



Scientific Findings:

Natural Rubber Latex Gloves Protect Against Viruses and Resist Leaks and Tears Better Than Synthetic Gloves

Barrier protection against the transmission of viruses and infectious diseases is the most important criterion for selecting medical gloves. Proper glove selection and use could prevent many viral and bacterial infections that have been estimated to affect some two million hospital patients each year, resulting in about 80,000 deaths.

Multiple studies comparing natural rubber latex and vinyl/PVC gloves have demonstrated that latex gloves consistently provide more effective protection for healthcare workers than vinyl gloves, which suffer from, high failure rates through leakage. Ineffective barrier performance of polyethylene gloves is also apparent. Nitrile gloves, on the other hand, have better barrier performance than vinyl, polyethylene, and co-polymer.

When needle punctures occur – a frequent occurrence during many clinical procedures – vinyl and nitrile are likewise shown to be less effective than latex in protecting workers against the risk of infection. These studies are summarized below.

Barrier Integrity of Latex, Vinyl, Polyethylene, Nitrile, and Co-polymer Gloves

The following eight studies, many of which were conducted under conditions designed to simulate heavy use in a healthcare environment, compared the barrier performance of natural rubber latex with that of synthetic substitutes. Findings invariably showed that vinyl gloves leaked water/dye solution or allowed bacteria/virus to penetrate more frequently than latex gloves, and that the volume leaked or penetrated was significantly higher. Studies No. 2 and 9 found that, unlike latex gloves, the barrier integrity of both vinyl and nitrile gloves is adversely affected by contact with an alcohol-based disinfectant

1. Viral penetration (phiX 174) in vinyl gloves was 63%, in contrast to only 7% of latex gloves. *Leakage of Virus through Used Vinyl and Latex Examination Gloves.* Korniewicz, D.M., Laughon, B.E., Cyr, W.H., Lytle, C.D. and Larson, E. *Journal of Clinical Microbiology*, 1990; 28: 787-8.
2. 22% of vinyl gloves and 40% of polyethylene gloves leaked virus (lambda phage), while leakage was detected in less than 1% of latex gloves. Failure rate of vinyl increased sharply to 56% and 94% respectively when gloves were pretreated with 70% alcohol (disinfectant). Latex gloves showed no leakage increase after such treatment. *Virus Penetration of Examination Gloves.* Klein, R.C., Party, E. and Gershey, E.L. *Biotechniques*, 1990; 9: 196-9.
3. In procedures involving a healthcare worker's gloved hand contacting a patient's mucous membrane and thus becoming contaminated with gram-negative organisms and enterococci, 23.8% of vinyl gloves gave rise to microbial contamination of the worker's hands, about 10 times higher than that of latex gloves (2.3%). 42.6% of the used vinyl gloves failed the water leak test, compared with a failure rate of 8.6% in the case of latex gloves. *Examination Gloves as Barriers to Hand Contamination in Clinical Practice.* Olsen, R.J., Lynch, P., Coyle, M.B., Cummings, J., Bokete, T. and Stamm, W.E. *JAMA* 1993; 270: 350-3.
4. Regardless of levels of stress and duration for gloves worn in high and low risk clinical settings, the failure rate on vinyl remained high at 85.7%, in contrast to the 18.4% rate shown by latex gloves. *Leakage of Latex and Vinyl Exam Gloves in High and Low Risk Clinical Settings.* Korniewicz D.M., Kirwin M., Cresci K. and Larson E. *J. Am. Ind. Hyg. Assoc.* 1993; 54: 22-26.
5. Vinyl gloves were found to leak significantly more when worn one at a time than when double gloves were used (51.3% and 19.7% respectively). However, there was no difference between the very low leakage rates for single and double latex gloves (4.1% and 3.8%, respectively). *Barrier Protection with Examination Gloves: Double versus Single.* Korniewicz, D.M., Kirwin, M., Cresci, K., Tian Seng and Tay, E. C., Wool, M., and Larson, E. *American Journal of Infection Control*, 1994; 22(1):12-5.
6. Leakage rates ranged between 22% and 27% for stretch vinyl gloves and between 26% and 32% for standard vinyl gloves. A rate of only 1.1% was found for powder-free latex gloves. *Barrier Durability of Latex and Vinyl Medical Gloves in Clinical Settings.* Douglas, A., Simon, T. and Goddard, M. *Am. Ind. Hyg. Assoc. J.* 1997; 58:672-6.
7. Leakage rates ranged between 12% and 20% for stretch vinyl gloves and between 26% and 61% for standard vinyl gloves. Leakage rates for gloves of latex and nitrile were only 0 to 4% and 1% to 3%, respectively. *In-use Barrier Integrity of Gloves: Latex and Nitrile Superior to Vinyl.* Rego, A. and Roley, L. *American Journal of Infection Control.* 1999; 27(5): 405-10.
8. Vinyl and co-polymer gloves both leaked at a higher rate of 8.2% than latex and nitrile gloves at 2.2% and 1.3% respectively. *Performance of latex and non-latex medical examination gloves during simulated use.* Korniewicz D.M., El-Masri M., Broyles J.M., Marin C.D. and O'Connell KR *Am. J. Infect. Control*, 2002; 30: 133-138.

9. Vinyl and nitrile gloves were penetrated to a great extent by an ethanol-based disinfectant and at a rate of about 5 times faster than latex gloves. *The permeability of dental procedure and examination gloves by an alcohol based disinfectant.* Baumann, M.A., Rath, B., Fischer, J.H. and Iffland, R. *Dent. Mater.* 2000; 16(2):139-44.

Barrier Performance of Latex, Vinyl and Nitrile Gloves When Needle-Punctured

The probability of infection with punctured natural rubber latex gloves is markedly lower than with punctured vinyl or nitrile gloves, because latex gloves with needle punctures are far more resistant to viral penetration and tearing than are punctured gloves of vinyl or nitrile, as reported in the following two recent studies.

1. **"Barrier Performance of NR, Vinyl and Nitrile Gloves on Puncture."** Hasma, H. and Othman, A.B. Paper presented at the "Latex 2001" Conference, RAPRA, 4-5, December 2001, Munich, Germany.

The leakage rates of a solution containing very small phiX 174 viruses through examination gloves were studied after three brands of vinyl, four brands of nitrile, and four brands of latex (powdered and non-powdered) were punctured with needles of different diameters:

- Vinyl gloves exhibited failure (leakage) rates of 78% after puncture with 0.22-mm diameter needles and 100% after puncture with all needles, of > 0.3-mm diameter.
- Nitrile gloves exhibited failure rates of 53% after puncture with 0.22-mm diameter needles and 100% after puncture with all needles of > 0.4-mm diameter
- Latex gloves registered zero failure after needle-punctured with small holes of 0.22-mm or 0.25-mm diameter; < 20% leaked after puncture with 0.3-mm and 0.35-mm diameter needles.
- Puncture with large 0.45-mm diameter needles resulted in >2500 microlitres of virus suspension penetrating through vinyl and nitrile gloves, compared to < 25 microlitres with latex gloves.
- Latex gloves also proved to be five times more tear-resistant than either vinyl or nitrile gloves.

These findings indicate the self-resealing property of latex gloves, which acts to minimize the problem of leakage from needle punctures, compared to vinyl and nitrite gloves, which do not have the inherent ability to reseal punctures.

2. **A PCR Based Method for Detecting Viral Penetration of Medical Exam Gloves.**
Broyles J.M., O'Connell K.P. and Korniewicz D.M. J. Clin. Microbiol. 2002; 52: 965-999.
Also reported in "Barrier integrity of medical gloves," paper presented by Korniewicz D.M. at International Glove Conference, Malaysia 2002.

In their development of a new method for detecting viral penetration of examination gloves, the researchers tested a total of 30 medical gloves consisting of latex (powdered and powder-free), vinyl (PVC) and nitrile gloves. After puncturing each finger of the gloves five times with an 18-gauge needle, and filling the gloves with viral (phiX 174) suspension, they reported that the amount of phiX 174 penetrating the holes in vinyl and nitrile gloves was markedly greater than that in latex gloves:

Glove type	PhiX 174 penetration through gloves
Latex (powdered)	72 ± 23 pfu/microliter
Latex (non-powdered)	77 ± 22 pfu/microliter
Vinyl (powdered)	806 ± 109 pfu/microliter
Nitrile (non-powdered)	1271 ± 259 pfu/microliter

The significantly lower viral penetration in latex gloves compared to vinyl and nitrile gloves is attributable to the "resealing" property of natural rubber because of its greater resiliency, which enables holes in latex gloves to contract when punctured. In contrast, synthetic gloves may tear at the site of puncture or fail to retract around the hole when punctured. The findings indicate that latex gloves are superior to vinyl and nitrile gloves in providing needed barrier protection to healthcare workers.