The present invention is a handheld wound washing apparatus, which is primarily used for wound management. The effective wound management on mass scale is crucial to minimizing fallout of terrorist attack, explosion in factories, road and rail accidents. The jet-spray wound irrigation apparatus, working on spray atomization, addresses the requirement, on mass scale, of cleaning wounds with antiseptic solution to arrest infection, while victims are transferred on stretchers to hospitals. It alternately employs a narrow cone angle spray nozzle and a wide angle spray nozzle and a 12 volt battery for running a peristaltic pump.
Title of the Invention:

**A back-carried, battery-operated, jet-spraying apparatus for wound irrigation**

Field of the Invention:

This invention relates to the field of treatment of victims requiring urgent medical attention and more particularly to the field of wound irrigation with germicidal solutions of victims of burn, wound injuries to contain or prevent infection.

The present invention relates to medical device used in first-aid procedure with disinfectant and antiseptic solutions. It can be used for cleaning and disinfecting equipment used in first-aid and for spraying antiseptic liquid for washing wounds of trauma victims on a much wider scale. It is related to trauma management. In wide scale accidents or disasters - where number of people get injured and first-aid treatment becomes essential with minimum time loss - speedy cleaning of wound becomes essential. In case of external matter such as metal,
glass etc settling on the wound, to clean the affected area, the jetspray apparatus can be used very effectively.

Background of the Invention:
Following prior works are cited to pinpoint inherent drawbacks encountered in comparison to the present invention:

**US Patent Application 20090012484**
The cited work employs a diaphragm pump, with multiple compartments, a pressure sensing element and a barrier for preventing contamination of said pressure sensing element by liquid to be pumped. It is different from the present invention, which uses a peristaltic pump and multiple spray nozzles

**French Patent FR 2697755**
This work relates to an apparatus employing gas under positive pressure, an anti-static pipe, source of gas under positive pressure and a handle. It is different from the present invention.

**US Patent 5419772**
The cited work is different from the present invention, since the cited work relates to an apparatus, comprising an elongated handle having external ribbed surface for grip, a central passageway, a nose connected to plurality of spray nozzles and
a bulb pump capable of providing up to 600 mm positive pressure to solution held in a pressurized bag. It is different from the present invention, which employs a peristaltic positive pressure pump.

US Patent 6261275
This prior work relates to a wound irrigation device, comprising a fluid reservoir, a hollow tube member with an elongate arm tube portion, an elongate stem tube portion and a plurality of apertures for permitting solution flow. It is different from the present invention, which relies upon a peristaltic positive pressure pump and a plurality of spray nozzles.

US Patent Application 20070063075
This prior work relates to a device for home usage and is adapted to domestic water connection. It comprises a valve mechanism with lever for regulating flow and a singular spray nozzle suitable for entire range of domestic pressure. This prior work is dissimilar to the present invention, having no common features.

US Patent Application 20090069761
This prior work relates to a device, comprising a pressure housing, a diaphragm sealing said pressure housing, a magnet
coupled to said diaphragm and a magnetic switch configured to be actuated by said magnet for providing a vacuum for the working of the device. This prior work is different from the present invention, which employs a peristaltic positive pressure pump and a plurality of spray nozzles.

**US Patent 5941859**

This prior work employs vacuum, instead of positive pressure, for irrigating wound area and comprises a spray nozzle for delivery of liquid under high pressure, an irrigation tube, a suction trap and a portable suction unit for the working of the device. The present invention has no features found in this prior work.

**US Patent 5792109**

This prior work, for medical irrigation, comprises a plurality of flexible reservoirs containing liquids to be sprayed on predetermined area, a pair of air bladders and a pair of pressure dump valves. The device of this prior work is different from the present invention, employing a peristaltic pump and a plurality of pressure spray nozzles.

Disasters such as earthquake, bomb blast and railway accidents entail speedy first aid treatment to mass victims, before they are transferred to hospitals. A large number of victims need
their wounds to be properly cleaned with antiseptic solutions before dressing.

The starting point of first-aid is washing wound. If the wound is washed properly the infection can be controlled. Manually washing of the wound is time consuming and requires a large number of trained personnel, who may not be available at the place of accidents. To address this issue, the wound washing apparatus is developed.

In case of hospitals the inflow of trauma patients is very large in number, and effective cleaning and disinfection activity may not be effective. Due to improper cleaning of the wound sepsis and other complication may develop. The present invention is designed to handle a large number of persons within a short period so that wounds and burn injuries of mass victims can be effectively cleaned and disinfected.

Objects of the Invention:

One object of the present invention is to provide a compact, light in weight and easy-to-carry-on-back apparatus for mass cleaning and disinfecting of wounds.

Another object of the present invention is to provide sterilizable
contact parts and to eliminate crevices that promote bacterial growth.

Another object of the present invention is to provide ease in assembling and dissembling the apparatus.

Another object of the present invention is to deliver consistent operation in terms of cone angle of spray, droplets size, volume of liquid pumped irrespective of level of liquid in the tank.

In case of peristaltic pump all the above-required conditions are fulfilled. Silicone tubing, which is used as a part of the jetspray apparatus, is sterilizable.

The peristaltic pump can be operated for achieving greater discharge of disinfectant solution. The major advantage of using a peristaltic pump is its non-contact method of pumping. The disinfectant solution does not come in contact with rollers of the pump, thereby eliminating contamination of the solution being pumped. Peristaltic pump has less moving parts thereby, drastically reducing breakdown.

Description of the Drawings:

Drawing # 1 illustrates schematic arrangement of jetspray
wound washing apparatus (100).

Drawing # 2 illustrates silicon tube (60), traversing a path of inverted hyperbola around eccentric cam (36) of peristaltic pump (30).

5 Drawing # 3 illustrates front sectional view of 5-litres capacity stainless steel 316-L tank (10) and accessories thereof.

Drawing # 4 illustrates discharge spray of 10 degree cone angle of spray nozzle (50).

Drawing # 5 illustrates discharge spray of 120 degrees cone angle of spray nozzle (50').

Drawing # 6 illustrates installation of spray nozzle (50, 50') in horizontal direction.

Drawing # 7 illustrates working of the programmable logic control (70).

15 Drawing # 8 illustrates isometric view of the apparatus (100) and of the control panel (80) for operator, fitted on top surface of the apparatus (100).

Drawing # 9 illustrates electrical circuit for array of light emitting diodes (86).
Drawing # 10 illustrates 12 volts battery (40) and its circuit (41).

Detailed description of the Invention:

Spray automation covers large area and enters all corners of wound thereby leaving no part of the wound remaining unwashed. While victims are carried on stretcher, wound-washing activities could be performed minimizing time delay. Without moving victim, cleaning of the wound can be achieved by using spray nozzles. Evaporation of fine droplets depends upon exposed surface area. The droplets coming out of nozzle are controlled in such a fashion that a part evaporated creates sterile environment around the affected area and remaining droplets cleanse the wound. While the droplets evaporate, they take out the heat from surrounding atmosphere thereby causing cooling effect that reduces burning sensation to victims.

To clean eyes, purified water can be used to flush eyes with appropriate automation to spray. The container, which encloses the jetspray apparatus (100), is made up of unbreakable plastic ergonomically designed to ease carrying. The container is provided with back carrying arrangement due to which both hands of the operator are free to engage in effective cleaning of wound. The container has a place to store the following accessories:
gloves
eye protection goggles
irrigation pan
torch
5 scissors and surgical kit.

The battery (40) and its electrical circuit (41) provide 5 hours of continuous operation with deep discharge characteristic. The battery (40) is sealed lead acid type and maintenance free.

All tube fittings are safe push fittings. While in operation, should a fitting come out loose for any reason, the flow of liquid gets stopped. The peristaltic pump (30) allows for step less increasing and decreasing of the speed because of which the discharge become adjustable to take care of the distance.

Minimum pressure required to clean wound without pain varies from 8-12 psig and safety valve is set at 15 psig pressure. The wound irrigation is divided into high pressure irrigation where the pressure maintained is 8 - 12 psig and low pressure irrigation where pressure is maintained between 5 - 6 psig. The programmable logic controller (70) (with digital and analog controls) controls the entire operation and is provided with an extra e-prom to take care of break downs at a last movement pre-program.
The spray controllers (61, 61') provided to the tank (10) are detachable and control spray angle from the nozzle (50, 50') respectively to give large coverage area.

On the top of the apparatus (100), a control panel (80) is fitted and is operated by operator for control of the jetspray apparatus (100). It comprises a pump speed regulator (84), light emitting diodes button (86), visual alarm (81) and on/off switch (85). Additional buttons/switches on the control panel (80) are power (82), motor switch (83).

In case of washing wound in darkness, additional lighting arrangement is provided by array of light emitting diodes (86). When antiseptic solution levels go down below the specified limits, visual alarm (81) is activated, thereby allowing adequate time in advance for replenishing antibacterial solution.

The jetspray wound irrigation apparatus (100) has all contact 200 parts which are compatible with commonly used antiseptic solutions.

The tank (10) and all the contact parts of the disinfectant solution are made of stainless steel 316-L. The peristaltic pump (30) works on direct current power with 12 volt battery or it has a transformer 240 volt AC supply is converted into 12 volt AC supply, which is further converted into 12 volt DC. An electronic circuit/varic resistor (31) fitted to the motor controls
speed of the peristaltic pump (30). The speed regulator (84), provided on the top of said apparatus (100), controls the motor drive that controls speed of the peristaltic pump (30). By controlling speed of the pump (30), the pressure and flow get controlled. The discharge side of the pump (30) has spray patterns. These spray patterns are connected to two independent spray nozzles. One-spray nozzle (50) has a 10° spray angle and the other spray nozzle (50') has a 120° spray angle. These two sprays are solid cone spray.
These are connected as shown below.

\[
\tan 5^\circ = \frac{x}{15}
\]

\[
0.087 = \frac{x}{15}
\]

\[
x = 13.05 \sim 13
\]

Therefore, Whole cone \sim 26 \text{ mm } \phi
Spray nozzle 10°

Solonide Valve

Narrow Angle Spray

Pump disinfectant

Wider Angle Spray

Solonid Valve

Spray nozzle 12°

Figure 2

In case of wider angle spray............

120°

150 mm

260 mm

520 mm

60°

260 mm

Wound Area

Figure 3
\[ \tan 60 = \frac{x}{150} \]

\[ x = 260 \text{ mm} \]

The concentration of spray and the velocity of spray can be calculated as under.

5 Concentration of spray -

The volume of cone is given as

\[ \frac{1}{3} \pi r^2 h \]

Where,

\[ r = \text{radius of base of the cone} \]

10 \( h = \text{height of the cone} \)

To have homogeneous spray depends on the pressure. The outflow from nozzle is directly proportional to pressure \((Pr)^n\)

Where 'n' is exponent and for a full cone nozzles standard time

\[ n = 0.46 \]

15 Normally the spray angle and the coverage are roughly given in the table 1.
<table>
<thead>
<tr>
<th>Included Spray Angle</th>
<th>Theoretical Coverage at Various Distances From Nozzle Orifice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2&quot;</td>
</tr>
<tr>
<td>5°</td>
<td>.2&quot;</td>
</tr>
<tr>
<td>10°</td>
<td>.4&quot;</td>
</tr>
<tr>
<td>15°</td>
<td>.5&quot;</td>
</tr>
<tr>
<td>20°</td>
<td>.7&quot;</td>
</tr>
<tr>
<td>25°</td>
<td>.9&quot;</td>
</tr>
<tr>
<td>30°</td>
<td>1.1&quot;</td>
</tr>
<tr>
<td>35°</td>
<td>1.3&quot;</td>
</tr>
<tr>
<td>40°</td>
<td>1.5&quot;</td>
</tr>
<tr>
<td>45°</td>
<td>1.7&quot;</td>
</tr>
<tr>
<td>50°</td>
<td>1.9&quot;</td>
</tr>
<tr>
<td>55°</td>
<td>2.1&quot;</td>
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<tr>
<td>60°</td>
<td>2.3&quot;</td>
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<td>90°</td>
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<tr>
<td>95°</td>
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<td>120°</td>
<td>8.6&quot;</td>
</tr>
<tr>
<td>130°</td>
<td>10.9&quot;</td>
</tr>
<tr>
<td>140°</td>
<td>14.9&quot;</td>
</tr>
<tr>
<td>150°</td>
<td>22.7&quot;</td>
</tr>
<tr>
<td>160°</td>
<td>45.8&quot;</td>
</tr>
</tbody>
</table>
The factors affecting the spray nozzles performance for various physical parameters are given in the table 3.

**TABLE 2**

<table>
<thead>
<tr>
<th>Spray Pattern Type</th>
<th>Spray Angle</th>
<th>Unit Impact Per Sq. Inch as a Percent of Theoretical Total Impact*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Cone</td>
<td>15°</td>
<td>11%</td>
</tr>
<tr>
<td></td>
<td>30°</td>
<td>2.5%</td>
</tr>
<tr>
<td></td>
<td>50°</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>65°</td>
<td>.4%</td>
</tr>
<tr>
<td></td>
<td>80°</td>
<td>.2%</td>
</tr>
<tr>
<td></td>
<td>100°</td>
<td>.1%</td>
</tr>
</tbody>
</table>

* At 12° (30 cm) distance from the nozzle.
The pump (30) is a peristaltic pump, battery operated with the flow rate and other technical data as given under.
### Specification of pump

<table>
<thead>
<tr>
<th>Flow rate, max.</th>
<th>3.4 liters/min at max. 1.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity with one charged battery</td>
<td>Ca. 45 liters</td>
</tr>
<tr>
<td>Pump rollers</td>
<td>3</td>
</tr>
<tr>
<td>Pump-head materials</td>
<td>Housing PP / Rotor mill</td>
</tr>
<tr>
<td>Tubing ID</td>
<td>0.8 to 8.0 mm</td>
</tr>
<tr>
<td>Tubing WT</td>
<td>1.6 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>2.7 kg complete pump * with water (+21°C)</td>
</tr>
</tbody>
</table>

### Specification of Drive

<table>
<thead>
<tr>
<th>Voltage</th>
<th>12 volt</th>
</tr>
</thead>
<tbody>
<tr>
<td>No load speed</td>
<td>1st gear 0-450 rpm / 2n</td>
</tr>
<tr>
<td>Speed control</td>
<td>Continuously variable speed</td>
</tr>
<tr>
<td>Max. torque</td>
<td>45 Nm</td>
</tr>
<tr>
<td>Power pack</td>
<td>NiCd 2.4 Ah</td>
</tr>
<tr>
<td>Battery charger</td>
<td>230 Volt (Standard), 12</td>
</tr>
<tr>
<td>Charging time</td>
<td>Approx. 60 Min.</td>
</tr>
<tr>
<td>Charging cycles</td>
<td>Up to 1800 cycles</td>
</tr>
</tbody>
</table>
The peristaltic pump (30) is integrated with the nozzle spraying system (50, 50') to give required spraying arrangement. To avoid pulsating flow 3 metallic coil of the same ID (Internal Diameter) are provided and the pump (30) is connected to silicon tubes (60) on intake and discharge sides. As seen in the data sheet once the battery (40) is charged, the apparatus (100) can work for discharging 45 liters of antiseptic solution.

Beast method for operating the Invention:

1. Nozzles be made of S.S. 316
2. 120 degree wide angle spray nozzle (50') flat type, free of wear and tear.
3. droplets medium-sized
4. Surface tension and viscosity of anti-septic solution small.
We claim:

1. A back-carried, wound irrigation jetspray apparatus (100) with a battery-operated peristaltic pump comprising,
   (i) a stainless steel 316-L, 5-litre capacity tank (10), filled with 3-5 litres volume of a germicidal solution (20);
   (ii) a peristaltic pump (30), fitted with a ceramic filter (35) on its suction end;
   (iii) a 12 volt, sealed, lead acid maintenance free battery (40) and electrical circuit thereof (41);
   (iv) a narrow angle spray nozzle (50) alternating with a wide angle spray nozzle (50) on discharge end of said peristaltic pump (30);
   (v) silicon tubes (60) completing suction and discharge end connections of said peristaltic pump (30);
   (vi) a programmable logic control (70) with internal circuit (71) thereof for operation of said apparatus (100);
   (vii) a control panel (80) for operation - by operator - of said jetspray apparatus (100).
2. A back-carried, wound irrigation jetspray apparatus (100) with a battery-operated peristaltic pump (30) as claimed in claim 1, wherein said stainless steel 316L tank (10) is 1 mm thick and is fitted with a manhole (09), threaded cap (11), gasket (08) for said manhole (09) and a level indicator (07) on top end thereof.

3. A back-carried, wound irrigation jetspray apparatus (100) with a battery-operated peristaltic pump (30) as claimed in claim 1, wherein said peristaltic pump (30) is mono block and is made of aluminum alloy.

4. A back-carried, wound irrigation jetspray apparatus (100) with a battery-operated peristaltic pump (30) as claimed in claims 1 and 3, wherein said pump (30) runs on 12 volt D.C. sealed, acid lead battery (40) of 2.4 Ah rating and is capable of spraying 45 litres of said germicidal solution (20) on a single battery charge.

5. A back-carried, wound irrigation jetspray apparatus (100) with a battery-operated peristaltic pump (30) as claimed in claim 1,
wherein said germicidal solution (20) is pumped with a pressure relief valve (34) being activated at 15 psig pressure.

6. A back-carried, wound irrigation jetspray apparatus (100) with a battery-operated peristaltic pump (30) as claimed in claim 1, wherein a varic resistor (31) fitted to motor (32) of said peristaltic pump (30) controls speed of said peristaltic pump (30).

7. A back-carried, wound irrigation jetspray apparatus (100) with a battery-operated peristaltic pump (30) as claimed in claim 1, wherein said nozzles (50, 50') are flat, are constructed of stainless steel 316, have a 10 degrees and 120 degrees spray angle respectively and are fitted in horizontal direction.

8. A back-carried, wound irrigation jetspray apparatus (100) with a battery-operated peristaltic pump (30) as claimed in claims 1 and 3, wherein said silicon tube (60) traverses around eccentric cam (36) of said peristaltic pump (30) along inverted-hyperbola-shaped path.
9. A back-carried, wound irrigation jetspray apparatus (100) with a battery-operated peristaltic pump (30) as claimed in claim 1, wherein discharge end of said peristaltic pump (30) is fitted with spray controller (61, 61') in parallel, which are respectively connected to input end of spray nozzles (50, 50') respectively.

10. A back-carried, wound irrigation jetspray apparatus (100) with a battery-operated peristaltic pump (30) as claimed in claim 1, wherein said spray controllers (61, 61') are manually operated knobs and are fitted in vicinity of one lateral end of said jetspray apparatus (100).

11. A back-carried, wound irrigation jetspray apparatus (100) with a battery-operated peristaltic pump (30) as claimed in claim 1, wherein an array of light emitting diodes (86) constitute an additional light source, which is positioned above said spray controllers (61, 61') on said one lateral side of said jetspray apparatus (100).
12. A back-carried, wound irrigation jetspray apparatus (100) with a battery-operated peristaltic pump (30) as claimed in claim 1, wherein said jetspray apparatus is provided - on top surface thereof - with a liquid level visual alarm (81), power indicator (82), motor switch (83), pump speed regulator (84), on-off switch (85) for apparatus (100) and additional light source button (LED) (86).

13. A back-carried, wound irrigation jetspray apparatus (100) with a battery-operated peristaltic pump (30) as claimed in claim 1, wherein said battery circuit (41) of said battery (40) directs discharge of said peristaltic pump (30) through either said narrow angle spray nozzle (50) or said wide angle spray nozzle (50').

14. A back-carried, wound irrigation apparatus (100) with a battery-operated peristaltic pump as substantially described herein above and illustrated in the accompanying drawings # 1 to # 10.
## INTERNATIONAL SEARCH REPORT

International application No
PCT/IN2009/000690

### A. CLASSIFICATION OF SUBJECT MATTER

I NV. A61M3/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internai 1, WPI Data

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
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Further documents are listed in the continuation of Box C.

See patent family annex.

### Date of the actual completion of the international search

18 November 2010

Name and mailing address of the ISA/Authorized officer
European Patent Office, P.B. 5018 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016

Kaden, Malte
# DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
</table>
Continuation of Box II.2

Claims Nos.: 14

No search report has been established for claim 14 in view of Articles 17(2)(a)(ii) and 17(2)(b) PCT. This claim merely refers to the drawings and fails to comply with the requirements of Rule 6.2(a) PCT to such an extent that a meaningful search cannot be carried out.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.2), should the problems which led to the Article 17(2) declaration be overcome.
**INTERNATIONAL SEARCH REPORT**

**Box No. II  Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. □ Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:

2. □ Claims Nos.: 14 because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
   
   see FURTHER INFORMATION sheet PCT/ISA/210

3. □ Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III  Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1. □ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. □ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. □ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. □ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

- □ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- □ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- □ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (April 2005)
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