, such as age, sex, nature, types and severity of disease and complaints and sociocultural habits. Superficial lesions, for example, a boil will require few numbers of cautery application and results in superficial marks. However chronic deeper ulcers will require heated cautery multiple times in several sessions often followed by gross big scars (Fig. 5) [29,62]. In case non-healing deep ulcers or sub-dermal lumps, the cautery instrument should be conical in shape, and to be passed to the area for cauterisation. Rub the area intended to cauterise with rough cloths so that burned material sloughed off. Then cauterise the area till it reached to muscles or more up to bones if also involved [46].

According to Albinali, cautery therapy is also used at different places away from the affected internal organs. For example jaundice due to liver disease, the cautery is applied to the left hand. If the patient complains of chest pain with shortness of breath, which could be angina or myocardial infarction or embolism, cautery is applied to the skin overlying the 4th and 5th anterior or posterior ribs on the same side of the pain [7]. The patient is usually instructed to avoid wetting the burnt area for a few days after the procedure. Similarly, the patient is also advised not to use perfumes or eat food that produces gut gases [7]. For sciatica, it could be from one to 17 cautery burns at different locations. In a qualitative study, Ghazanfar specified more details of cautery types, techniques, indications, specific sites of application on the body corresponding to the specific diseases [29].

Children are often exposed to multiple cautery sessions with increasing number of cautery applications because of their complicated, neurodevelopmental diseases [47,48]. Children were cauterised very frequently, from birth to year 1 (26 times) to 2 to 5 years (5 times). The most important cautery sites included anterior chest wall for respiratory diseases and abdomen and abdominal wall around umbilicus for gastrointestinal disorders. Furthermore, the numbers of superficial cauterisation more than 100 times were done on different areas concerning neurological diseases, splenomegaly, liver disease, and kidney ailments with generalised oedema [47].

In the Arab world, cloth or palm leaves or boiling oil instead of heated metal were rarely used for cauterisation [7,63]. The boiled oil was mainly used to cauterise bleeding vessels from cut limbs especially right side, which was a legal punishment for thieves, especially in the Arabian Peninsula. Now it is nearly extinct including from Saudi Arabia. Unlike ancient practitioners who suggested spring is the best time for cautery application, Al-Zahrawi differed and recommended that cautery could be used at all times [7,23]. Furthermore, Al-Zahrawi criticised the earliest physicians' belief that once a patient treated with cautery never relapse or complain of old or new symptoms. Hence, cautery is associated with permanent cure only in some diseases, mostly skin diseases. Al-Zahrawi developed special cautery instruments for individual eye diseases, acute migraine attacks and lung medical conditions [7,23]. Notably, Nikhat and Fazil have described comprehensively specific procedures of cauterisation in various diseases as recommended by ancient healers including Persian, Arab and Greek-Roman practitioners [14]. However, the advent of ligatures and tourniquets to control bleeding and the use of antiseptic measures in infected wounds helped decline clinical applications of cautery. Modern cautery developed with the invention of electrical diathermy. This form of cautery produces heat in a controlled way [64]. This technique became a very common practice to date for stopping bleeding during surgery. In sum, there have been continuing developments in cautery instruments and procedures and its use in diverse diseases since ancient times, and yet traditional cautery is used in some parts of the world because of multiple dynamic reasons including sociocultural values and religious significance.

3.10 Cautery Precautions

All treatment interventions need certain precautions and guidelines for their better use and efficacy along with minimal adverse effects. Like medico-surgical professionals, CAM practitioners must take all necessary precautions while performing cauterisation concerning a specific disease. Cauterisation should be done superficially on the affected skin or skin overlying a diseased organ. Deeper cauterisation is needed only when putrefied or dead material involves tissues other than skin-such as muscles. Cautery application should not reach the spinal cord and brain in any way. Cautery should also avoid burning ligaments, tendons and bones [46]. Traditional healers must avoid injuring or burning normal arteries, veins, lymphatic vessels, and nerves whenever possible. Deeper cauterization of skin overlying diseased organs should be done rarely and only in indicated cases, because such practices, may be wrong at first place, and tends to cause disfigurement forever due to sizable skin marks [65] and other serious to fatal complications including tubal pregnancy, spread of viral hepatitis and HIV infections, and death [50,66]. Notably, several adverse effects of traditional cautery observed in the distant past were attributed to multiple reasons: no use of aseptic methods, serious diseases, unqualified practitioners and wrong place for cauterisation. Like in surgical practice, traditional cautery practitioners must use antiseptic measures pre-, peri- and post- cauterisation [67,68] and select specific, most painful or afflicted place for cauterisation in a particular systemic or local disease [69]. Modern cautery and body piercing similar to cautery are associated with serious adverse effects and complications [70-74], which are preventable if necessary steps, especially regarding aseptic means along with appropriate indications, are taken into consideration.

With special reference to some clinical cases, the practitioners must avoid accidental burns using special cautery shapes, catheter, insulating materials, techniques and precautions, and these diseases may relate to nose, ear, rectum, and uterus [40,45,46,75,76]. In epistaxis, the posterior nasal passage of the nose presents a greater challenge to the cautery practitioners compared to anterior bleeding points, and standard cautery techniques limit the simultaneous use of other equipment in the narrow posterior nose. However, a novel device combines suction, cautery stick and sheath for insulation in one single-handed instrument for cauterising bleeding in posterior nose passage enables successful treatment by a single CAM practitioner who is even not skilled [33,40,45,46]. By the same token, cauterization of breast cancer needs special care, precautions and consideration of several factors to avoid the spread of cancer cells to axilla lymph nodes [44]. Other related details of traditional healing practices are found here [77,78]. In a nutshell, CAM practitioners should take maximum precautions when using cautery therapy in a patient with the systemic or local disease to achieve better results and prevent its adverse effects and complications.

3.11 Possible Mechanisms

The ancient healers from all cultures and societies provided some primitive insights into the mechanisms of action concerning cautery therapy. Nonetheless, healers were short of explaining how cautery works to bring about clinical improvement among patients with medical illnesses. However certain postulations were described; humoral theory, stagnation and qi energy, imbalance between Yin and Chang, religious and social belief system, distraction model, counter-irritation concept, placebo effect and self-remission theory (self-limiting) since antiquity. But these theories were rarely subjected to scientific rigorous investigations. According to Maunoir, the practitioners of 18-19th century believed that the putrefying principle or venom (detoxifying theory) was extracted with the infected fluids that were dried up by the hot cautery. Cauterists thought likewise that the separation of the sloughs was assisted by cauterisation and they imagined that the life of the part was quickened, by drawing the spirits to it and freeing it of all humid materials [9]. Apparently, earlier views regarding cautery mechanisms were a mix of detoxification, removal of putrefying tissue, drying up the affected part, rejuvenation of leftover tissue, and spiritual beliefs. Some of these theories including detoxification model, pain reduction postulation and humour balance resonate action mechanisms of cupping therapy [79]. It is a challenging task to show precise contributions or variance of each theory to therapeutic benefits of cautery in individual disease. We presume that presently more than one biological or psychosocial mechanism tends to operate underlying its effectiveness in diverse ailments and wellbeing of people with no disease.

There are other mechanisms of action concerning cautery. For example, children with chronic debilitating diseases and self-remitting ailments get cauterised repeatedly due to parental beliefs and hope (theory of hope) that child will improve with cautery. In diseases with a self-remitting course such as viral throat infection, cutaneous cautery works like analgesics to reduce a sore throat and pain through humoral and counter-irritant effects. According to this study, heat leads to coagulation, drying and sterilisation, and, thus, fire and heat have therapeutic worth in various ailments [47]. Overall, cautery works through multiple mechanisms which need extensive research in future for collecting evidence-based data. From the perspective of experimental studies, veterinary doctors used herbs and cautery to treat many animal diseases including infections and inflammatory conditions caused by various microorganisms [80]. In a study, conversely, cautery was found to depress the immune system and, hence, increases animals' susceptibility for infections [43]. Overall, the research avenue of the underlying mechanism of actions and effects concerning cautery therapy is challenging and needs concerted global efforts of researchers to explore them in the future.

3.12 Case Reports and Effectiveness

Cautery is an integral part of CAM therapies. Evidently, it is because of its cultural values and efficacy in many diseases [14]. Also, ancient healers and now CAM practitioners narrated terrific clinical case series and single case reports with therapeutic benefits, and better outcome in various diseases. Albinali's reflections concerning cautery are very authentic. According to Albinali, his father witnessed a dramatic incident about Sultan AlMannai who was about 60 years old when he had severe chest pain, dyspnea, and sweating while walking with him. His father sent him to a local traditional doctor who cauterised Sultan over the xiphoid area and left lower ribs using charcoal heated metal sticks. Sultan became calm and slept for one hour. When he woke up, he had no more chest pain. It was a temporary therapeutic benefit as this patient had recurrent pain subsequently and died later [7]. Albinali's mother had several cauteries at different times for several symptoms including at one time for dizziness, nausea and vomiting and sleep disturbance. She was cauterised on the top of her head. She fell asleep immediately after the procedure and all her symptoms improved after three days [7].

According to Hana, one of her patients reported: "The intense heat pain of cautery made the original pain seemed less . . . while the excitement about the impending cure made me forget the cautery pain fast" [63]. Another patient stated: "I was semi-crippled with sciatica. I could not stand to pray. Medical doctors treated me for months … but when my father cauterised me . . . as soon as I felt the cautery pain . . . I stood up and ran" [63].

The report of several cases treated by Maunoir using cautery is highly authentic [9]. This section will not be completed without briefly describing those cases. Maunoir treated a chronic case of

Scrofula (cervical tuberculous lymphadenitis caused by tubercular infection of the neck lymph glands) who initially used a dozen of traditional treatment including silver nitrate, exercise, dietary supplements and artificial sea-bath without any benefit. Then Maunoir used actual cautery and burned the glandular ulcers one by one followed by sloughing and cicatrisation after two cautery treatments, and the patient improved completely within 6 months. The second case effectively treated by Maunoir was of chronic sinuous ulcers situated between skin and muscles of the left thigh. This adult patient initially treated by half a dozen traditional interventions but in vain. However, the multiple applications of olive-shaped cautery resulted in complete improvement of all sinuous ulcers and fistulae. Another case unsuccessfully treated by various remedies including carious teeth extraction was of a scirrhous tumour, which caused enlargement of the inner lining of cheeks and gums but not related to a fungus or scorbutic aetiology. The patient was prescribed olive-shaped actual cautery three times, and each time with twenty applications at an interval of two weeks resulted in sloughing and suppuration followed by complete recovery. The 4th case concerning a surgeon with localised chronic ulcer of lower lip earlier treated with best remedies but no benefit. Maunoir applied deep cauterisation to the ulcer followed by another cauterisation of its hard part, twelve days apart with sloughing and complete cure. The 5th bedridden case was of rheumatism involving lumber region extending to the sacrum and spinal area with the weakness of both legs treated by Maunoir using cautery applied to six sites at lumber region resulting in sloughing and recovering strength in both legs. This patient developed swelling in left iliac fossa with fluctuation, which tracked down to leg muscles near trochanter. Maunoir applied pressure below the swelling and decided not to operate it. The swelling improved within two months but left with a hard lump near little trochanter not adversely affecting his walking. No symptom of rheumatism recurred till his death. Maunoir partially treated using fire a female patient of fungus haematodes with bleeding ulcers involving her shoulder and an independent tumour. Furthermore, Maunoir treated a series of cases bitten by a mad dog with heated actual cautery applied on wounds with complete success. Maunoir also treated successfully a series of cases with caries of teeth with fire. Maunoir suggested that white heated iron cautery needs to be used carefully minimising the damage to healthy tissue. Overall these difficult patients effectively treated by Maunoir in late 18th and 19th centuries using cauterisation provided evidenced-based data (evidence level 4 & 5) about iron cautery in various diseases, and iron cautery is now used mostly as complementary therapy in resistant cases not responding to modern treatments [7,81]. Although case studies are important researches, this review calls for conducting comparative studies of cautery therapy in various diseases in the future.

3.13 Cautery Application Shapes (Marks)

Application shapes and size of cauterisation marks may differ across the board. According to Ghazanfar, iron cautery is applied on the affected and most painful skin or site in three shapes: a plus (+); (b) in a straight line, approximately 2 cm in length (-); and (c) in a sign of period [or point or full stop] (.). The last two marks are used more commonly [29]. However, cautery application shape and size may differ from the above classification (Fig. 5a&b) because of nature of diseases, chronicity and number of treatment sessions done on a patient and healers' experience. Shapes of cautery applications and corresponding diseases and conditions are summarised in Table 2.

3.14 Use of Catheter

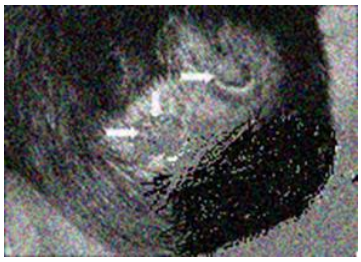
Some diseases require the simultaneous use of white-hot cautery and catheter for safely reaching the site for cauterisation and protecting the healthy tissue in the passage. Razi in 'Al-Hawi' instructed to insert catheter first in hollow organs like nose, mouth, uterus and anus. Then allow passage of instrument down the way through the catheter to cauterise the targeted area of the organ [40,46]. One of modern technologies such as endoscopically guided cauterisation is just an advancement relating to the concept of Razi. He also stated that wide catheter should be used to cauterise lower palate [40]. Razi also advised wrapping cold, wet cotton around the catheter. This prevents the catheter to warm up and, hence, does not affect adversely the non-intended part. Ibne Sina in 'Al-Qanoon' advised to apply abrak (mica), gaeru dipped in vinegar (sirkah) on catheter (qalib) first. Afterward, a cloth has to be wrapped around and then chilled with rose (Gulab khoora) and then inserted into the intended area of cauterisation [46]. In sum, proper size catheter needs to be used for cauterising diseases not easily accessible to cautery instruments.

Table 2. Cautery (Wasm) application shapes used for diverse diseases

Diseases and conditions	*Wasm* application shape
Abnormal growth of child	As (b) (-), on the back between the shoulders
Anterior fontanelle (infants)	As (c) (.), along the splits on the forehead
Boils on the head or elsewhere	As (b) (-), on the blood vessel near to the boil
Bronchitis, with severe cough and phlegm	As (b) (-), three on the right side of the chest and two at the same level at the back
Crying baby, colic	As (c) (.), on the right and left of the umbilicus
Diarrhoea; diarrhoea with blood	As (b) (-), below the anus; as(c) (.), above and below and the right side of the umbilicus
Earache with pus and to cure snoring	As (b) (-), in front of both ears
Eye problems;	As (b) (-), on the upper part of the forehead;
Weak eyesight	As (c) (.), with a needle on top of the nose
Headache	As (b) (-), on the forehead
Headache with pain spreading to the face and nose	As (c) (.), near the tear duct, the patient's eyes are covered with a paste made from dates
Hernia	As (b) (-), above and below the place of hernia or on the veins right or left of the hernia
Inflammation of the testis	As (c) (.), on the scrotum
Inflammation of the throat	As (b) (-), on the back about the level of the second vertebra
Jaundice (yellow) with eyes, face and tongue yellow with weakness, loss of weight and difficulty in urination and white jaundice with eyes, face and tongue white and red urine	As (b) (-), on the upper arms, ca. 10 cm above elbow on the upper side or on top of the head for males and below the breast for females
Meningitis with pain in the head	As (b) (-), on the abdomen
Mumps	As (c) (.), with a needle on the swelling
Pain in the back and thorax muscles	As (b) (-), at the site of the pain
Pain in chest with difficult breathing and fever	As (c) (.), two on the chest, one on the forehead and one at the back
Pain, abdominal with cramps or stomach-ache	As (c) (.), above and below the umbilicus
Pain in the lower limbs	As (c) (.), ca. 10 cm above the left foot or below the ankle with the patient standing
Pain in the upper limbs	As (b) (-), on the shoulder and arm
Pain in the spleen	As (b) (-), on the site of the pain
Pain in the lower back after miscarriage or childbirth	As (b) (-), on the right lumbar region
Pain in the spine region	As (c) (.), on the back, at about the level of the 6th thoracic vertebra
Paralysis or weak muscles of limbs and face	As (b) (-), on joints and along the backbone; for facial paralysis on the back of the head or the hand between the thumb and index finger and on the outer side of both feet
Pimples with pus	As (c) (.), on the back at the level of the second vertebra or tip of the nose
Prolapse of the uterus	As (c) (.), on the coccyx
Toothache; tooth decay, carries	As (b) (-), for pain in the lower jaw was under the lobe of the same ear, for pain in the upper jaw was on the head above the ear on the side of the pain, for tooth decay a piece off rank incense is placed on the bad tooth and burned using a hot needle

Diseases and conditions	*Wasm* application shape
Trachoma	As (b) (-), on the forehead
Weakness	As (b) (-), on the forehead between the eyes
Venereal diseases for males; rashes on penis or blood or pain during urination	As (b) (-), on the big toe of both feet or as (c) (-) on the glans .
Whooping cough, chest pains, tuberculosis, pneumonia	As (b) (-), at the location of the pain or between the ribs
Vomiting	As (c) (.), below the sternum

(a)



(b)

Fig. 5a&b. Cautery shape-marks on the abdomen and the occipital region [50,82]

3.15 Management of Cautery Burn Scab

Scab is formed on the skin following a burn or cauterisation of the skin, and it may be dry and wet or oozing. Ancient healers advised effective traditional methods for the management of scab from cautery burn. Razi advised the local application of paste, made up from wheat flour, water and olive oil (Roghan-e-Zetoon) to slough off the burn scab. In addition, Razi also advised application of Marham basliqoon after grinding with Apium Graveolens Linn (Persian name-karaf or Indian name - ajwan-ka-patta) with antimicrobial activity [40,60,83], or Doronicum Hookeri (in Persian- Daronaj aqrabi & in English "Leopard's bane") with antibacterial property [84] considered highly effective in scab sloughing [40,60]. Munbit-ul-Leham adviyah, i.e., drugs which promote scabbing were also recognized in olden times: Irsa (Iris ensata root, or Japanese iris), Zarawand (Curcuma zedory or white turmeric), shehad (bee honey), and Ghee (clarified butter). A paste made with grinding the mooli (Raphanus sativus, radish) with vinegar (sirkah) and its local application eradicates the after-effect of cauterisation including scabs [27]. Currently, the biological stages of wound healing have been identified in Drosophila larvae which are similar to mammals [85,86], and guide surgeons how to manage surgical wounds. Also, modern medicines and surgical approaches including dressing and drug treatment methods are very useful in the management of burn wound and scab [87].

3.16 Cultural Significance of Cautery

Cautery is a traditional method of treatment and a powerful vehicle to propagate cultural and religious values and beliefs of the individual country since olden days. In a Hadith narrated by Al-Tirmidhi, Prophet Mohammed (SAW) cauterised Anas (Rade Allah Anho) for managing sepsis of his finger. On another occasion, the Prophet (SAW) cauterised Sa'd bin Mu'ādh on his medial arm vein to stop bleeding. However, Prophet (SAW) allowed the use of kayi (cautery) only in difficult-to-treat cases; he was not in favour of this procedure as a routine practice [88]. The Prophet never prohibited the use of cautery but of course the use of direct fire. Despite this notion, the ancient Arab and Persian physicians and surgeons had great faith in the therapeutic values of fire. The Prophet discouraged the use of (direct) fire for treating various diseases. One probable reason given for that was his awareness of the Arab's strong trust in cautery as a curative therapy. Besides keeping this conviction lively and sustained, he wanted Muslim healers around the world to keep their faith in God as the ultimate healer, not cautery or fire. Another reason may be that he did not want a man to be subjected to the pain of fire, which will be used for the punishment of sinners in life after death [89]. From another perspective, cautery provided basic tenets and effectiveness evidence for its further progressive developments by modern healers and professionals resulting into modern devices associated with better

management of many diseases worldwide, i.e., a new light (advances) through the old window (traditional cautery) will certainly attest to its significance. Overall, currently qualified and experienced CAM practitioners use cautery in many diseases with good results and its sustainment will carry cultural values of diverse nations from generation to generation.

3.17 Cautery and Research

The research-based data that support biopsychosocial mechanisms and clinical efficacy are the two most important vehicles to carry on the use of cautery in various diseases, and this principle applies to all traditional and modern therapies. From the perspective of research, the ancient traditional healers, physicians and surgeons inspired the Muslim scholars to further the science of cautery therapy. Significant academic and clinical researches especially case series were performed and documented in several textbooks during the Middle Ages that contributed greatly to knowledge buildup and, thus, helped to preserve the essential aspects of cautery (kayi) for future reference and use. Among the earliest Muslim physicians to research on kayi (cautery) was Rabban Tabri (770–850 AD) and used kayi in the treatment of sciatica as evidenced in his famous treatise Firdaus al-Hikmah [90]. Later, based on his extensive clinical expertise, opinion and experienced (evidence level 4 & 5), Zakariya Razi (865–925AD) contributed tremendously to the effective use of cauterisation in several ailments including haemorrhoids as documented in his illustrious book [40,60,91]. Another famous physician with research interests, Abul Hasan Ahmad Bin Mohamed Tabri (d. 985AD) was also a proponent of kayi and described its use in various disorders [92]. Ibn Rushd advocated the use of cauterisation and documented some drugs that “act like fire” [26]. Abul Qasim Zahrāwi further strengthened the scope of research in and clinical uses of cautery therapy and, thus, greatly helped in establishing kayi as a mode of treatment in various disorders [93]. Later, a Turkish physician, Şerefeddin Sabuncuoğlu (1385–1468) improvised the art of cauterisation including its techniques, diagrams and clinical uses documented in his book “Cerrahiyetül Haniye” (Imperial Surgery) [94]. The Unani surgeons and physicians also contributed to the research pool on cautery, and the documented results were encouraging [14]. Notably ancient healers preserved the use of cautery based on their clinical experience and expertise (Level 4 & 5) rather than sophisticated researches. Currently the use of cautery in different advanced forms- electro- and galvanocautery-is advocated by modern healers and practitioners in various diseases, supported by contemporary research conducted around the world. However the experience of recent years has attested few things including modern therapies have also failed to treat certain diseases, and cautery therapy requires less sophisticated instruments, cost-effective and suitable in low-and-middle-income countries. Relevant researches are certainly needed concerning actual cautery because till now research evidence is simply based on single case reports and case series along with practitioners’ opinion and experience (Level 4 & 5).

4. DISCUSSION

This narrative review described critically the several clinical aspects of cautery since ancient times along with progressive developments in its classification, shape, marks, procedures and techniques, precautions, the anatomy of skin, health seeking pathways, case series and case reports and research. In addition, continuous contributions of ancient physicians, surgeons, healers and religious scholars concerning cautery are appraised in this review. Evidently, there were developed its several shapes [1,10,41-44], types [1,5-7,10,14,24-27,31-36], application marks [29,50,62,65,82], procedures and techniques most suitable for a particular local and systemic disease [1,7-10,14,17,18,31,40,4658-64] together with use of catheter [40,46]. The therapeutic efficacy of cautery was documented through single case reports and case series [7,9,14,63] and most of the patients completely recovered. The biopsychosocial mechanisms of cautery were postulated [9,43,47,79] along with recommendations concerning protective measures and precautions [33,40,45,46,67-69,75,76]. We suggest that the basic translational researches need to be conducted on a priority basis to explore the biological mechanisms of cautery. The management of burn/cautery scab [6,27,40,83-87], sociocultural impact and values [5,6,88,89], and researches [14,26,40,60,91-94] related to cautery therapy were discussed critically. Overall traditional healers and professional practitioners continuously remained engaged in improving cautery therapy since ancient times despite persistent opposition to its clinical applications in many diseases. Mother-traditional cautery-an influential source for innovation and advancements concerning modern cautery-

should never be forgotten. Most importantly cautery is a powerful means of transportation to propagate sociocultural values, beliefs and traditional medical system of diverse cultures and societies across the world. Cautery, one of the three religious therapies (others are honey and Hijamah), is safe and effective in many diseases provided it is used by qualified and trained CAM practitioners.

This review has some limitations. It is not comprehensive and systematic. Publication and selection biases are apparent because all relevant published papers were not accessible due to multiple reasons including high subscription charges of journals and high price for buying individual articles. The strength of this review is that it deals with some important bio-clinical perspectives of cautery including shapes, types, application marks, procedures and techniques, case reports and series reflecting efficacy, treatment and dressing of burn scab, mechanisms of action, along with necessary precautions and a brief description of related research and modern cautery. Training programs, integration into mainstream integrative medicine and campaigns directed towards traditional healers, untrained professionals and health consumers may result in improving the status of cautery globally. These strategies will further help establish its efficacy as well as validity in perpetuating the use of cautery in indicated medico-surgical conditions around the world.

5. CONCLUSION

In summary, the ancient healers, religious scholars, surgeons and physicians mainly of the eastern world contributed to the progressive development of cautery therapy and provided its numerous definitions, shapes, types, application marks, procedures and techniques, theoretical mechanisms, evidence of efficacy, and scanty research inputs. This CAM therapy has been widely practised by traditional healers, scholars and professionals since antiquity. Concerning research, cautery remains one of the largely unexplored areas not only in ancient times but also in modern days. Besides exploring underlying biological mechanisms of cautery, scientific rigour studies especially randomised clinical trials need to be conducted in future.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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