THE NORTHERN HOSPITAL

BURNS BITUMEN

"The fleet of the Romans setting ablaze the fleet of their enemies", Byzantine Illuminated Manuscript, 12th Century, Codex Skylitzes Matritensis, Bibliteca Nacional de Madrid.

"In the two sieges the deliverance of Constantinople may be chiefly ascribed to the novelty, the terrors, and the real efficacy of the Greek Fire. The important secret of the compounding and directing this artificial flame was imparted by Callinicus, a native of Heliopolis in Syria, who deserted from the service of the Caliph to that of the Emperor. The skill of a chemist and engineer was equivalent to the succour of fleets and armies; and this discovery or improvement of the military art was fortunately reserved for the distressful period when the degenerate Romans of the East were incapable of contending with the warlike enthusiasm and youthful vigour of the Saracens. The historian who presumes to analyse this extraordinary composition should suspect his own ignorance and that of his Byzantine guides, so prone to the marvellous, so careless, and, in this instance, so jealous of the truth. From their obscure, and perhaps their fallacious hints, it should seem that the principle ingredient of the Greek fire was the naphtha or liquid bitumen, a light, tenacious, and inflammable oil which springs from the Earth, and catches fire as soon as it comes in contact with the air. The naphtha was mingled, I know not by what methods or in what proportions, with sulphur and with the pitch that is extracted from evergreen firs. From this mixture which produced a thick smoke and a loud explosion, proceeded a fierce and obstinate flame, which not only rose in perpendicular ascent, but likewise burnt with equal vehemence in descent or lateral

progress; instead of being extinguished, it was nourished and quickened by the element of water...

It was either poured from the rampart in large boilers or launched in red hot balls of stone and iron; sometimes it was deposited in fireships, the victims and instruments of a more ample revenge, and was most commonly blown through long tubes of copper, which were planted on the prow of a galley, and fancifully shaped into the mouths of savage monsters, that seemed to vomit a stream of liquid and consuming fire. This important art was preserved at Constantinople as the palladium of the state: the galleys and artillery might occasionally be lent to the allies of Rome; but the composition of the Greek fire was concealed with the most jealous scruple, and the terror of the enemies was increased and prolonged by their ignorance and surprise. In the treatise of the administration of the Empire, the royal author suggests the answers and excuses that might best elude the indiscrete curiosity and importunate demands of the barbarians. They should be told that the mystery of the Greek fire had been revealed by an angel to the first and greatest of the Constantines, with a sacred injunction that this gift of Heaven, this peculiar blessing of the Romans, should never be communicated to any foreign nation: that the prince and subject were alike bound to religious silence under the temporal and spiritual penalties of treason and sacrilege, and that the impious attempt would provoke the sudden and supernatural vengeance of the God of the Christians. By these precautions the secret was confined, above four hundred years...."

Edward Gibbon,
"The History of the Decline and Fall of the Roman Empire",
Volume 5, 1786.

The initial shock of the West over the Arabic explosion out of Arabia in the Seventh century A.D, had begun to settle by mid-century. But then came a further even greater threat from the newly established dynasty of the Umayyad Caliphate that was to endure for the next eighty years. Instead of attacking the provinces of the Byzantine Empire, the Umayyads dramatically upped the stakes and by turning their attentions on the very heart of the empire itself. In 672 A.D an immense Arabic fleet sailed up the Hellespont and into the sea of Marmara. The prize was no less than the great City of Constantine and the complete annihilation of the Byzantine Empire. The fleet carried heavy siege engines and huge catapults in preparation for an assault on the immense walls of the city. Of the half dozen or so of the critical battles in history where the very fate of Western civilization hung in the balance, among them is included the great Arabic siege of Constantinople of 674-680 A.D. There had been previous small scale attacks on Constantinople launched from the land, and although the Arabic armies would frequently be successful, they could not hope to breach the great walls of the city itself without a simultaneous siege and assault from the sea. The very fate of the Christian world now hung in the balance and at this critical juncture in history, an obscure Greek refugee from the Umayyad occupied Syrian city of Heliopolis, suddenly and dramatically emerges from the shadows of obscurity onto the bright stage of recorded history. Very little at all is known about this enigmatic man, other than the fact that he was both a brilliant engineer and chemist. He had developed a new weapon so devastating it would give the Byzantines renewed hegemony over their enemies for the ensuing six hundred years. His name was Callinicus and when his new weapon was launched for the first time on the grand scale onto the Arabic fleet outside of Constantinople, its effects were horrifying and unprecedented. To

those who had never before encountered this technology, it would have seemed as terrifying and unexpected as the death rays of H.G Well's Martians in terms of modern days sensibilities. Callinicus had developed the "Greek fire" - the atomic weapon of the Seventh century, and with it saved the West from a very different alternative future. The Greek fire was a petrochemical bitumen or asphalt based substance in a liquefied form. Its exact composition was the greatest secret of Byzantium, and it was so well kept that even today scientists and engineers do not know exactly how it was produced. The secret was lost forever in the Crusader sack of Constantinople in 1204. The substance had a previously unimagined capacity to ignite and to burn with a ferocity that Gibbon describes in graphic detail as "a fierce and obstinate flame, which not only rose in perpendicular ascent, but likewise burnt with equal vehemence in descent or lateral progress; instead of being extinguished, it was nourished and quickened by the element of water..." Umayyad sailors watched in horror as their ships and men spontaneously ignited amidst unquenchable infernos produced by the new weapon. The genius of Callinicus did not end with the Greek fire itself, but also extended to the technology he provided that could deliver it with such catastrophic effect to the enemy. Incendiary devices of lesser ferocity had existed for many centuries, but these had been delivered by clumsy and inaccurate catapults or trebuchets. A second aspect of what made the Greek fire so terrifyingly effective was its novel means of delivery, via an ingenious, mechanical siphon through copper piping, the exact mechanism of which is, like the secret of the formulation of the Greek fire itself, unknown to us today. A weapon of such ferocity would not be seen again until the flame-throwers of the First World War. The Umayyads, unused to defeat, continued to throw their ships and men against the Greek fire for a further six years, but neither their numbers, their religious fanaticism nor their superior fighting skills were any match for Callinicus's "infernal machine". By 680 A.D the Umayyad's, after suffering catastrophic losses, had had enough. They packed up their siege engines and sailed back to Damascus. The walls of Constantinople had prevailed under the protection of the Greek fire and the shadowy figure of Callinicus, who though largely unknown today, should properly be remembered among the pantheon of the great defenders and saviours of the West - Leonidas, Aetius, Charles Martel, John Hunyadi, the Duke Eugene of Savoy.

When one thinks of Callinicus today one sees quite fascinating and poignant parallels with another brilliant scientist of a far more recent century. He could be styled the "J Robert Oppenheimer" of the Seventh century. Like Oppenheimer's family he had emigrated from a homeland that would become the bitter enemy of his adopted land. He was one of the foremost scientists of his time, though in the Seventh century the concept of scientist did not exist. Like Oppenheimer he developed the greatest weapon of his age, and with it ensured victory over his nation's enemies. One parallel falls down however. The secret of the Manhattan Project despite all the power and technological might of a modern day superpower was compromised in less than half a generation. The secret of the Greek fire, under the most extreme threats of both corporal and spiritual damnation, remained a secret for over six hundred years, until it was lost forever amidst the chaos the Fourth Crusade - and the secret of its production remains unknown to us, to this day.

The Greek fire reminds us of the powerful potential of the petrochemical group of hydrocarbons to inflict serious burns. A threat that remains present to us - even in their far less aggressive forms such as bitumen and asphalt.

BURNS BITUMEN

Introduction

The management of burns from hot **bitumen** requires some specific considerations due to its propensity to stick to the skin as it cools which then makes it difficult to remove.

Cool water, as for thermal burns, remains the most important immediate first aid treatment.

Once the bitumen is cooled and solidified, certain hydrophobic solvents can then be used to dissolve and gradually remove it. Harsh organic hydrocarbon solvents (such as kerosene or gasoline) should **not** be used.

More active removal of bitumen is required in certain emergent situations, such as cases of airway, ventilatory or circulatory compromise.

Pathophysiology

Bitumen is a general term that is used to describe a number hydrophobic petroleum-derived substances including petroleum, mineral tars and asphalt.

Heated bitumen, (to over 200 degrees Celsius) is used by road-pavers and roofers, and is a potential source of severe contact burns.

The extent of the burn will depend on the temperature and the volume of the bitumen contacting the patient.

Circumferentially solidified bitumen can cause vascular compromise in limbs, ventilatory problems in chest injury and airway compromise in neck/ facial injury.

Clinical assessment

Left: Road worker's head covered with bitumen following a work accident. Right: All the bitumen has been emulsified using "Dermeze", a paraffin preparation. The hair has then been shaved off. Fortunately for this man, his hair largely protected him from direct bitumen burns to the skin, (courtesy Yvonne Singer & The Alfred Burns Unit).

Assess the adequacy of patient's airway and breathing in cases of significant neck, facial and chest injuries.

Assess for any neurovascular compromise in limb involvement, particularly in the case of circumferential bitumen deposition.

Document the *location* and *extent* of the bitumen injury.

Investigations

None are specifically needed other than those required to assess possible secondary complications.

Management

1. First aid measures:

   - Apply **cool running water** for at least **20 minutes** to cool the bitumen and aid analgesia.

     This will reduce the intensity of the burn and assist in dissipating the retained heat of the bitumen.

     Be mindful of inducing possible hypothermia with this treatment in cases of more extensive injures.

     Once cooling of the bitumen is complete, keep the patient warm to avoid hypothermia.

   - Do not remove clothing that is stuck to the bitumen, as this may cause further injury.

   - Belts, rings or other constricting articles should be removed, providing doing so does not cause further damage.

   - Elevation of the affected area is also useful to minimize swelling.

2. Removing the bitumen:

   Bitumen should not be traumatically removed once it has become adherent to the skin, and the use of emulsifying agents is used first in order to soften the bitumen.

   Note that complete removal of the bitumen using these solvents may take a period of days.

More urgent removal, or release *via incision through the bitumen* may be required in cases of:

- Airway compromise
- Ventilatory impairment
- Circulatory impairment
- Extensive deposition.

After cooling in less urgent cases the *solidified* bitumen can then be removed slowly by dissolving it with an appropriate solvent.

Coat the bitumen with the solvent to allow gentle debridement.

Options include the use of solvents with hydrophobic molecules that can dissolve tar such as:

- Liquid paraffin oil:
    - ♥ e.g. **"Dermeze"**, (a 50% liquid paraffin / 50% white soft paraffin preparation).
- Petroleum based jelly:
- Citrus based solvent:
    - ♥ e.g. **De-solv-it** (a commercially available citrus based solvent)

In the absence of the availability of the above, more immediately available (but less effective) solvents include:

- Butter, (emulsifies bitumen within 20-30 minutes)
- Plant oils, (emulsifies bitumen within 20-30 minutes), Olive oil, Sunflower oil.
- Baby oil.

Chemical debridement of bitumen burns with alcohol; acetone or harsh organic hydrocarbon solvents such as kerosene or gasoline are **not** recommended. These have been proven to be not only *ineffective* but *harmful* for the patient, as they are painful and toxic with harsh effects on the skin.

As a result of natural re-epithelialisation of the wound, any remaining bitumen will naturally peel off with time.

3. Extensive and full thickness burns:

- More active removal of bitumen is generally indicated in these situations.
- This will be best carried out immediately in the operating theatre, by a specialist burns surgeon.
- A combination of surgical removal and dissolution using solvents may be required.

4. Circumferential burns:

- These may be more immediately problematic in limbs, chest and neck areas as vascular supply or airway /ventilation can be compromised.
- The bitumen in these cases must be removed or at least split on an urgent basis.

5. Bitumen to the eye:

- Analgesia and local anaesthetic drops can be administered, followed by saline irrigation.
- Do **not** attempt removal
- Urgent Ophthalmological referral.

Disposition

Consultation with a specialist burns unit is advisable.

The exact extent of the burns, together with the body surface area involved and the general condition of the patient will dictate when transfer to a specialized Burns Unit is indicated.

Modern reconstruction of the Greek-Fire being deployed against the Arabic fleet outside the Walls of Constantinople in the mid-Seventh Century A.D, (source unknown).

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