This study was used to improve access and ensure equity by re-distribution of resources including the establishment of new health centres and by defining vulnerable groups and fixing targets accordingly.

(ii) Family health file to ensure continuous comprehensive health care, with built-in protocols for the additional care of the at-risk and vulnerable.

(iii) A written action plan with defined indicators so as to monitor performance and self-evaluation of progress in achievement in service targets.

(iv) Establishment of a committee called 'friends of health committee' consisting of members of the community, local health related sectors and the health centre to develop the impetus of working together and initiate community and sectoral involvement.

(v) Defining of registers and records related to different services ensuring uniformity in recording monitoring parameters.

(vi) Pre-designed protocols for common health problems and promotive/preventive service so as to ensure uniformity in content of care.

(vii) Development of manual of procedures related to all PHC services to ensure uniformity and adherence to standard procedures.

(viii) Development of training manuals and protocol to prepare the PHC personnel for revised tasks to be performed and to inculcate team approach.

(ix) Development and implementation of quality assurance programmes.

Today, every health centre is providing PHC services to all and to the needy by defining vulnerable groups, by providing target-based services and through organised out-reach services for preventive, promotive and disease control activities. Accordingly, the under-served and at-risk groups of the community are recognised, registered and followed through an established system.

As these activities represent an on-going process, innovative changes are to be introduced in the health delivery system to accommodate the changing health needs. The established health delivery system in Saudi Arabia is flexible and culturally acceptable and should stand the test of the time continuing to evolve with the pace of development of new medical technologies and knowledge.

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CHANGING CONCEPTS OF FEVER: BC TO THE PRESENT

A. S. El-Radhi, Queen Mary's Hospital, Sidcup, Kent*

INTRODUCTION

Through the ages varying concepts of disease have reflected the contemporary culture as much as the available investigative technology. The same may well apply to present day medicine despite its enormous successes. It is likely that physicians who bled fevers for at least 1,400 years, sometimes with catastrophic results, were mostly learned and intelligent. The following account may therefore have lessons for contemporary medicine.

ANCIENT CONCEPTS OF FEVER

Fever is perhaps the most ancient hallmark of disease. It dates back as far as civilisation itself.

Egyptian medicine

The most valuable of the Egyptian medical tests are the *Edwin Smith surgical papyrus* and the *Ebers papyrus*, written about 1700 years BC.[1] These papyri, the oldest known medical texts, contain the first record of anatomy observations, experiments in surgery and pharmacy, the use of splints, bandages, compresses, and other appliances, and the first evidence that specialists existed even at that time, in the descriptions 'physician of the belly', 'physician of the eyes', 'guardian of the colon', and 'treater of the teeth'. Fevers, infections and eye diseases are mentioned. The ancient Egyptians recognised that local inflammation was responsible for fever and that the pulse underwent acceleration during physical exercise and fever.

The *Edwin Smith surgical papyrus*[2] lists 48 medical cases. Local inflammation was differentiated from general fever, the latter usually meaning high fever: 'A diseased wound in his breast inflamed (*nsr-y*), high fever (*smmt-t*) comes forth from it'.[3]

Palpation was used to compare high and mild fever; the word '*srf*' indicated a lesser degree of fever. Cold and warm compresses, were prescribed for local inflammation, as well as willow leaves, which is the earliest known example of external application of salicylic acid.

Mesopotamian medicine

Early Sumerians, about 2500 BC, used a flaming brazier as a pictogram symbol for both fever and inflammation. The only source of information about Mesopotamian medicine is cuneiform writing from about 500 BC.[4] This writing was found on the 30,000 or so tablets recovered from Nineveh in present day northern Iraq in 1845 from the ruins of the library of Assurbanipal (668–625 BC). Of these, about 1,000 were medical texts which contain lists of medicines,

*Consultant Physician.

ingredients, diagnoses and prognoses of various febrile illnesses.[5] Otitis media for example was recognised as fire that extends into the interior ear and dulls the hearing.[6] Inflammation was related to fever clinically as early as the 6th Century BC. The Akkadian word *Ummu* was used for both inflammation and fever and as with many ancient concepts, evil spirits played a major role. Nergal, the god of pestilence, and Ashaka were believed to infest mankind with fever. Priests used exorcism to 'expel' it.

Chinese medicine

The ancient Chinese believed that the soul possessed two antagonistic elements, good and evil, and that health and disease depended upon their balance.[7]

The greatest medical Chinese classic is the *Canon of Medicine* by Nei Ching, written about 3,000 years ago.[8] Although the method of examination was detailed, palpation focussed on the pulse only, on which the diagnosis, including that of fever, and the prognosis were based.[9] Treatment of fever by antipyretic drugs and the use of cold applications were also described. Branches of peach trees were used to strike febrile patients to expel the evil spirit and the fever. Watermelon and material from deer horns were prescribed.

Hindu medicine

During the earliest period of Indian civilisation, medicine was also characterised by belief in magic and demons. Fever was feared since it was begotten by the wrathful fire of the god of destruction, Rudra, hence his name, 'destroyer of created beings'.[10] The fire demons, Takman and Yakshma, were also believed to cause various fevers.

The highest development in early Hindu medicine was achieved during the Brahman period (800 BC to AD 1000).[11] One of the greatest exponents was Susruta, who wrote the *Physiology of Susruta*. Like the Greek scholars (it remains debatable which culture influenced the other), he believed that the human body contained three humours: bile, air and phlegm. Diseases were thought to be due to the disturbance within these and were classified by symptoms, beginning with such manifestations as fevers or tumour. Intermittent, remittent, double quotidian, tertian and quartan fevers were defined. When the fever was intermittent, the time interval between the peak periods of fever provided the key to prognosis.

Greek medicine

Greek scholars believed that the body was composed of four humours (or fluids): phlegm, blood, yellow and black bile.[12] Health was maintained when these humours were in equilibrium, while diseases, and most especially fevers, were caused by a disturbance of the four humours. This theory of humoural equilibrium in health, and disequilibrium in disease, which persisted until the middle of the 19th century, was the first organised concept of thermoregulation. The present concept also envisages an equilibrium, between temperature production and loss.

Knowledge about fever was extensive in Greek medicine compared to other ancient cultures. Fevers were divided, as they were in Susruta's *Physiology*, according to their patterns into continuous (from excess of fire), or intermittent in the form of sub-tertian, tertian (from excess of water), quotidian (from excess of air), or quartan (from excess of earth). Other classifications described five-day, seven-day, nine-day, nocturnal and diurnal fevers.[13] Most fevers encountered at that time (for example continued, quotidian, tertian and quartan), were also thought to be caused by excess of yellow bile, perhaps because at that time many infections were associated with both fever and jaundice. Each of these fevers were studied according to the characteristics in its nature and in spacing of the paroxysms, and the prognosis for each was determined. The Greek scholars knew that diseases were responsible for producing fever. The Hippocratic writings characterise many febrile illnesses with such accuracy that diagnosis can be made from the descriptions. Malaria is evident, with its paroxysms of fever, and mumps with its soft, non-suppurative swelling and absence of high fever, complicated sometimes by orchitis.[14] Hippocrates also observed that febrile convulsions occurred in children up to the age of 7 years. Typhoid fever, a classical example of continuous fever with its ladder-like rise in body temperature during the first week, was also well described: 'The worst, most protracted diseases were the continued fevers, these showed no real remissions. They began mildly but continually increased, each paroxysm carrying the disease a stage further. Shivering fits and sweat were least frequent and most irregular in these patients'. It is remarkable that these observations were made by palpation only.

The Hippocratic writings also contain evidence that fever was thought to be beneficial to the infected host 'fever was beneficial in ophthalmia, and it cured it'.[15] Because Hippocrates believed in the benefit of fever, he placed little emphasis on the treatment of it. When a disease was caused by an excess of one of the four bodily humours, the excess humour was then 'cooked' by the fever, separated and eventually removed. He considered that nature provided the best medicine, a concept that influenced physicians until the beginning of the 20th century. The best treatment for fever, if any, was dietary and consisted of starvation, accompanied by cool drinks. Acutely ill patients were usually given barley gruel or barley water, supplemented with hydromel (honey with water) or oxymel (honey with vinegar). The purpose of the relative starvation and fluid regimen was to reduce the amount of bile and blood in the body.

Rufus of Ephesus a surgeon who lived at the beginning of the 2nd century AD strongly advocated the beneficial role of fever. He was the first physician to recommend the use of 'fever therapy' (such as by malaria) to treat epilepsy. 'Fever is a good remedy for an individual seized with convulsion, and if there were a physician skillful enough to produce a fever it would be useless to seek any other remedy against disease'.[16]

About 18 centuries later in 1917, Wagner von Jauregg treated neurosyphilis with malarial fever, for which he received the Nobel Prize ten years later.[17]

Although considerable progress took place in the interval between the third century BC and the second century AD, Galen (AD 130–200), retained the Hippocratic humoural theory. Fever, according to Galen, could result from either excess of yellow bile, black bile, or phlegm (a condition which he called a cacochymia), or from an excess of blood, a plethora. To restore a healthy balance, Galen advocated bloodletting.

Hebrew medicine

The roots of Hebrew medicine can be traced to the Bible (compiled between 1500 BC and 300 BC) and the Talmud (a book of rules and precepts completed between 70 BC and the second century AD). Magic, incantation, and mystics appear to be less significant than in other cultures. Certainly, Biblical record contains no indication that fever was caused by demons or evil spirits. In the Old Testament, fever was part of God's punishment for sins. The Creator of heaven and earth, Yahweh, states 'but break my covenant, then be sure that this is what I will do: I will bring upon you sudden terror, wasting disease and recurrent fever' (*Leviticus 26*: *16*; *Deuteronomy 28*: *22*). Fever is also mentioned on several occasions in the New Testament, always without comment on causation. The first time, Jesus saw in Peter's house, 'his wife's mother laid and sick of a fever. And he touched her hand and the fever left her' (*Matthew 8*: *14–16, Mark 1*: *29–34, Luke 4*: *38–41*). Elsewhere, Jesus healed the official's son with his words (*John 4*: *49–52*), and the apostle Paul prayed to God and placed his hands on Publius, who was then healed of fever and a bloody flux (*Acts 28*: *8*).

In summary, the oldest civilisations (Egyptian, Mesopotamian, Chinese, Indian, Greek) demonstrated extensive knowledge of fever, but tended to view it as being induced by evil spirits. Hence exorcism was used in many ancient cultures (to a lesser extent in Greek medicine) in the treatment of fever. Many ancient physicians however, fostered mainly by the Greeks, believed in the beneficial effects of fever but early Jewish and Christian writers regarded it as a punishment from God.

CONCEPTS OF FEVER AD 400–1990

European medicine in the Middle Ages

With the beginning of the Middle Ages (c. 400–1400 AD) science and medicine became less important than theology and philosophy.[19] Galen's writings remained a great influence on medicine during the Middle Ages. He had a philosophy embracing body, mind and soul, which was highly acceptable to the religion of the developing church.[20] The central development of medicine was in anatomy learned mainly from animal dissections but a few were performed on humans. Anatomical studies began at Bologna (1158) and Padua University (1222). Physiology and pathology were still based upon the four humours (blood, phlegm, yellow and black bile). All diseases were characterised as hot, cold, moist or dry. 'Hot diseases' were treated by cooling, 'moist diseases' by drying. Bloodletting, was widely practised in febrile illnesses, as Galen and some of the ancient physicians had done—based on the notion of plethora—a theory that attributed disease to part of the body being overfilled with blood. Apart from bloodletting, other methods used in the attempted cure of acute fevers included cooling, emollients and laxatives.

With the destructive epidemics of the Black Death which killed as much as one third (reputedly twenty-five million) of the European population in the 14th century (with a peak in 1348), fever became a marker of death. Medicine was not helpful in preventing or treating the illness. The wrath of fever still attributed to demonic possession required exorcism to expel it in line with evolving theological doctrine. The belief that fever constituted divine punishment also prevailed, particularly among the devout.

Arabic medicine in the Middle Ages

Unlike this 'dark period' in European medicine, Arabic medicine reached its

golden age in the ninth and tenth centuries. The writings of both Hippocrates and Galen were carefully translated from Greek into Syriac and Arabic. Two scholars were outstanding in this period. Abu Ali Husayn ibn Abdulla ibn Sina (AD 980–1037), latinised as Avicenna[21] was, like Galen, a philosopher and physician. His best work, Qanun Fit-Tibb, or Canon of Medicine was a vast encyclopaedia.

Abu Bakr Muhammad Zakariya Al-Razi (AD 864–923, latinised as Rhazes) was the first scholar to differentiate measles from smallpox with his original treatise on the two diseases.[22] On smallpox he wrote: 'The eruption of the smallpox is preceded by a continued fever, pain in the back, itching in the nose and terror in sleep. There is redness in both cheeks, a redness of both eyes, a heaviness of the whole body, distress of the whole body, distress and anxiety'.

Rhaze's best-known medical work, *Kitabul-Hawi Fit-Tibb*, or *Contents of Medicine*, appeared in 25 volumes. The books contain his views on fever and febrile illnesses. He noted that for example 'exercise excites fever and fuels it like blowing into fire', and that fever in tuberculosis is mild and blunt.

One of Rhaze's remarkable observations was his differentiation of fever (elevated thermoregulatory set-point) from heat stroke (normal thermoregulatory set-point): there is another fever with a higher core temperature than the common fever, where patients are much thirstier and the body feels hot all over.[23] Rhazes was probably the first scholar to distinguish between the two terms, fever and hyperthermia in the form of heat stroke, often equated even nowadays. However, most of the progress in relation to fever in this period took place in Europe.

European medicine 16th–19th centuries

Towards the end of this period, medicine achieved an important milestone with the invention of a means of measuring body temperature: the thermometer. Before that, physicians though aware of the importance of body temperature measurement could not utilise it until Galileo (1564–1642) re-invented the thermoscope. The first thermoscope was invented by Heron of Alexandria in the second century BC.[24] Galileo's thermoscope (1592) was an air-filled bulb with an open ended stem inverted over a container of water. The level of water in the stem varied with ambient temperature but was influenced by the pressure. In 1644 Ferdinand II of Tuscany sealed the neck of the flask thereby eliminating the air pressure variable. Santorio Sanctorius (1561–1636) added thermal graduation to the thermoscope, thereby producing the first thermometer.[25] Temperature was measured by allowing the individual to grasp the bulb of the thermometer. The rate at which the fluid subsequently fell was used as an indicator of body temperature.

During the 17th century, fevers were classified as continued (such as typhus), intermittent (such as malaria) or eruptive (such as smallpox). The most prevalent febrile disease in England at this time was malaria, notably the benign tertian form, which was described at that time as the annual spring epidemic of intermittent fevers. For Thomas Sydenham (1624–1689), the writings of Hippocrates remained the principal source of medical knowledge.[26] He emphasised, however, only one humour, namely blood. In this he had possibly been influenced by the discovery of the circulation of the blood by William Harvey (1578–1657). The other humours, Sydenham thought, were either contained in, or derived from the blood. Sydenham believed that these spring fevers were attributed to the warmth of the sun acting on humours accumulated in the blood during the winter. He advocated as a treatment a low calorie diet without meat, with a mild purgative on the day of intermission. He clearly regarded fever as beneficial as witnessed by his remark 'fever is a mighty engine which nature brings into the world to remove her enemies'.

Hermann Boerhaave (1668–1738), Professor of Medicine at Leyden was one of the most well-known physicians of his time. He described the prime symptom of fever as an accelerated pulse and heartbeat, arising, from stagnation of the blood at the ends of capillaries and accompanied by an irritation of the heart. He maintained that a rapid pulse was pathognomonic of fever and strongly advocated the measurement of body temperature by means of an alcohol thermometer held in the patient's hand.[27]

During the 18th century, fever became divided into symptomatic (such as pneumonia or wound infection) and idiopathic or essential. The concept of fever most widely accepted by British physicians was that of William Cullen (1710–1790),[28] of the University of Edinburgh from 1773–1790. Cullen divided fevers into a simple inflammatory fever without delirium, and those fevers accompanied by delirium or stupor, which he called 'typhus'. Although he thought of fever as a general disease that might assume various forms, he believed the common underlying pathophysiology was a spasm of the arteries.

By the mid-1800s, the ancient humoural theory began to disintegrate, and with it the concept that fever was beneficial. The belief that fever could result from inflammation also evolved further during this century. François Broussais (1772–1838) recognised the relationship between the two and suggested that the usual seat of inflammation was the stomach and the intestines.

In the 19th century, fever was still regarded as both part of a symptom complex (as it is today) and a disease in its own right.[29] Examples of fever regarded as a disease in itself were 'autumnal fever, jail fever, and hospital fever'. Fever could also be described in terms of the severity of the disease, for example 'malignant fever' or 'pestilential fever', or even in terms of the supposed pathology of the fever, 'bilious fever' or 'nervous fever'. The multiplicity of names for fever reflects the lack of a breakthrough into an understanding of the causes of febrile illnesses.

The breakthrough came with the science of bacteriology, which was able to reveal the aetiology of many infectious diseases, such as the identification of the typhoid bacillus in 1880, and the discovery of the tubercle bacillus in 1882. These discoveries relegated fever to a sign of disease.

Claude Bernhard (1813–1878), the great French physiologist, recognised that body temperature was regulated in healthy organisms by the balancing of heat production and loss. He demonstrated that animals died quickly when the body temperature exceeded the normal by 5–6°C, thus suggesting that fever may be harmful and that antipyretics, which were introduced later, may be beneficial.[30] William Osler declared that 'the humanity has three enemies, fever, famine and war, but fever is by far the greatest'.

One of the most important lines of enquiry in the 19th century was the attempt to isolate a fever-inducing substance from the host. Although ancient scholars had recognised that local inflammation was responsible for fever, it was Billroth (1829–1894) in 1868 who attempted to confirm this ancient observation

by injecting pus into animals, thereby producing febrile response. His attempt to prove that fever resulted from activity in the host cells themselves failed because the injected material was contaminated with endotoxin, a product of Gram-negative bacteria that induces fever. It was not until 1948 that Beeson, using aseptic techniques to exclude endotoxin, isolated a fever-inducing substance from the host leukocytes, leukocyte pyrogen,[32] which later became known as endogenous pyrogen.

PRESENT CONCEPTS: EVIDENCE THAT FEVER MAY BE BENEFICIAL

Only in the past three decades has there been successful research into the subject of fever and its role in disease. One of the most important outcomes of these investigations has been the discovery of a single mononuclear cell product, interleukin-1, whose effects include induction of fever by its action on a hypothalamic centre.[33] In addition to its function as an endogenous pyrogen, interleukin-1 activates T-lymphocytes to stimulate the production of various other factors (such as interferon and interleukin-2).[34] Few issues in medicine have been more controversial than the biological role of the febrile response. The onset of fever simultaneously with lymphocyte activation constitute the clearest and strongest evidence in favour of the beneficial role of fever. The accumulated data now suggest that fever has a protective role in promoting host defence against infection, rather than being a passive by-product.

Theoretically, fever could benefit an illness in any of three ways. It could adversely affect the infecting organisms, could enhance the host defences or could be beneficial in an indirect way such as by causing morbidity and thereby enforcing rest. The first two of these possibilities will be discussed.

Effects of elevated tempeature on microorganisms

Bacteria. In 1894, temperature was recognised as a determinent of bacterial growth rate. Immersion of rabbits in warming baths was shown to reduce the severity of infection following inoculation with streptococci isolated from a case of erysipelas.[35]

As mentioned previously, Wagner von Jauregg aroused great interest in fever therapy in 1917 when he treated patients with syphilis by injecting them with infected blood from malarial patients. Subsequent *in vitro* experiments demonstrated the marked attenuation of the growth of *Treponema pallidum* and *Neisseria gonorrhaeae* at temperatures above 40°C.[36,37] More recent studies have demonstrated that the bacterial growth rate in experimental pneumococcal meningitis is significantly reduced at elevated temperatures.[38,39] Also gram-negative bacteria, such as *Salmonella typhi*, were shown to be increasingly susceptible to the antibacterial effects of normal serum when cultivated at a temperature greater than 37°C.[40]

The most recent evidence for the beneficial role of fever in response to infection has been reported by Kluger and colleagues who have demonstrated that elevation of the body temperature of bacterially infected lizards into the febrile range was associated with significantly higher survival rate compared to animals who were prevented from raising their body temperature.[41]

Possible mechanisms for these effects of elevated temperature on bacteria include direct effects of bacterial growth, degradation of ribonucleic acid (RNA) and inactivation of temperature sensitive enzymes.[42] In addition, plasma iron and zinc concentrations decline rapidly during fever thus depriving invading microorganisms of essential nutrients.[43,44] There is evidence that the reduction in growth rate of the microorganisms is especially striking when the body store of iron is low.[45]

Viruses. Available data indicate that growth is impaired with increased temperature. Most viruses cease to replicate at a temperature between 40°C and 42°C. For example, Lwoff demonstrated that the replication rate of poliovirus at 37°C was 250 times that at 40°C.[46] He and others have suggested that fever may be a host defence mechanism against viral infection. Again, it is unclear how temperature affects viral replication.

Effects of elevated temperature on host defence mechanisms

Experimental studies. Elevated temperature has been reported to induce the following effects:

The mobility and phagocyting ability of human polymorphonuclear cells is significantly greater at temperatures above 40°C.[47] Several studies have confirmed small but significant bactericidal activity, including phagocytosis and killing power, against gram-negative bacteria with elevated temperature levels of 40 and 41°C.[48] There is now clear evidence that interleukin-1 is more active at elevated temperatures than in an afebrile state.[49] Interferon (INF), a potent antiviral agent, has enhanced antiviral activity above 40°C.[50] T-cell proliferative response to interleukin-2 and interleukin-1 was greatly increased at 39°C compared to 37°C.[51] Elevated temperatures of 38 and 39°C have a direct effect on lymphocyte transformation, the generation of cytolytic cells, B-cell activity, and immunoglobulin synthesis.[52]

The above results concerning the role of fever on host defence mechanisms were in the main from laboratory animal experiments. These results may not always be applicable to those in humans, because humans, as endotherms, have more complex thermoregulatory mechanisms. While ectoderms such as fish and reptiles rely on simple behavioural means (for example by seeking a warm environment) only to generate heat, endotherms, in addition, generate heat through complex physiological means.[53]

Studies of the effects of fever in humans have been few, mainly because of the difficulty of isolating fever as a single variable in human disease. Atkins noted, for example, in 1983 that there were relatively few studies in mammals and none in humans, that documented the effect of fever on infection.[54] Insufflation of humidified air at 43°C (three 30-minute sessions at 2–3 hourly intervals) into the nasal passages of patients suffering from coryza resulted in the suppression of symptoms in 78 per cent of patients.[55] In a study of children with salmonella gastroenteritis in Finland, we showed that there was a significant, linear correlation between the degree of fever and duration of excretion of organisms.[56] A fever greater than 40°C was associated with the shortest (mean: 1·9 weeks), and the absence of fever with the longest duration of bacterial excretion (mean: 11·7 weeks) ($P=0{\cdot}004$). Fever thus appeared to constitute a favourable prognostic sign for the length of salmonella excretion. In a series of children with their first febrile convulsion, we found that those with temperatures of 40°C or more were nine times less likely to have subsequent convulsion than those with temperatures of 38–38·9°C.[57] Fever may also be beneficial in patients with meningitis. In one report, the presence of fever greater than 40°C did not indicate a poor prognosis, but all children presenting with hypothermia died.[58]

Fever in non-infectious diseases. Fever may occur in non-infectious diseases. Before the advent of antibiotics, fever therapy was the principal form of treatment, not only for syphilis and gonorrhoea but also for various ailments such as neoplasm, rheumatoid arthritis and asthma.

Fever is a prominent feature in many types of malignancies, particularly leukaemia and Hodgkin's disease in the absence of infection. Cells of these tumours may release interleukin-1 spontaneously, which acts upon the hypothalamus to produce fever.[59]

The asssociation between elevated body temperatures and tumour regression has been known for over a century. Occasional remissions of Hodgkin's disease occurred after an attack of measles.[60,61] The metabolism of many types of cancer cell is selectively damaged at temperatures of 42–43°C.[62] Lysosomal enzymes, INF and IL-2 have increased activity at such temperature, which may contribute to tumour cell destruction.

Although the overall success rate of fever therapy in patients with tumours was modest, further work is needed to study the effect of fever or hyperthermia on tumours. At present, this method is likely to be effective only as an adjuvant to other conventional antitumour therapy.

Improvement was reported to occur in up to 80 per cent of cases with rheumatoid arthritis treated by fever of 40°C, but only 20 per cent sustained improvement.[63] At the turn of this century, several authors observed that asthmatic attacks improved in association with infection such as erysipelas. Several methods of hyperthermia, for example diathermy, were then used to treat asthma. The results obtained were reported as satisfactory.[64]

Effects of suppression of fever on underlying disease

If fever is considered beneficial, it might be expected that suppression of fever would have a harmful effect. There is some evidence to support this. In human volunteers infected with rhinovirus, the use of antipyretics was associated with suppression of serum antibody response, increased symptoms and signs and a trend towards longer duration of viral shedding.[65] In a study of children with chickenpox, half of whom received paracetamol four times a day, and half who received a placebo, the time to total scabbing was slightly shorter in the placebo group (5·6 days) than in the paracetamol group (6·7 days).[66]

As for the relationship between hypothermia and febrile illnesses, many studies have found that hypothermia may impair various defence mechanisms, including delayed and often depressed activity of leukocytes, decreased phagocytosis and antibody formation as well as increased susceptibility to viral infection. All animals infected with pneumococci, which were rendered hypothermic (body temperature between 30°C and 34°C) died, whereas only five of the 31 control animals infected with the same bacteria at normal to low febrile levels died.[67] Husseini and colleagues showed that significantly more influenza virus was shed in the nasal washes of ferrets whose febrile response was suppressed by shaving or by treatment with sodium salicylate compared to untreated ones.[68] In paediatric practice, it is well established that the prognosis for serious infection is worse in hypothermic infants than in euthermic or febrile children. For example in a series of children presenting with severe infection, such as pneumonia or septicaemia, it was found that the lower the body temperature, the higher the mortality.[69] The accumulating data thus suggest that fever is an adaptive response that confers survival value during an infection.

Although this article has focused on the beneficial effects of fever, the author does recognise that the issue as to whether fever is beneficial or not is still controversial, and there are scholars who maintain the view that the function of fever is still uncertain. In particular, we need to know which diseases are likely to benefit from the presence of fever, so that minimal interference during their courses may be considered? Also it should be determined what degree of fever is harmful and thus ought to be reduced? Until these types of studies are conducted for a wide assortment of infections, the question of whether most fevers should be left alone or treated in the paediatric or adult patient will remain unanswered.[70]

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DR WILLIAM FULLERTON AND THE PATNA MASSACRE OF 1763

K. K. Sinha, 'Mansarovar', Booty Road, Ranchi 834009, Bihar, India*

POLITICAL LIFE IN EAST INDIA IN THE 18TH CENTURY

The political history of India in the 18th century is a chronicle of kings, nawabs, zamindars (landlords), commanders, courts and their intrigues, struggles, battles and wars. It is not a story of national growth. The principles and methods of administration did not change appreciably in spite of the diversity of successive rulers including the English East India Company. But in the character and life of the rulers there is infinite variety and it is around these men that the chief interest of this period centres. There were more violent periods, full of deceits and killings, than peaceful ones. The East India Company was emerging as the paramount power and played a great role in the happenings of the period.

Doctors, usually called surgeons, were an essential part of the Company administration, required to look after the health of the employees, but when necessary they were also expected to participate actively in administration and even to fight. In combat, many suffered severe injuries and humiliations, were made captive or even killed. In one such tragic event in October 1763 known as the Patna Massacre, an entire group of Company employees including several doctors was killed, except for Dr William Fullerton who survived to tell the story.

Fullerton's career in India up to 1760

Fullerton was born in Symington, Ayrshire and came to India about 1745. His name is first mentioned in Fort William consultations of 19th August 1749[1] but he may have been posted in Bombay between 1746 and 1749. Dr Holwell had resigned his post as second surgeon in Calcutta on 30th April, 1750 and Fullerton applied for the job. The President of the Council sought to appoint Dr John Knox senior. The Court of Directors however refused to confirm this and ordered that William Fullerton be appointed. He held the post of second surgeon in Calcutta for over ten years and was in service at the siege of Calcutta and Fort William in July 1756. At the moment of surrender he was on board a ship, perhaps on duty, attending the sick women and children and the wounded. One of the sick was Mrs Mackett, wife of a member of the Council.

Fullerton was elected Mayor of Calcutta on 8th December 1757 for a year. He is reported to have made good money in Calcutta and received 230,000 rupees (nearly £30,000) as compensation as a sufferer in the siege and capture of Calcutta. He was also successful in his private business particularly in the saltpetre trade in Bihar. Early in 1760 he was transferred to Bihar and on 9th February he

*Physician and Neurologist.