Barrier protection with examination gloves: Double versus single

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In a series of experiments, the barrier integrity of single and double vinyl and latex examination gloves were tested for dye and water leaks after being placed under stress. A total of 886 examination gloves (385 vinyl: single, 199; double, 186; and 501 latex: single, 290; double, 211) were tested with a standardized clinical protocol designed to mimic patient care activities. Leakage rates for single or double gloving were significantly higher for vinyl than for latex gloves. Single vinyl gloves were significantly more likely to leak than were double vinyl gloves (51.3% and 19.7%, \( p < 0.0001 \)). However, there were essentially no differences in leakage rates for single or double latex gloves (4.1% and 3.8%, \( p = 1 \)). Significantly higher rates of leakage were identified with the water leak test than with the dye test for vinyl (\( p < 0.001 \)) but not for latex (\( p = 0.22 \)) gloves. For vinyl but not latex gloves, there were significant differences in leakage rates by brand. We conclude that double gloving offers little advantage during routine procedures associated with minimal stress to the gloves or when latex gloves are worn. (AJIC Am J Infect Control 1994;22:12-5)

The AIDS epidemic has prompted health care personnel to question the barrier effectiveness of gloves used in clinical settings. The fear of exposure to contaminated blood and body fluids has forced providers to seek alternate ways to add protection. One such method has been the use of a double rather than a single pair of gloves during certain high-risk patient care activities, such as handling sharp objects during surgical procedures.

Although Kotilainen and coworkers\(^1\) suggest that no difference exists between vinyl and latex examination gloves before use, Korniewicz and associates\(^2\) demonstrated that there was a difference in barrier effectiveness between vinyl and latex examination gloves after use for procedures common in clinical practice. Dalgleish and Malkovsky\(^3\) showed that the quality of gloves may depend on manufacturer, and Klein and coworkers\(^4\) demonstrated that the type of material used may affect the effectiveness of the barrier. Matta and colleagues\(^5\) reported that double gloving during routine surgical procedures could provide added protection between the patient and the hands of the surgeon. Additionally, Gani and associates\(^6\) found that double gloving could reduce the risk for operating room personnel of hand skin exposure to the patients’ blood and body fluids from 20.8% to 2.5%. Albin and coworkers\(^7\) reported that surgical gloves tested every 15 minutes had leaks 25% of the time when double gloves were used, as compared with 59% with single gloves. McCue and associates\(^8\) suggested that use of both inner and outer gloves during total joint
arthroplasty may provide better protection against microbial contamination. Additionally, Dodds and colleagues\(^7\) found that unnoticed perforations occurred 12% of the time during perioperative procedures, and suggested that surgeons should change their gloves to protect themselves from the body fluids of patients.

McLeod\(^8\) found that the use of double gloves during orthopedic surgical procedures resulted in a leakage rate of 6%, compared with 14% when single gloves were used. Sanders and co-workers\(^9\) found that punctures occurred 17% of the time on the inner glove during orthopedic surgical procedures and procedures lasting more than 1 hour. Barrie\(^10\) reported that surgical gloves had a higher rate of puncture during wound closure and suggested that more careful technique be used when just one pair of gloves is worn. The most frequent location of hole punctures for both single and double gloves was the dorsum of the hand, fingers, and thumb of the nondominant hand.\(^11\)

The use of two pairs of gloves for protection against blood-borne infections such as HIV or hepatitis B virus (HBV) during surgical procedures has been suggested by Bartlett,\(^12\) Sim and Dudley,\(^13\) and Gerberding and colleagues.\(^14\) However, we found no data on the use of double examination gloves among health care personnel outside the surgical arena. This study was conducted to test differences in barrier protection between double and single latex and vinyl examination gloves after use.

**METHODS**

Eight research assistants were trained by an investigator (M.K.) to perform a standardized clinical protocol designed to mimic patient care activities while wearing single or double gloves. They wore no rings and had fingernails filed short and smooth.

**Procedures**

A simple glove stress protocol was developed to simulate the manual operations used during routine patient care procedures (Table 1). For each test, subjects were randomly assigned to number of gloves (single or double) and glove material (vinyl or latex). At each test time, both a vinyl and a latex glove (either single or double) were worn, assigned at random as to right or left hand. After the glove stress protocol, all gloves (inner and outer) were tested for leakage by two techniques, dye and water. A positive glove leak was recorded by either of these two test methods. The first leakage test was done before removal of the gloves from the wearer’s hands. Each hand was immersed in a flat pan containing a 0.5% solution of trypan blue; leakage at the wrists was precluded by judicious positioning of the hand and use of a rubber band around the wrist. After 1 minute of immersion, the hand was removed from the pan, the glove (or gloves) was removed, and the hand was visually examined for any traces of blue dye. Double gloves were then separated and labeled for later individual testing.

After the dye test, all gloves were tested for pinhole leaks by means of the water-fill test (Food and Drug Administration, 1990). Each glove was attached by means of both an O-ring and a rubber band to the bottom end of a vertical, open-ended plastic tube (2½ inches in diameter), from which the glove was allowed to hang over a trough. The glove cuff overlapped the cylinder by no more than 4 cm. After attachment of the glove, 1000 ml room-temperature water was poured into the cylinder. The visible presence of any water on the glove or in the collection trough after 2 minutes of elapsed time was taken to signify the presence of a leak.

The following data were recorded: material of glove (vinyl or latex); number of gloves (single or double) type of leak (dye or water); and manufacturer. Latex gloves were brand A (Aladan Corp., Norcross, Ga.); brand B (Curity, The Kendall Company, Mansfield, Mass.); and brand C (Digitcare Corporation, Los Angeles, Calif.). Vinyl gloves were brand D (Trutouch; Becton Dickinson and Co., Rutherford, N.J.) and brand E (Travenol; Baxter Healthcare Corp., Deerfield, Ill.). Brand C was only tested with single gloves and was therefore not included in analyses of double gloves.

**Data analysis**

A \(\chi^2\) analysis or Fisher’s Exact Test was used to assess differences in the proportions of single and double gloves that leaked. In addition, leakage rates were compared between vinyl and latex gloves and between manufacturers.

**RESULTS**

A total of 886 examination gloves (385 vinyl: single, 199; double, 186; and 501 latex: single, 290; double, 211) were tested for dye and water leaks after being stressed. The proportions of the five brands tested were as follows: A (latex), 30.3% (152/501); B (latex), 51.3% (257/501); C (latex),...
Table 1. Glove stress protocol: Preparation of gloves before tests

1. Remove gloves from box.
2. Don gloves.
3. Rub each gloved hand with a washcloth in the following sequence: palm, each finger in a twisting motion, thumb, and back of hand.
4. Attach and remove a capped needle from a Luer-Lok syringe to intravenous tubing and manipulate a stopcock eight times.
5. Connect and disconnect Luer-Lok syringe to intravenous tubing and manipulate a stopcock eight times.
6. Wrap, tape, and unwrap a blunt object two times to simulate bandaging an amputated stump.

Table 2. Leakage rates for vinyl and latex gloves by either dye or watertight test

<table>
<thead>
<tr>
<th></th>
<th>Single</th>
<th>Double</th>
<th>Between single and double</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vinyl</td>
<td>51.3% (102/199)</td>
<td>19.7% (37/186)</td>
<td>39.5 (P &lt; 0.001)</td>
</tr>
<tr>
<td>Vinyl</td>
<td>4.1% (11/290)</td>
<td>3.8% (6/211)</td>
<td>0.00 (1.0)</td>
</tr>
<tr>
<td>Between latex and vinyl</td>
<td>108.1</td>
<td>23.5</td>
<td>&lt;0.0001 &lt;0.0001</td>
</tr>
</tbody>
</table>

Table 3. Total leakage rates by dye and water test (single and double gloves)

<table>
<thead>
<tr>
<th>Dye</th>
<th>Water</th>
<th>χ²</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latex</td>
<td>3.2% (16/501)</td>
<td>1.4</td>
<td>0.22</td>
</tr>
<tr>
<td>Vinyl</td>
<td>11.9% (46/385)</td>
<td>20.0</td>
<td>&lt;0.001</td>
</tr>
</tbody>
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Table 4. Leakage rates of single and double gloves by manufacturer

<table>
<thead>
<tr>
<th></th>
<th>Single</th>
<th>Double</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brand A</td>
<td>4.5% (3/67)</td>
<td>0% (0/85)</td>
</tr>
<tr>
<td>Brand B</td>
<td>3.8% (5/131)</td>
<td>6.3% (8/126)</td>
</tr>
<tr>
<td>Brand C</td>
<td>7.5% (7/92)</td>
<td>Not tested*</td>
</tr>
<tr>
<td>Vinyl</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brand D</td>
<td>0.0% (0/142)</td>
<td>19.8% (29/147)</td>
</tr>
<tr>
<td>Brand E</td>
<td>29.8% (17/57)</td>
<td>20.5% (8/39)</td>
</tr>
</tbody>
</table>

Differences in leakage rates by brand: Latex, single glove, Fisher's Exact Test, p = 0.78, latex, double glove, Fisher's Exact Test, p = 0.05; vinyl, single glove, χ² = 13.5, p = 0.0002, vinyl, double glove, χ² = 0.01, p = 0.90.

*Brand C was excluded from analysis; only single gloves of this brand were tested.

18.4% (92/501); D (vinyl), 75% (289/385); and E (vinyl), 24.9% (96/385).

Leakage rates for single or double gloving were significantly higher for vinyl than for latex gloves. For latex gloves, there was no significant difference in leakage rates between single and double gloves (χ² = 0.00, p = 1.0). However, vinyl gloves leaked significantly more often when single than when double (χ² = 39.5, p < 0.0001; Table 2).

For latex gloves, there was no significant difference in leakage rates detected by the dye (3.2%) and water (1.8%) tests (p = 0.22). For vinyl gloves, however, the water test was significantly more sensitive (p < 0.001; Table 3).

There were no significant differences in leakage among brands of latex gloves worn singly (p = 0.78), or doubly (p = 0.05). For vinyl gloves, there was a significant difference among brands on single gloving (p = 0.0002) but not with double gloves (p = 0.90; Table 4).

DISCUSSION

This study was designed to evaluate the difference in leakage rates between double and single latex and vinyl examination gloves after use. Although several authors5, 10, 14-16 have suggested that two pairs of gloves be worn during surgical procedures, our results indicate that for routine nonsurgical procedures, when gloves are worn for shorter periods and are stressed less, one pair of latex gloves provides adequate protection.

That the water test was less sensitive in detecting holes in latex gloves than the dye test may be a result of the ability of the natural rubber of latex to reseal itself. The dye test, which can detect leakage of smaller molecules, would allow the


detection of smaller leaks than would the water test. Vinyl gloves, on the other hand, are less pliable and will not reseal once a hole has occurred.

Both single and double gloving procedures provided protection. For latex gloves, there is no advantage to double gloving for routine patient care activities; however, there were significantly fewer leaks when double vinyl gloves were worn. Perhaps use of single vinyl gloves should be reserved for minor patient care activities that do not put much stress on the glove material.

We were able to observe distinct differences by manufacturer in the number of holes in both vinyl and latex gloves. The manufacturer differences demonstrated in this study are consistent with the findings of Dalgleish and Malkovsky and Klein and associates, who reported that manufacturers offer a spectrum of glove quality.

On the basis of our findings, we suggest the following: (1) Double gloving offers no advantage during routine procedures associated with minimal stress or manipulation of glove material. (2) For procedures that involve handling of blood-contaminated materials and considerable manual manipulation, either a single pair of latex gloves or a double pair of vinyl gloves should be worn. (3) Glove brands with good quality-control programs should be selected.

References
