Position Paper

Vinyl Gloves: Causes For Concern

Background

Polyvinyl Chloride (PVC) gloves, more commonly known as vinyl gloves, are sometimes provided by hospitals as a cheap choice for examination gloves.

While hospitals want gloves with a synthetic origin to avoid concerns about the risk of natural rubber latex (NRL) allergy, vinyl gloves have several features that limit their performances in terms of protection and safety.

Therefore, vinyl gloves should not be used in all situations due to the potential risk they can present for patients and healthcare workers.

The objective of this paper is to review these limitations in the light of recent studies and publications in order to provide guidance and risk assessment to support end users and purchasing decision makers.

Vinyl Gloves and Barrier Integrity

More holes occur in vinyl gloves than other gloves during routine use

KEY POINT

PVC is a petroleum-based film which is not molecularly cross-linked, in contrast to NRL or other types of synthetic latex such as nitrile. Because of this lack of cross-linking, the individual molecules of vinyl tend to separate when the film is stretched or flexed.

This relative weakness of the vinyl film means that manufactured vinyl medical gloves do not have comparable resistance to stretch and elongation than that offered by NRL or nitrile gloves. This is reflected in the European Standard EN 455-2 (Medical gloves for single use- Part 2: Requirements and testing for physical properties), which specifies a minimal force at break before ageing for vinyl gloves at a level 2.5 fold lower than for natural rubber and nitrile gloves. This difference is not known by many healthcare workers who believe that vinyl examination medical gloves offer the same features as those made of NRL and nitrile.

The lower resistance of vinyl, due to the lack of cross-linking, may cause small holes and breaches to form during use or make the gloves liable to puncture and tear easily on extension. In addition, vinyl does not return to its original shape after stretching, which means that glove fingers sag and can easily get caught. Furthermore, due to the lack of elasticity, vinyl gloves do not grip cuffs, compromising barrier integrity.

Many studies have been published during the past 20 years (1989-2007) that have clearly shown the worse barrier integrity and shorter durability of vinyl gloves by comparison with natural rubber latex gloves or nitrile gloves.

These poorer features of vinyl gloves were shown whether the gloves were tested under simulated conditions or clinical conditions[1-5], as well as in situations involving double-donning[6].

Other publications have also highlighted the greater permeability of vinyl gloves to bacteria and virus than natural rubber latex or nitrile gloves during use[7-12]. Such permeability increases the risk of cross-contamination for both patients and healthcare workers.

Data from these studies on leakage of vinyl gloves compared with natural rubber latex, are summarized in Table 1. In each study, vinyl gloves demonstrated a barrier performance significantly lower than that of natural rubber latex gloves.

Higher permeation of bacteria and virus

KEY POINT

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Barrier Performance Studies

Author	Date	Type of use		Leakage rate(*)			Leakage Specific conditions
		Simulated	Clinical	Vinyl	NRL	ratio(*)	
Korniewicz[7]	1989	X		53%	3%	18	
Korniewicz[8]	1990	X		63%	7%	9	
Klein[11]	1990	X		22%	1%	22	Without contact with ethanol
				56%	1%	56	After contact with ethanol
Korniewicz[1]	1993		X	85%	18%	5	
Olsen[9]	1993		X	43%	9%	5	
Korniewicz[6]	1994		X	51%	4%	13	Single gloving
				20%	4%	5	Double gloving
Douglas[2]	1997		X	26%	8%	3	
Rego[3]	1999	X		30%	2%	15	
Korniewicz[4]	2002	X		8%	2%	4	
Kerr[5]	2004	X		33%	10%	3	

*failure rates were averaged and rounded to nearest whole number

Vinyl gloves have, in general, a poor resistance to many chemicals, including glutaraldehyde based products[13] and alcohols used in formulation of disinfectants for swabbing down work surfaces or in hand rubs, which use has recently expanded greatly with the implementation of best practice recommendations for Hand Hygiene[14]. Vinyl gloves, compared with other types, have also been shown to be the most permeable to antineoplastic cytotoxic drugs[15-17].

Poor resistance to many chemicals and highest permeation of cytotoxic drugs

KEY POINT

Therefore, they are not recommended for any use in relation to chemotherapy.

Vinyl Gloves and Comfort

Vinyl is less flexible and elastic than latex, resulting in vinyl gloves not fitting well and becoming uncomfortable during prolonged use.
In addition, sensitivity is reduced and some studies have shown that tactile sensitivity of vinyl is appreciably lower than natural rubber latex gloves[18].

Because of the reduced flexibility and sensitivity, several guidelines recommend either latex or nitrile gloves for clinical care and procedures that require manual dexterity and / or that involve patient contact for more than a brief period[19-21].

Vinyl is less flexible and elastic than latex, resulting in vinyl gloves not fitting well

KEY POINT

Vinyl Gloves and Allergic Reactions

Several publications have highlighted cases of skin reactions due to chemical additives used in the manufacturing process of vinyl gloves:

- **Bisphenol A**, which is used as an antioxidant in PVC plastics and as an inhibitor of end polymerization in PVC, has been identified as a cause of some cases of allergic contact dermatitis[22,23].
- Exacerbation of hand dermatitis while using PVC gloves was noted in 8 patients who were allergic to **benzisothiazolinone**, a biocide widely used in the manufacture of disposable PVC gloves[24].

In Finland, benzisothiazolinone in powder-free PVC gloves caused a small epidemic of allergic contact dermatitis in dental personnel and other health care workers, and 1/3 of disposable PVC gloves marketed in Finland contained some benzisothiazolinone[25].

Other studies identified additional chemical agents, such as an **adipic polyester[26]**, **propylene glycol compound and ethylhexylmaleate[27]**, as a cause of allergic contact dermatitis in vinyl gloves.

Vinyl Gloves and Phthalates

Polyvinyl chloride (PVC) molecular chains form an attraction to one another, which produces a rigid material. In order to obtain a soft and flexible end product, it is necessary to add a plasticizer, which allows the PVC chains to slide against each other.
In vinyl gloves, the average content of plasticizers necessary to get a sufficiently soft product is quite significant and represents approximately 45% by weight of the final glove material.
Although several types of chemicals can be used as plasticizers, phthalates are by far the most commonly used.

Phthalates do not bind to the PVC molecules, remaining as a freely mobile and leachable phase in the product material.

Although the general population is commonly exposed to phthalates, there is currently a great deal of debate about their health toxicity.

The controversy is particularly in regard to DEHP (di 2 ethyl hexyl phthalate), the dominant plasticizer used in PVC due to its low cost. Several regulations on phthalate content have then been put in place in recent years:

- The use of phthalates in children's toys is restricted in many countries around the world[28,29] and draft proposals have been tabled in the European Union for the regulation of phthalates in others products[30]

- The use of vinyl gloves that contain phthalates for applications involving food contact has been restricted in Japan for several years. In their place, vinyl gloves containing non-phthalate plasticizers have been introduced.
In Europe, Directive 2007/19/EC has banned use of most phthalates for contact with fatty foodstuffs[31].

- In medical devices, such as intravenous tubing, blood bags and respiratory equipment, there has been an ongoing debate on phthalate safety.

The European Union Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) reviewed the safety of DEHP in medical devices in 2008[32].

The report concluded that the potentially high exposure during medical treatments, such as prematurely born babies, may raise a concern for harmful effects in humans, despite the absence of clinical or epidemiological evidence.

While some alternative plasticizers are available, with sufficient toxicology data to indicate a lower hazard compared to DEHP, the functionality of these plasticizers should be assessed before they can be used as an alternative for DEHP in PVC medical devices.

KEY POINT

Although the general population is commonly exposed to phthalates, there is currently a great deal of debate about their health toxicity

Vinyl Gloves and Environment

The production and disposable of PVC may give rise to emission of several toxic pollutants such as vinyl chloride monomers, dioxin and others potentially dangerous products.

The impact of PVC on the environmenthas provoked a vast ongoing controversial debate, which has not yet been concluded.

In contrast to vinyl gloves, natural rubber latex gloves do not produce toxic emissions when incinerated[33]

KEY POINT

Vinyl gloves, like all medical waste, are either incinerated or added to landfill according to local practices and/or country regulations.

In both cases, the environmental impact of vinyl medical gloves needs to be integrated in a medical waste management approach, which takes into account their contaminated state and the risk of infection transmission, in addition to the environmental threat from PVC waste itself.
In contrast to vinyl gloves, natural rubber latex gloves do not produce such toxic emissions when incinerated[33] and are biodegradable by a combination of chemical and biological attack[34].

Furthermore, natural rubber latex is obtained from rubber trees, which are a sustainable and renewable resource, while PVC is derived, for the most part, from crude oil chemistry[35].

Conclusion

Use of vinyl gloves in any healthcare setting should be properly assessed and not offered as the only choice

KEY POINT

Vinyl gloves raise several issues in terms of protection and safety for end-users and patients.

Permeability to chemicals and biological agents is worse than for other glove materials, while the chemicals present may cause contact dermatitis and there is most likely a greater environmental cost.
Use of vinyl gloves in any healthcare setting should be properly assessed and not offered as the only choice for all types of care and examination procedures.

Alternatives such as natural rubber latex or nitrile gloves should, therefore, be available for all clinical procedures requiring manual dexterity and/or involving patient contact for more than a brief period.

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