

# Prevention of Projectile and Aerosol Contamination During Pulsatile Lavage Irrigation Using a Wound Irrigation Bag

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## Abstract and Introduction

### Abstract

Pulsatile lavage is a high-pressure irrigation treatment commonly used in the debridement of wounds. The risk of exposure to bloodborne pathogens and contaminants using high-pressure irrigation has been well documented in the literature. Projectile droplets and aerosolized fine droplets may form and spread, potentially contaminating the treatment facility and infecting personnel. A new device (Wound Irrigation Bag<sup>®</sup>, Pulse Care Medical LLC, North Andover, Mass) has been designed to decrease the dissemination of projectile and aerosolized particles. The wound irrigation bag (WIB) uses containment to decrease the amount of projectile and aerosolized pathogens spread during pulsatile lavage. This randomized prospective trial demonstrated that the WIB significantly decreased the amount of bacterial colony forming units disseminated during pulsatile lavage of infected wounds compared to standard wound irrigation techniques. The WIB is a useful new tool in the armamentarium of wound care that protects the debridement facility and the personnel who operate it by significantly reducing the dissemination of infectious particles.

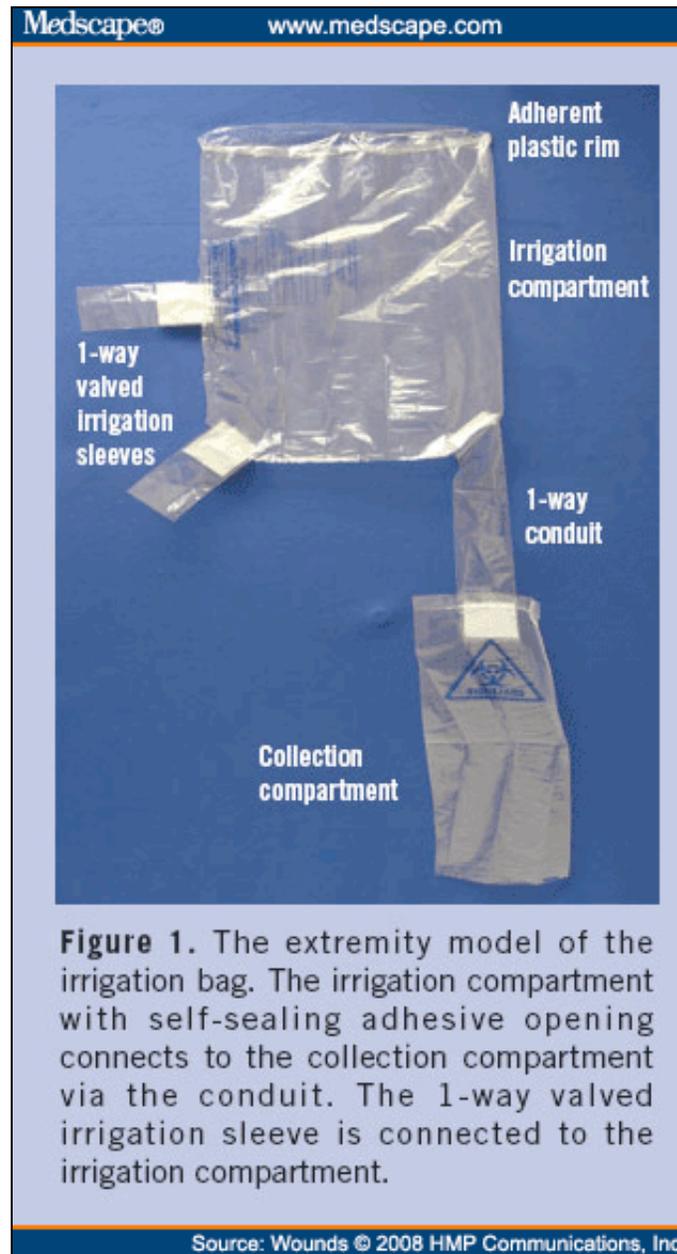
### Introduction

Pulsatile lavage is a high-pressure wound irrigation system commonly used in operating rooms and wound care facilities. The system consists of a battery-powered device which delivers a pressurized sterile crystalloid solution to the wound bed at usually no greater than 15 psi. The device administers a fluid stream to the wound surface and has a built-in suction tube that concurrently removes the fluid as it is dispensed. A small circular shield is attached to the nozzle of the device, which serves to decrease gross splash when placed in contact with the wound bed. Tubing connects the device to a sterile irrigation fluid bag and a suction pump with a collection canister. Proper technique requires close proximity of the device's suction tip with the wound bed at all times during irrigation. This can be difficult to achieve when used on wounds with irregular contours. For example, sacral decubitus ulcers present a challenge with their jagged irregular surfaces. Often the vacuum seal is broken leading to splashing and contamination from fluid droplets.

The risk of exposure to bloodborne pathogens for surgical personnel is well established in the literature.<sup>[1,2]</sup> The risk of percutaneous injury and contact via mucous membranes, conjunctiva, or non-intact skin has also been described.<sup>[3-6]</sup> High pressure irrigation is associated with a particularly high incidence of contamination from fluid dispersing around the wound.<sup>[4]</sup> Facial contamination of personnel resulting from droplets during pulse lavage irrigation has also been reported.<sup>[7]</sup> Adequate barrier protection during the course of the pulsatile lavage is important in decreasing the risk of human immunodeficiency virus (HIV), hepatitis B virus, and multi-drug resistant bacterial exposure.<sup>[8,9]</sup> The literature describes a few innovative methods of decreasing projectile and aerosolized emissions in the operating room.<sup>[1,4,8,10]</sup> Each of these methods requires the placement of holes in a bag in order to insert the pulse lavage device and suction tubing.

The authors evaluated an easy and convenient method of decreasing projectile contamination in the operating room and protecting personnel from exposure while using pulse lavage. The Wound Irrigation Bag<sup>®</sup> (Pulse Care Medical LLC, North Andover, Mass) is a sterile plastic self-sealing system, which consists of a bag with 2 compartments connected by a conduit. The irrigation compartment has a 1-way valved sleeve that permits the pulsatile lavage device to enter but restricts any fluid or splatter from leaking out. Any fluid runoff from the irrigation compartment flows by gravity through the

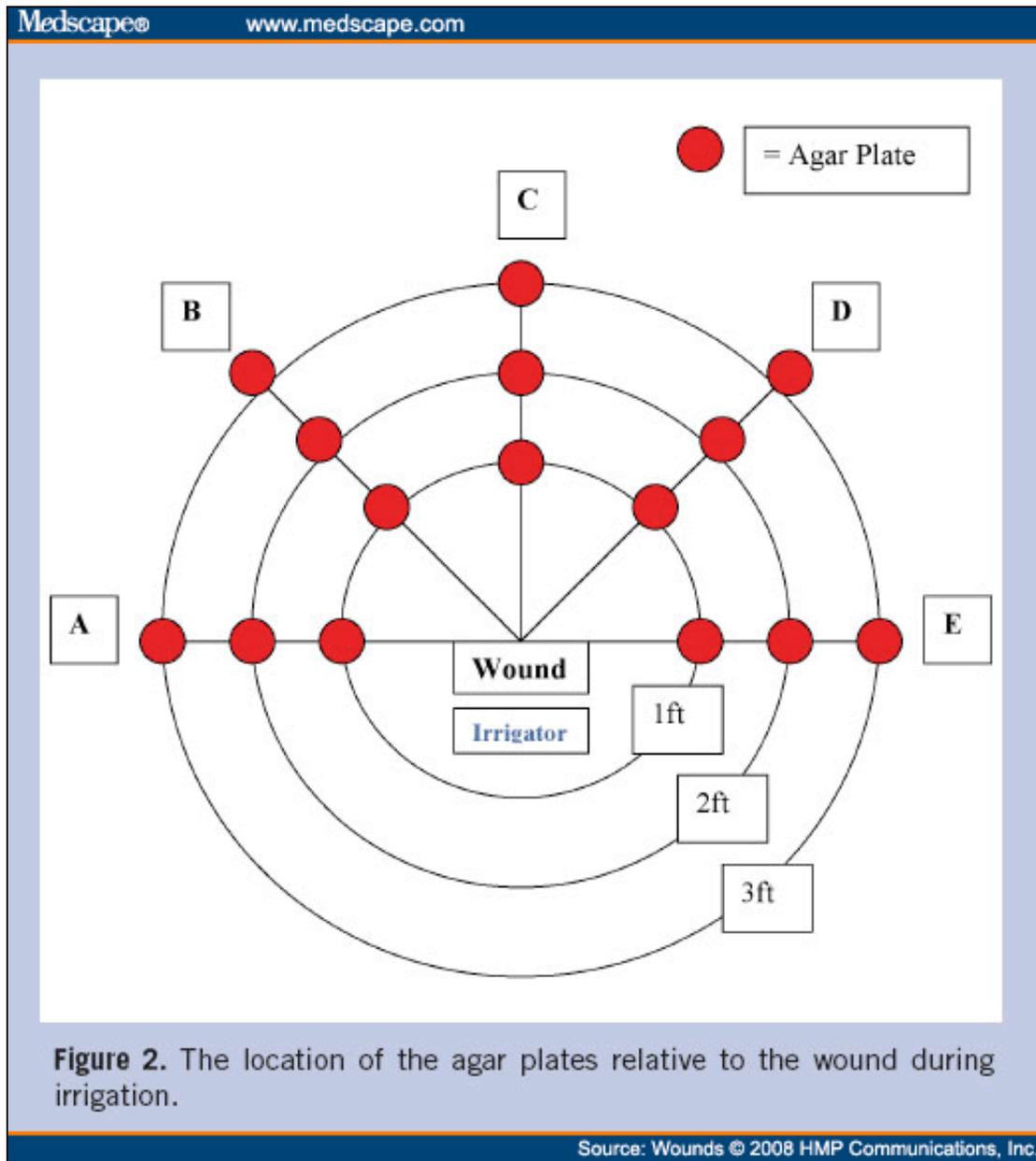
conduit into the collection compartment where it is contained for disposal (Figure 1). This study compared the amount of aerosol and projectile contamination that occurs during pulse lavage with and without the WIB. No previous study has shown objective evidence of decreased operating room contamination and reduced risk of exposure to personnel performing pulse lavage.



**Figure 1.**

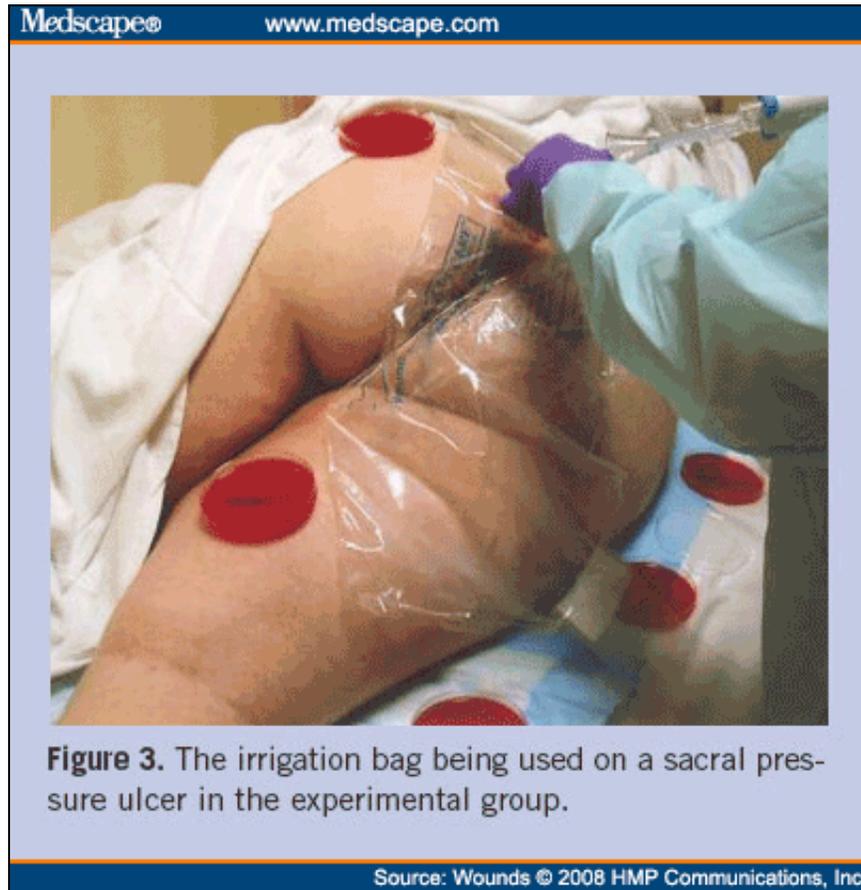
## Materials and Methods

The study consisted of 10 patients with 10 infected wounds who were randomly selected to receive or not receive the WIB treatment. Each wound was measured and the surface area calculated. Wounds were assessed for level of contamination and randomized accordingly so that the control and experimental groups had approximately the same level of contamination. Five sets of 3 agar plates were placed in a semicircular pattern at a distance of 1, 2, and 3 feet from the wound (Figure 2). Each group of 3 plates was separated by a 45-degree angle. Fifteen plates were used for each wound.



**Figure 2.**

The operative field was prepped and draped in the usual sterile manner. In the experimental group, the WIB was adhered to the skin surrounding the wound creating a watertight seal (Figure 3). Pulse lavage was performed by placing the irrigation device through the 1-way sleeve and irrigating with 3-L of sterile normal saline mixed with 50,000 units of bacitracin. A nearly identical technique was used in the control group, except for the absence of the WIB.



**Figure 3.**

## Results

The experimental group (WIB) showed a statistically significant difference in the mean number of colony-forming units as compared to the control group: 0.24 versus 30.1, respectively:  $P < .01$  ( Table 1 ). The experimental group also showed statistically significant differences in the mean number of colony-forming units at 1, 2, and 3 feet when compared to the control group ( Table 2 ). Data analyses were conducted using SPSS Independent Samples t-test.

### Table 1.

Medscape®		www.medscape.com				
Table 1. Location and level of contamination of study wounds.						
Wound location	Level of contamination	WIB used?	Surface area (cm <sup>2</sup> )	Average CFUs (total per group)	Average CFUs	P
Ischium	2	No	674	18.3	30.1	< .01
Upper extremity	1	No	424	5.6		
Trochanteric	1	No	603	33.2		
Sacrum	2	No	188	42.1		
Ischium	4	No	95	51.2		
Trochanteric	4	Yes	377	0.13	0.24	
Sacrum	1	Yes	589	0		
Sacrum	4	Yes	119	0.27		
Ischium	4	Yes	376	0.07		
Lower extremity	2	Yes	541	.73		

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Table 2.

Medscape®		www.medscape.com	
Table 2. Colony forming units (CFUs) in study and control groups at 1, 2, and 3 feet.			
Distance (ft)	Average CFUs (experimental group)	Average CFUs (control group)	P
1	0.02	52.8	< .01
2	0.08	23.7	< .05
3	0.44	13.5	< .05

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## Discussion

The management of infected wounds remains a challenging problem for wound care specialists. Removing foreign bodies and debriding necrotic tissues are first line actions, but decreasing the bacterial colony count in the wound is of equal importance. Tissue bacteria levels  $\geq 10^5$  are associated with compromised wound healing.

The removal of bacterial exotoxins, endotoxins, and metalloproteinases is essential to preventing a colonized wound from progressing to an infected wound. Irrigation in the form of pulsatile lavage is pivotal in the reduction colony forming units. Pulsatile lavage not only washes away bacteria, but also breaks up dangerous biofilms that block the penetration of systemic antibiotics and contribute to sensitive bacteria acquiring resistance.<sup>[11]</sup>

The utility of pulsatile lavage is well documented as evidenced by its routine use in the management of infected wounds. However, with the alarming problem of antimicrobial resistance, it is imperative to develop techniques that prevent the spread of potentially lethal bacteria, while effectively treating difficult wounds. Pulsatile lavage offers several advantages when used in the treatment of wounds infected with multidrug-resistant bacteria. Pulsatile lavage is effective in removing

the infectious bioburden of the bacteria and does not promote the further development of resistance. Pulsatile lavage may reduce the need for additional antibiotics. However, because of the mechanical debridement caused by pulsatile lavage and the difficulty in maintaining a closed system while irrigating, additional measures should be taken to prevent the dissemination of infectious material.

This study demonstrates that infection control can be accomplished with the use of containment devices such as the WIB. The WIB effectively reduced the number of bacterial colony forming units captured on the agar plates within a 3-foot radius by physically blocking the splatter created during pulsatile lavage. Containment cuts down on risk of exposing personnel to infectious pathogens and protects the treatment facility from contamination. Examples can be found in the literature where contamination has been traced back to pulsatile lavage of wounds with multidrug-resistant bacteria. Maragakis et al<sup>[9]</sup> reported an outbreak of multidrug-resistant *Acinetobacter baumannii* where the investigators determined transmission was caused by pulsatile lavage contaminating the treatment facility and spreading the infection to multiple patients. Such outbreaks likely can be avoided with improved containment techniques, ultimately protecting patients and personnel while preventing nosocomial infections.

Hospitals and wound care facilities have addressed the issue of contamination by isolating patients during treatment in special treatment rooms. While this strategy is effective, it is also costly and time consuming. A better strategy is to isolate the treatment process itself. The WIB, which traps infectious material in a self-sealing disposable bag, allows containment to be brought to the patient. This eliminates the need and risk of transporting the infected patient through the facility to a special treatment room. Daily treatments can be performed safely at the patient's bedside without leaving the hospital room or ICU bed.

## Conclusion

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This study compared the WIB with the standard techniques of pulsatile lavage. Use of the device decreased the amount of projectile and aerosolized pathogens during irrigation. The results showed statistically significant differences overall and at all 3 distances of exposure measured. A comparison of bacterial growth results concludes that the use of the WIB decreases contamination of the treatment facility and reduces exposure risk to operating room personnel.

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