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## Increased Safety of Surgical Glove Application: The Under/Over Method

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### Abstract

**Background:** Surgical gloves are a necessity in performing abdominal and pelvic surgery not only to protect the patient from bacterial contamination but also to protect the surgeon, the nurses and surgical assistants from biological fluids. The interface of the surgical gown and the surgical gloves at the wrist is a site for interruption of the barrier between biological fluids in the open abdomen and the surgeon.

**Methods:** In the under/over method (UOM) for double-glove application the first pair of gloves are positioned under the surgical gown and the second pair are positioned over the cuff of the surgical gown and secured with self-adherent wrap.

**Results:** Using the UOM, the proximal portion of the surgical gloves did not roll down to the wrist. The self-adherent wrap reduced the entrance of biological fluids into the space between the surgical gloves and the cuff of the surgical gown. If the cuff of the surgical gown became wet, it was not in contact with the wrist skin.

**Conclusion:** The UOM prevents the surgical gloves from rolling down on the forearm. Contact of the cuff of the surgical gown with the wrist skin is prevented. The possibility of exposure of the wrist skin to biological fluids, especially large volume irrigation, during abdominal and pelvic surgery may be reduced.

**Keywords** Surgical gloves; Skin contamination; Abdominal irrigation; Intraperitoneal chemotherapy; Double gloves; Surgical attire; Surgical gown

### Introduction

A hospital is one of the most hazardous places to work. Between 2003 and 2011 in the United States, 263 health care workers died from work-related injury and 37 (14%) were a result of work-related contamination by biological fluids [1]. A majority are caused by puncture wounds by a needle. In a meta-analysis performed by the Cochrane group, all studies showed that there were fewer perforations of the inner glove when double gloves were worn. Currently, most surgeons prefer double-gloving as a method of self-protection from body fluid exposure [2]. However, another prominent cause of work-related injury is skin contamination by biological fluids that contain blood products, urine, feces or saliva. This is more prominent with cutaneous scratches, skin lesions, abrasions or burns on exposed skin [3]. All these sources of injury to health care workers have been reduced in recent years by increased safety practices and safety awareness. Yet diseases continue to be transmitted and skin exposures to biological fluids does occur. In the operating theatre a prominent site for contamination from patient to surgeon is the interface of the surgeon's gloves with the surgical gown. Quebbeman et al. [4] reported the skin of the wrist (forearm) is the site for contamination of surgeons performing abdominal and pelvic surgery in 22% of 234 cases that were monitored. The mechanism for this contamination at the surgical gown/surgical glove interface is invariably two-fold. First, the surgical gloves with motion at the wrist roll down to expose the cuff of the surgical gown. Biological fluids can then rapidly permeate the cloth

cuff of the surgical gown and contact (sometimes over a prolonged time period) the skin at the wrist. Usually, when this occurs, the gown and double gloves are changed and there is no incident. Yet the distant possibility remains for disease transmission especially if there are cuts or abrasions of the skin at the wrist. This manuscript describes a double-glove technique that is not more expensive. It is suggested that the UOM may be more effective in prevention of intraoperative contamination at the interface of the surgeon's gloves and surgical gown.

### Method

After the surgeon has scrubbed and dried his/her hands and forearms to the elbow, the first pair of surgical gloves (under gloves) is applied and the upper part of the glove brought up to the level of the mid-forearm. These are the under gloves (Figure 1). The second step is to put on the surgical gown. The cuffs of the surgical gown should only be pulled up to the level of the upper palm/lower wrist. The cuff of the surgical gown should not be touching the skin of the surgeon's wrist at any place. In other words, the first pair of gloves is positioned beneath the cuff of the surgical gown (Figure 2). The third step is to place the second pair of gloves up and over the cuff of the surgical gown (over gloves). These gloves should be stretched so that the upper portion of the surgical glove is at the level of the mid-forearm (Figure 3). The fourth and final step of the under then over method (UOM) is to secure the outer gloves at the mid-forearm with a sterile self-adherent wrap (Coban, 3M Health Care, St. Paul, MN). 1½ times around the forearm with the adherent wrap is sufficient to maintain the upper limit of the over gloves at the level of the mid-forearm (Figure 4). The adherent wrap is applied equally on the upper part of the surgical

gloves and the surgical gown. Excessive adherent wrap should be avoided. If this occurs, the wrap will make removal of the gown and outer gloves difficult at the termination of the surgical procedure.

At the termination of the surgical procedure the surgical gown, adherent wrap (1½ times around the forearm) and outer surgical gloves are removed as a unit. The under surgical gloves can be used during further direct skin contact with the patient as, for example, for application of the surgical dressing.



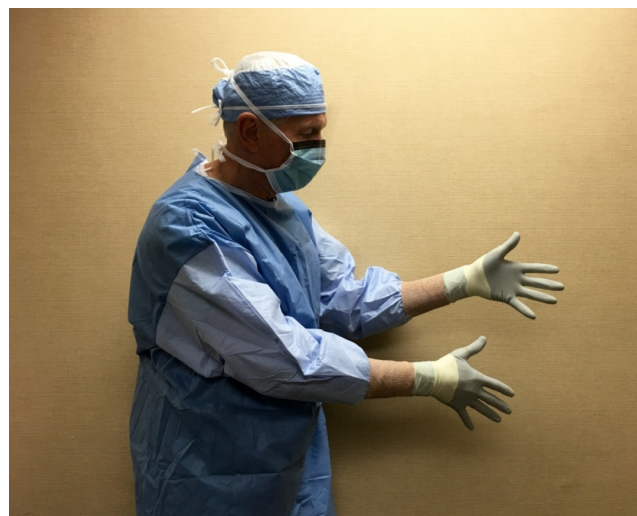
**Figure 1:** After the surgeon, nurse, or surgical technician scrubs and dries his/her hands, the first pair of surgical gloves (under gloves) are applied and the upper part of the glove advanced to the mid-forearm. Putting on the first pair of gloves before putting on the surgical gown is an essential feature of the under/over method.



**Figure 2:** The surgical gown is put on and care is taken to advance the cuff of the surgical gown only to the level of the upper palm/lower wrist.



**Figure 3:** The outer gloves are then put on and the upper portion of the surgical gloves, are stretched to the level of the mid-forearm over the top of the surgical gown.



**Figure 4:** The outer gloves are secured at the level of the mid-forearm using a self-adherent wrap. The wrap is applied equally 1½ times around the forearm to the gown and surgical glove.

## Results

In a single operating room the scrub nurses and operating room technicians were instructed in the UOM without difficulty. The rationale was well understood and the new method initiated and continuously sustained. I used the UOM in 100 consecutive cases without evidence for skin contamination at the wrist. On 8 occasions the cuff of the surgical gown became wet by copious irrigation of the open abdomen but there was no skin contact. With UOM for surgical glove application, the upper limit of the surgical gloves cannot roll down with surgical activity as often occur in the absence of self-

adherent wrap. The upper limit of the outer surgical glove always stayed in place when a self-adherent wrap was applied one and one-half times around the mid-forearm. The cuff of the surgical gown, even though it became wet, never came in contact with the skin of the surgeon's wrist.

Upon occasion excessive sterile self-adherent wrap (more than 1½ times around the mid-forearm) was applied. If this occurred the gown and outer surgical gloves are difficult to remove as a single unit. If there is excessive self-adherent wrapping a blunt scissor should be used to cut the self-adherent wrap and outer surgical glove beneath prior to removal of the surgical gown and outer surgical gloves. If the outer gloves and then the inner gloves are not removed in an orderly manner, contamination of the under surgical gloves may occur. Wrist exposure will not occur if the surgical gown and outer surgical gloves are pulled off as a unit, first gown and then gloves. Or if the gown and double gloves do not strip off together, remove the outer gloves and surgical adherent wrap, then gown and finally the inner gloves in an orderly manner.

## Discussion and Conclusion

Elbow-length surgical gloves help prevent the possibility of wrist skin contamination if the gloves are prevented from rolling down using a self-adherent wrap. However, the increased expense of elbow length gloves and their decreased availability make this an unlikely solution to this problem. These elbow-length gloves have been recommended for extensive intra-abdominal irrigation techniques with large volumes of intra-abdominal fluid (X-tender cuff, Ansell Healthcare, Massillon, OH). When available, these elbow-length gloves allow for increased safety for delivery of hyperthermic intraperitoneal chemotherapy (HIPEC) [5]. Similarly, extensive intraperitoneal lavage (EIPL) after surgical procedures along with manual distribution of the irrigation fluid has been recommended to clear cancer cells from the abdomen and pelvis. Their lack of availability on a routine basis makes this an imperfect solution to the wrist contamination problem. Large volume intraoperative irrigation with saline or a saline plus antibiotic solution is of value in decreasing the incidence of intra-abdominal infection and reducing the incidence of peritoneal metastases [6,7]. This cleansing of the abdominal surfaces should be accompanied by generous use of closed-suction drains to remove serous fluids that will accumulate postoperatively. During these large volume irrigations vigorous manual distribution of the irrigation fluid is required. With all large volume irrigation, the UOM should always be used in order to minimize contamination of the surgeon's skin. Its routine use with all open abdominal surgical procedures will minimize an otherwise prominent cause for skin contamination by health care workers in the operating room. A brief description of the UOM technique has appeared in the British surgical literature [8]. There are several reasons why routine use of the UOM was initiated in my operating theatre rather than elbow length gloves. First and perhaps most important is a lack of latex-free elbow length gloves. The powder-free elbow length gloves available were latex and all latex-containing products have been

discontinued. Second, the elbow length gloves are double the price of standard surgical gloves. The same protection as elbow length gloves provide can be obtained by the UOM. Routine use of elbow length gloves would be prohibitively expensive. Also, we have found that the cuff of elbow length gloves do not stay at the elbow unless self-adherent wraps is used to keep them in place on the forearm. Finally, elbow length gloves are hot and their routine use would not be well received.

The UOM has been shown to reduce skin contamination by biological fluids if the cuff of the surgical gown inadvertently becomes wet. This strongly suggests benefit for routine use of UOM. Unfortunately, a clinical trial to establish increased safety would be difficult or impossible and very expensive. The endpoints of the trial would be difficult to establish and very large numbers of cases analyzed to achieve statistical significance. Reduction in the incidence of an unusual event is, however, a valuable long-term objective. UOM has face value if the skin contamination at the wrist in the operating theater can be prevented without increased cost. The UOM can result in reduced operating room costs. If abdominopelvic surgeries result in contamination of wrist skin, the gown and double gloves must be changed. This causes a needless increased expense. The surgical gown (approximately \$8.00 each) and one pair of surgical gloves (approximately \$2.00 per pair) may be repeated many times each year. The UOM prevents this unnecessary expense. One roll of self-adherent wrap is sufficient for all surgeons for a single case and costs approximately \$2.39 per roll.

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