Introduction
Mercurochrome is 2% aqueous merbromin solution, used as an antiseptic with a wide range of activity against Gram-positive and Gram-negative bacteria and other organisms. In 1919, the surgeon and urologist Dr. Hugh Young (with associates) at Johns Hopkins University discovered the antiseptic qualities of mercurochrome. The pharmaceutical company of Hynson, Wetscott and Dunning Inc. developed mercurochrome into an everyday antiseptic.

The form of mercurochrome that is found in medicine cabinets is mercurochrome tincture which is nothing more than diluted merbromin dissolved in either alcohol, acetone, water or a combination of the afore mentioned. If you remember mercurochrome as a stinging antiseptic, you will be interested to know that the alcohol and acetone tinctures of mercurochrome sting wounds whereas the water-based mercurochrome solution does not.

Generally speaking, methylmercury is the poisonous form which is not the form of mercury found in mercurochrome, thermometers, dental fillings, electrical switches, or vaccines. Mercurochrome contains mercury in a disodium salt form which is considered to be perfectly safe.

The present controlled prospective study was designed to evaluate efficacy of 1% mercurochrome solution as an antiseptic in the management of burns and to compare it with the routinely used agent silver sulfadiazine.

Materials and Methods
Two hundred cases admitted to a district hospital between April 2004 and April 2006, were included in this study. They were divided into 2 groups, viz. study group and control group. Patients were again subgrouped according to the depth of the wound as partial and full thickness as well as according to the involvement of percentage of the total body surface area as 0-20%, 20-40% and 40-60%. The purpose of subgrouping was simplifying the outcome of the study depending upon the depth and percentage of the burns.

The study (mercurochrome) group comprised of 100 patients (age ranged between 9 and 65 years; mean 23.76 yrs) with extent of burn injury varying from 14% to 58% (mean 35.07%) of body surface area. In this group, 1% mercurochrome (1:1 mixture of mercurochrome 2% and normal saline) was applied with a sterile cotton swab over the burns till an eschar was formed. After eschar formation the wound was dressed with Eusol. No sedation was given at the time of application, but injectable or oral analgesics were given. Pain intensiveness during dressing change and half an
hour later was studied according to pain scores. Additionally, the rate and number of painkillers were compared to estimate the effectiveness of each method in reaching local pain relief. For initial the 2-3 days of treatment wounds were covered with cotton dressings to absorb the discharge from the wound. Once the eschar started developing, the wounds were kept open unless burns were circumferential and patients could not be ambulated.

The control group had 100 patients (age range: 8-58 yrs; mean 28.67) with extent of burns varying from 15 to 56% (mean 26.56%) of body surface area. Two per cent silver sulfadiazine was applied topically to their burns. Occlusive gauze dressings were then applied which were changed once daily. The distribution of the patients according to age, sex, percentage of involved total body surface area and thickness in 2 groups is detailed in table 1.

**Table 1:** patient distribution

<table>
<thead>
<tr>
<th>Group</th>
<th>Mercurochrome</th>
<th>Silver Sulphadiazine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Children (below 12 years): 18</td>
<td>Children (below 12 years): 20</td>
</tr>
<tr>
<td></td>
<td>Adults (above 12 years): 82</td>
<td>Adults (above 12 years): 80</td>
</tr>
<tr>
<td>Sex</td>
<td>Male: 17</td>
<td>Male: 19</td>
</tr>
<tr>
<td></td>
<td>Female: 83</td>
<td>Female: 81</td>
</tr>
<tr>
<td>Body surface Area (%)</td>
<td>Below 20%: 15</td>
<td>Below 20%: 13</td>
</tr>
<tr>
<td></td>
<td>20-40%: 47</td>
<td>20-40%: 50</td>
</tr>
<tr>
<td></td>
<td>40-60%: 38</td>
<td>40-60%: 37</td>
</tr>
<tr>
<td>Thickness</td>
<td>Partial: 44</td>
<td>Partial: 51</td>
</tr>
<tr>
<td></td>
<td>Full: 56</td>
<td>Full: 49</td>
</tr>
</tbody>
</table>

In addition to intensive monitoring, intravenous fluids were administered to all the patients according to Parkland's formula. Baseline investigations included estimation of hemoglobin, packed cell volume, total and differential blood count, urea nitrogen and liver function tests. Burn wound biopsies were evaluated for culture on admission, and were repeated every week. Cultures were considered significant if the growth exceeded 10 organisms per gram of burn tissue. Renal chemistry and liver function tests were monitored weekly. Prophylactic antibiotics were administered in the form of ampicillin and chloramphenicol for 10 days and modified according to the sensitivity report. The patients were managed as inpatients until the healing process was complete. Superficial burns healed without any further treatment and deep burns required skin grafting after healthy granulations had appeared.

Time taken for eschar formation and separation, development of infection, mortality if any, duration of hospital stay and cost were noted for each patient and both groups were compared statistically using 't'-test with respect to these parameters.

**RESULTS**

No side effects or allergic reactions from local medication were noted in patients in either group. On the first two days, pain intensity during bandage changing was high in patients of both groups, reaching 8-9 points, with an average of 8.6 points on pain (visual analogue) scores. Patients in both groups required a high dose of pain relief drugs during this period. In the mercurochrome group, after 2-3 days of application of the drug, the pain subsided due to beginning of eschar formation. The patients did not complain of pain after 4-5 days due to the formation of tough eschar. On the contrary, patients treated with silver sulfadiazine complained of pain till 8-9 days especially at the time of dressing because of late formation of eschar as well as soft nature of the formed eschar.

Eschar formation occurred after 3.23 days (with a standard deviation of 0.82) in the study group. Eschars were found to be dry without any exudation or maceration of the wound and surrounding edema was less as compared to that observed in the control group. In the latter group, eschar formation was observed at an average of 5.85 days (with a standard deviation of 1.45). That means it took 2.62 days more for SSD to form an eschar as compared to mercurochrome (P < 0.001).

Eschar separation started after 11.72 days (with a standard deviation of 2.45) in the mercurochrome group whereas in case of SSD it started after 16.42 days (with a standard deviation of 3.56 days, P < 0.05).
Figure 2
Figure 1: Superficial burns: Eschar formation - day 4
Figure 3
Figure 2: Superficial burns: Eschar formation - day 6
Mercurochrome 1% as an antiseptic for burns: Economical - but is it efficacious and safe?

**Figure 4**
Figure 3: Superficial burns: Eschar formation - day 9

**Figure 5**
Figure 4: Deep burns: Eschar formation - day 5

**Figure 6**
Figure 5: Deep burns: Eschar formation - day 10

**Figure 7**
Figure 6: Tough eschar of mercurochrome
Multiple cultures of the burn wounds were done and the organisms isolated in each group are tabulated in Table 2. Pseudomonas pyocyaneus was the most common organism isolated in both groups followed by Staphylococcus aureus, though their percentage in the mercurochrome group is almost one fourth of that in the SSD group. Multiple organisms were isolated in the cultures done after 1 week in the SSD group but not in the mercurochrome group.

Table 2: Microorganisms isolated in the burn wounds

<table>
<thead>
<tr>
<th>Pathogenic organism</th>
<th>Mercurochrome</th>
<th>Silver Sulphadiazine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staphylococcus aureus</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Pseudomonas pyocyaneus</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Proteus</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Klebsiella</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>E. coli</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Pseudomonas + Klebsiella</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Pseudomonas + Proteus</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Pseudomonas + E. coli</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Pseudomonas+Kleb+Proteus</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

There were 15 mortalities in the SSD group and 6 mortalities in the mercurochrome group. Out of these 21 patients in total, 19 developed septicemia and multiple organ dysfunction (MODS) while 2 died because of ARDS. In the mercurochrome group, all the 6 patients who died had 40-60% involvement of body surface area while in the SSD group, among 15 patients who died, 12 had 40-60% burns and 3 had 20-40% burns. All the 6 patients who died in the mercurochrome group had sustained full-thickness burns and there was no mortality in the patients with partial-thickness burns treated with mercurochrome. In the SSD group, 10 patients had full-thickness burns while 5 had partial-thickness burns.

Hospital stay of the patients in both groups was compared according to the percentage of the burns (Table 3). Hospital stay was nearly equal in both groups for the patients with 0-20% burns. But the stay differs significantly as percentage of burns increases.

Table 3: Hospital stay depending upon the percentage involved of TBSA and depth

<table>
<thead>
<tr>
<th>%</th>
<th>Partial Thickness</th>
<th>Full Thickness</th>
<th>Partial Thickness</th>
<th>Full Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20%</td>
<td>4.2</td>
<td>5.1</td>
<td>4.3</td>
<td>6.6</td>
</tr>
<tr>
<td>20-40%</td>
<td>8.7</td>
<td>14.7</td>
<td>14.4</td>
<td>26.2</td>
</tr>
<tr>
<td>40-60%</td>
<td>12.3</td>
<td>25.8</td>
<td>22.5</td>
<td>39.5</td>
</tr>
</tbody>
</table>

The cost of the local antiseptic used throughout the treatment of patients for both the groups was calculated according to percentage as well as depth of the burn wounds and given in table 4. The treatment of 40-60% full-thickness burns treated with SSD cost $156 on an average while mercurochrome used for similar burns cost $1.9 on an average.

Table 4: Cost of antiseptic depending upon the percentage involved of TBSA and depth

<table>
<thead>
<tr>
<th>%</th>
<th>Partial Thickness (US $)</th>
<th>Full Thickness (US $)</th>
<th>Partial Thickness (US $)</th>
<th>Full Thickness (US $)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-30</td>
<td>0.36</td>
<td>0.52</td>
<td>1.2</td>
<td>7.6</td>
</tr>
<tr>
<td>20-40</td>
<td>0.6</td>
<td>0.82</td>
<td>5.4</td>
<td>29.2</td>
</tr>
<tr>
<td>40-60</td>
<td>1.4</td>
<td>1.9</td>
<td>40.2</td>
<td>156</td>
</tr>
</tbody>
</table>

(Prices according to Indian Market)
DISCUSSION

The local treatment of patients with superficial burns is still controversial. According to modern concepts, wound care preparation for local treatment should have several characteristics. It should be antiseptic but not interact with cellular wound substrate, keep the wound wet enough for cell movement but not macerate the skin around the wound, have an anesthetic effect, and be non-adhesive and easily removable from the wound surface [1]. A search for an ideal antiseptic for burns is going on since last century and the antiseptics worth listing are silver sulfadiazine [2] and mafenide acetate [3]. Silver sulfadiazine is notorious for acid-base imbalance [4] as well as organ deposition of silver [5]. Povidone iodine [6] is also tried but it is known to cause changes in the thyroid hormone levels [7]. Recently, biobrane [8,9] and aquacel [10,11] are being tried but the costs are too high.

Mercurochrome is scheduled as S1 drug and classified as antiseptic, disinfectant, cleansing agent by the Food & Drug Administration (FDA). Merbromin is an organomercuric disodium salt compound and a fluorescein with the chemical name dibromohydroxymercurifluorescein. Mercurochrome is being used as a day-to-day antiseptic for cuts, wounds and burns since a century. The Food and Drug Administration (FDA) removed it from the “generally recognized as safe” into the “untested” classification to effectively halt its distribution in the United States in 1998 over fears of potential mercury poisoning. It is readily available in most other countries [12]. A group of people is active and trying to reverse the FDA ban on mercurochrome in the United States [13].

We used mercurochrome as an antiseptic for local application on burn wounds. We compared the results with silver sulfadiazine (SSD) 2% cream on the basis of time required for eschar formation and separation, rate of infection of the burn wounds, mortality, cost and hospital stay.

Eschar formation occurs around the 6th day with the use of silver sulfdiazine and our results were comparable with the study of Nair et al. [14]. With mercurochrome used as a local antiseptic, the eschar formation occurs in significantly less amount of time, usually on the 4th day, the reason being that Mercurochrome keeps the burn wounds dry, decreasing the exudates from the raw surface of the burns. This needs repeated application of mercurochrome, at least 3-4 times a day.

As the time required for eschar formation with mercurochrome is less, the time required for the separation of the eschar is also less. In our study, eschar separation took place around the 11th day with mercurochrome, while it took an average of 17 days for eschar separation with the use of SSD.

For the initial 1-2 days of mercurochrome application, patients complain of pain at the local site, which was measured on visual analogue scale [15, 16] but the severity is not more than with SSD. But after 2 days, there is no pain at application of mercurochrome and that is because of early formation of eschar as well as toughness of the mercurochrome eschar. In superficial burns, separation of eschar causes early healing by epithelialization. As mercurochrome causes eschar formation by controlling the wound exudates, the healing rate enhances. Decrease in the exudates on the raw surface of the wound along with the strong antiseptic action of mercurochrome causes resistance to infection. This leads to prompt healing of the wound without much scarring.

In case of deep burns, mercurochrome causes development of healthy granulation tissue beneath the eschar. As soon as the eschar is separated from the floor of the burnt surface of deep burns, the base is found to be covered with granulation tissue. The chances of sub-eschar abscess with mercurochrome application are much less owing to its strong antiseptic action and dryness of the eschar. Due to this property the sub-escharal raw area covered with granulation tissue readily becomes graftable and the graft uptake is good, again because of lack or scarcity of infection.

Early eschar formation and separation leads to early recovery of the patient, leading to significant decrease in the hospital stay. In our study, we found a significant difference in the hospital stay between the two groups. The difference in the hospital stay increases significantly with the increase in the percentage and the depth of the burns. This shows that mercurochrome is more effective in greater percentage burns though its role in small area burns is also undoubtful.

In the burns of more than 30%, mercurochrome plays an important role in decreasing mortality. In our study there was a single death in the 20-40% burns group and there were 5 deaths in the 40-60% burns group. The reasons for low mortality with mercurochrome are:

1. Decreased chances of electrolyte imbalance due to decreased exudates from the burn surface
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2. Decreased chances of infection, again due to decreased exudates

3. Decreased chances of subeschar abscess

4. Early ambulation and restoring of general condition

Apart from these qualities, still the most important factor for which mercurochrome has remained the favorite of the physicians in the developing countries is its attractive price. The compound is being sold at unbelievably low cost since years, the reasons being the low manufacturing cost, longer shelf life, use in diluted form and importantly less propaganda about its medical use. The cost does not differ much with the use of any antiseptic for small area and superficial burns. Cost matters when it comes to the dressing of larger areas and deep burns.

Mercurochrome is considered as a mercury compound and was hence banned in the United States lately because of fear of mercury poisoning [17]. The authors performed extensive search but were unable to find a single reported case of mercury poisoning due to external application of mercurochrome over the raw surface of the wound. Methyl mercury is the compound which is considered as a substance responsible for the mercury poisoning. Mercurochrome is a disodium compound of mercury and considered as non-poisonous. It is practically not absorbed at all from the raw surface of the wound. Authors checked the levels of mercury in the serum of the five patients of more than 50% burns in whom mercurochrome was being applied for more than 15 days as a token only to find it untraceable in the serum. These patients were again checked for the signs and symptoms of the mercury poisoning as well as serum mercury levels, 2 weeks, 1 month, 2 months and 6 months after the treatment. All of them were perfectly normal, without any signs and symptoms of mercury poisoning or without any rise in the serum mercury levels.

Properties of the mercurochrome which bring it near the ideal antiseptic are the ease of application and removal which does not need a medical person; though it causes staining of the floor of the ulcer and surrounding skin. There is no need of occlusive dressings after mercurochrome application as it dries immediately over the floor of the ulcer. After 2-3 days of application it dries up the discharge through the ulcer floor forming a tough eschar. This not only saves the cost of dressing material but also allows early and effective physiotherapy. It saves the patient from the painful experience of daily removal of dressings and also allows frequent applications throughout the day. In case of mercurochrome, there is no need to remove the previous application before new application, as it dries up over the raw surface and effective drug delivery to the raw area with each application is ensured as the previous application dries up. Mercurochrome develops tough eschar resistant to infection as well as water and minimal trauma.

Mercurochrome shows a wide spectrum of antimicrobial activity and is effective against resistant organisms.

Mercurochrome is minimally absorbed even after the application over a larger raw surface area and does not show any systemic toxicity or electrolyte imbalance. It is effective at any pH as well as in presence of pus, blood and serum. It is effective in very low concentration and at the same time inadvertent application of higher concentrations does not affect the wound. It does not interfere with the uptake of a graft on the local area.

References

13. Mercurochrome.org, a group trying to reverse the FDA ban (site powered by WikiMedia)
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