CLINICAL REVIEW

Review of Latex Allergy

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Background: **Allergy to latex has become an increasing concern to many patients and health care providers. Health care providers should become aware of this problem and develop strategies for treatment and prevention.**

Methods: **We searched MEDLINE from 1990 to 1998 for the topics of latex allergy using the key words "latex" and "allergy." Other sources were found from back-referencing these references and from the Internet.**

Results: **Latex allergy is emerging as a clinical and occupational health problem. Understanding the clinical and immunologic features, which range from dermatitis to anaphylaxis, can provide the basis of preventive and therapeutic strategies.**

Conclusion: **The clinician should be able to recognize latex allergy and educate patients about the potential hazards of latex-containing products. Providers can develop a plan for protecting patients and health care staff from latex exposure as well as treating allergic reactions when they occur. (J Am Board Fam Pract 1999;12:285-92.)**

In recent years patients and health care workers have experienced a marked increase in serious allergic reactions to latex[1] as a result of the increased exposure and sensitization to latex products in the health care industry, particularly latex gloves. Universal precautions were implemented as a health care policy in 1987 as a result of the human immunodeficiency virus (HIV) epidemic and spread of hepatitis. At that time 1 billion gloves were imported into the United States annually. The following year more than 8 billion gloves were imported.[2] This dramatic increase in the use of latex gloves has greatly contributed to the higher incidence of latex allergic reactions. Moreover, patients and health care workers are not the only ones at risk for latex exposure. With more than 40,000 commercial products in the marketplace that contain latex, persons in other occupations and a considerable portion of the general population are at risk for latex exposure and sensitization.

Methods

More than 500 titles were found during a search of the medical literature from 1990 to 1998 in MEDLINE using the key words "latex" and "allergy." These articles were reviewed based on their relevance to this review. Additional articles dating before 1990 were accessed by cross-referencing the more recent articles.

Epidemiology

General Population

The overall incidence of latex allergy is unknown, but the prevalence in the general nonatopic population is estimated to be less than 1 percent.[3] In a recent study in Detroit, however, 1000 blood donors were tested for immunoglobulin E (IgE) specificity for latex. Results showed a 6.4 percent positive response, which suggests a much higher prevalence in the general population than first presumed.[4] These results were basically replicated in another study, where the prevalence of latex sensitization in persons attending health screening was 6.6 percent.[5]

Patient Population

In the fall of 1989, the Food and Drug Administration (FDA) began receiving reports of patients going into anaphylactic shock while receiving barium enemas. Barium was originally suspected as the sole culprit, but it was soon discovered that the latex-cuffed enema tip was the cause of 16 deaths overall.[6] This finding led to an increased awareness of the risk of type 1 allergy associated with la-

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tex products. Patients with spina bifida are at increased risk for latex sensitization because they are frequently exposed to latex from urethral catheterizations, multiple surgeries, and ventriculoperitoneal shunt placement early in life. The prevalence of allergy in these patients ranges from 28 to 67 percent.[7] Pediatric patients with spina bifida have a risk of latex-related anaphylaxis during surgery that is 500 times greater than that of the general population. The marked increase in latex allergy in these spina bifida patients more likely results from extensive latex exposure early in life rather than a genetic predisposition.

Pregnant woman have also been found to be at risk for sensitization to latex. Four women developed systemic allergic reactions during delivery as a result of exposure to surgical latex gloves worn by the obstetrician.[8] In another study the incidence of latex sensitivity in an ambulatory surgical population was also found to be 6.7 percent (n - 996).[9]

Health Care Workers

The prevalence of latex allergy among health care workers is estimated between 5 to 10 percent.[3,10,11] In a study of registered nurses the prevalence of latex sensitization was 8.9 percent (n - 741).[12] In another study the prevalence of latex sensitization in a hospital employee population was approximately 8 percent (n - 135),[13] and in another hospital setting, the prevalence of latex sensitization was 12.1 percent among workers (n - 1351).[14]

Other At-Risk Populations

Workers in the latex-manufacturing industry are also at risk, with one glove-manufacturing plant reporting a 3.7 percent prevalence of occupational asthma based on positive skin-prick testing and spirometric data.[15] Workers at a latex doll-manufacturing plant were also found to be sensitized to latex sensitization.[16] Many other persons are at risk, especially the police and emergency medical personnel, food handlers who work in cafeterias and fast-food restaurants, and sanitation engineers in various fields, all of whom can wear latex gloves for prolonged periods.

Atopic Patients

Persons with atopy have higher risk for latex allergy. Two studies found that 54 and 57 percent of persons with latex allergy had a history of atopy (asthma, rhinitis, or food allergy).[17,18] In the same study it was estimated that 2.5 percent of hospital employees had occupational asthma secondary to latex hypersensitivity.[18] The prevalence of latex-specific IgE antibodies in atopic and nonatopic children with type 1 diabetes was 6 percent compared with 0.37 percent in the general population. The high rate of sensitization to latex in children with diabetes is secondary to the high rate of atopy in the study population. Atopic patients with diabetes, however, might be at risk for reactions secondary to latex from insulin vials and syringes.[19] Finally, in patients being evaluated for allergy, the prevalence of latex-specific IgE antibodies was 12 percent.[20]

Pathophysiology

Latex is the milky sap obtained by tapping the rubber tree, *Hevea brasiliensis.* It is derived from cells of the lactiferous system and is easily harvested.[21] The raw product is mixed with a preservative, such as ammonia; it is then concentrated and shipped as a latex concentrate.[22] Commercial use began with the discovery of vulcanization in 1839 by Charles Goodyear. Vulcanization (heating in the presence of sulfur) greatly enhances the elasticity, strength, and stability of latex. Numerous chemical accelerators reduce the temperature and time required.[23] These accelerators can cause allergic reactions and are responsible for many cases of contact dermatitis.[10] Chemically, latex contains proteins, cis-polyisoprene, water, and lipids. The proteins cause the severe immediate hypersensitivity reactions.[1,24]

More than 50 different proteins have been implicated in the allergic response, with up to a total of 240 different proteins found in latex.[25] Latex products are made either by pouring the rubber into molds or by forming a coating in a dipped process, as is done with gloves, balloons, and condoms. Dipped or very soft rubber products appear to have the highest content of latex proteins and, therefore, have the greatest allergenic potential.

Systemic reactions to latex can result from exposure to latex protein by various routes, including the skin, mucous membranes, inhalation, and intravascular or internal tissue. Medical devices that have been reported to trigger serious systemic reactions by cutaneous exposure include anesthetic masks, tourniquets, electrocardiogram electrodes, adhesive tapes, condom catheters, and ileostomy bags. Most severe reactions to latex have resulted

Table 1. Products That Contain Latex.

Medical Products		*Household and Personal Items*	*Infant and Child Items*
Adhesive tape	Nasopharyngeal and oropharyngeal airway tubes	Automobile tires	Balloons
Ambu bags	Reservoir breathing bags	Bath mats	Bottle nipples
Blood pressure cuffs	Rubber syringe stoppers	Buttons on electronic equipment	Elastic in clothing and disposable diapers
Bulb syringes	Stethoscope tubing	Carpet backing and pads	Halloween masks
Crutches (arm and hand pads)	Teeth protectors	Computer mouse pads	Infant pacifiers
Electrocardiogram electrode pads	Tourniquets	Condoms	Rubber balls
Elastic bandages	Tympanometers	Contraceptive sponges	Rubber toys
Electrode pads	Urinary catheters	Diaphragms	
Endotracheal tube	Ventilator bellows and hoses	Dishwashing gloves	*Sports Items*
Face masks, straps	Wheelchair tires, cushions	Foam rubber	Athletic shoe soles
Gloves	Wound drains	Hot water bottles	Rubber boats
Mattresses on stretchers		Pencil erasers	Scuba face masks
		Rubber bands	Sports racquet handles
		Rubber cements	Swimming caps and goggles

from latex proteins contacting mucous membranes of the mouth, vagina, urethra, or rectum. Materials used in dentistry, including gloves, mouth bite plates, and orthodontic elastics, are potential allergic sources. For infants pacifiers might be a possible source of exposure to latex allergens early in life.[26] Some of the most severe reactions to latex have resulted from contact between the rectal mucosa and balloon catheters used for barium enemas; these reactions are thought to be due to the high absorption rate of the rectum.[6]

Cornstarch powder is applied to latex gloves during the manufacturing process to prevent stickiness and to give the gloves a smooth feel. Latex protein particles have been shown to adhere to the surface of these cornstarch particles, which then become aerosolized on removal of the gloves.[25,27] Airborne latex protein absorbed by the cornstarch glove powder has been found to be related to asthmatic reactions. Health care workers who use gloves or work in a latex-laden environment are thus susceptible to occupational bronchial asthma.[28-30]

Many case reports describe severe intraoperative anaphylaxis associated with surgical gloves coming into contact with the peritoneum and viscera; these tissues readily absorb the water-soluble latex proteins.[30] Intravascular administration of latex proteins can result from disposable syringe plungers, medications stored in vials with rubber stoppers, and intravenous tubing with latex injection ports (Table 1).[28,31]

Because latex is a natural product of the rubber tree, many other fruits in this family of plants will have similar proteins. These proteins are so similar that the immune system recognizes these as latex proteins and then responds to it. The most common cross-reactivity has been found between latex and such foods as banana, avocado, chestnut, passion fruit, kiwi fruit, potatoes, and tomatoes, all of which have been found to be antigenically similar to latex (Table 2).[32] Other foods, including figs, apples, celery, melons, pineapples, milk, papayas, and grapes, and pitted fruits, such as cherries, peaches, and apricots, can also cross-react and cause symptoms. In one study, 42.6 percent of patients known to be allergic to latex reported allergic symptoms after ingestion of cross-reactive fruits, including kiwi, banana, pineapple, passion fruit, and mango.[32]

Clinical Manifestations

There are three main types of latex sensitivity reactions. Irritant contact dermatitis (nonimmune) has a gradual onset, taking days, and is caused by accelerators and chemicals used in the latex glove

Table 2. Foods That Cross-React With Latex.

Common Cross-Reactivity	Other Foods That Can Cross-React
Avocado	Apples
Banana	Apricots
Chestnut	Celery
Kiwi fruit	Cherries
Passion fruit	Figs
Potato	Grapes
Tomato	Melons
	Milk
	Papayas
	Peaches
	Pineapples

Table 3. Questionnaire to Determine Latex Sensitivity.

Allergies	1. Do you have a history of hay fever, eczema, asthma, hives, rashes, or allergic reactions to certain drugs?
	2. Do you have a history of allergic reactions (rash, swelling, oral itching, or wheezing) after eating certain foods such as bananas, avocados, kiwi, chestnuts?
Occupationally related symptoms	3. Have you ever had an allergic response to something in your work environment?
	4. Are you exposed to any latex-containing products at work?
	5. Have you ever developed a rash on your hands after wearing latex gloves? If so, how long after wearing the gloves did the rash develop, and what did the rash look like?
Risk factors for latex allergy	6. Do you have spina bifida or urinary tract problems requiring frequent catheterizations?
	7. Have you ever had an operation? If so, how many?
	8. Have you ever worked in an environment with latex products?
Hidden reactions to latex	9. Have you ever had a rash, swelling, shortness of breath, itching, cough, wheezing, or itchy eyes while wearing household gloves, blowing up a balloon, using a condom or diaphragms, or after a rectal or vaginal examination?
	10. Have you ever had an allergic reaction without a known cause, especially during surgery, hospitalization, or dental procedure?

manufacturing. Symptoms can include redness, cracks, fissures, and scaling. Allergic contact dermatitis, or type 4 (delayed hypersensitivity), has an onset 6 to 48 hours after contact. Symptoms, which are also caused by the accelerators and chemicals, include erythema, vesicles, papules, pruritus, blisters, and crusting. These lesions can resemble those caused by poison ivy or poison oak. Approximately 80 percent of the immunologic reactions are type 4.

The third type of reaction is immediate hypersensitivity, or type 1-IgE mediated reaction, which is caused by the latex proteins. Its onset occurs within minutes and rarely lasts longer than 2 hours. These symptoms include local and generalized urticaria, lightheadedness, angioedema, nausea, vomiting, abdominal cramps, rhinoconjunctivitis, bronchospasm, and anaphylactic shock. It is possible to have used latex for years without problems and suddenly progress to systemic symptoms. Anaphylactic reactions to latex have been reported in persons who had previously experienced only irritant or allergic contact dermatitis.[25]

Diagnosis

Because any product containing latex can trigger a reaction, cautious investigation of products at home, in the workplace, and at sites of medical and dental care should occur. A thorough medical history is the cornerstone of the diagnosis of latex allergy. The patient should be asked about occupational and other risk factors. Furthermore, the history should determine whether previous reactions have occurred and, if so, what type of reactions. A history of reactivity to foods, symptoms following use of a rubber condom or diaphragm, or symptoms associated with pelvic examination should raise the suspicion of latex sensitivity (Table 3).

Because of the lack of awareness of latex allergy or a concomitant history of atopic illness or both, sensitized persons typically do not attribute their respiratory symptoms of rhinoconjunctivitis or bronchospasm to latex exposure. For this reason, eliciting a history suggestive of latex allergy is vitally important before undertaking any elective procedure during which latex exposure will occur. In one study, however, none of the patients whose deaths were attributed to anaphylaxis caused by latex exposure had any known risk factors other than atopic illness, illustrating that even taking the above precautions can be insufficient.[33]

Standardized extracts for skin-prick testing are not readily available in the United States. Because such testing can cause an anaphylactic response, these tests should be conducted only at centers that have staff experienced in preparing extracts. FDA-approved in-vitro tests to measure latex-specific IgE are available (Pharmacia CAP, Pharmacia-Upjohn Diagnostics, Kalamazoo, Mich; AlaSTAT, Diagnostic Products Corps, Los Angeles, Calif)[34] The low specificity of these tests limits their clinical usefulness. A negative serologic test despite a strong positive history of sensitivity would suggest the value of skin-prick testing to confirm the diagnosis.[25]

Table 4. Nonlatex Gloves and Product Source.

Material	Product (Manufacturer)
Vinyl	TruTouch (Becton Dickinson) Vinylite (SmartPractice) Allerderm vinyl (Allerderm Labs) Royal Shield (SmartCare) SensiCare (Becton Dickinson) Triflex vinyl (Baxter Pharmaseal)
Nitrile	N-dex (Best Company) Nitrile (Pure Advantage) Allerderm Nitrile (Allerderm Labs)
Neoprene	Dermaprene (Ansell) Neolon (Becton Dickinson)
Thermoplastic elastomer	TactyLite (SmartCare) Allergard (Johnson & Johnson) Tactyl 1 (Allerderm Labs)
Styrene-butadiene block polymer	Elastyren (Hermal)

Adapted from Kam et al.[28]

Treatment of Reactions

Acute systemic reactions to latex should be treated in the same manner as any anaphylactic reaction. The airway, breathing, and circulation are assessed, oxygen is provided, and epinephrine and steroids are administered. Diphenhydramine (Benadryl) can be used for urticarial reactions. In the course of resuscitation, all contact with latex products should be avoided. Fluids and nebulized medications for bronchospasm might be required. Treatment should be continued with monitoring until after symptoms resolve. It is ironic that for the exquisitely latex-sensitive person who develops a type 1 hypersensitivity reaction, the hospital and emergency department settings can be most fraught with danger because of the great amount of latex found in medical equipment. Growing awareness of the magnitude of health risk posed by latex allergy might improve this paradoxical situation.[25]

Management Issues

In 1991 the FDA recommended that all patients be questioned for potential latex allergy, particularly those with spina bifida or any patient scheduled for surgical or diagnostic procedures. All physicians are requested to report all episodes of anaphylaxis during procedures requiring general anesthesia through state health departments to the epidemiology branch of the hospital infections program at the National Center for Infectious

Table 5. Operating Room Guidelines for Patients With Latex Allergy.

Latex Items	Nonlatex Alternatives
Implements	
Bulb syringes	Jackson Pratt Evacuator Bulb (Davol relia Vac #100)
Blanket warning mattress	Completely cover with linen
Blood pressure cuff and tubing	Wrap with gauze or latex-free tape
Catheters (Foley, caude, Malecot, red rubber)	Silicon (Silastic) Foley catheter, feeding tubes, nasogastric tubes
Chest tube drainage system tubing	Wrap with gauze or latex-free tape
Electrocardiogram lead cords	Wrap with gauze or latex-free tape
Fenestrated sheets	Large sheets cut into shape for opening
Gloves	TactyLite gloves, sterile 6 $^1/_2$ to 8 $^1/_2$ SensiCare nonlatex gloves 7 to 7 $^1/_2$, 8 to 8 $^1/_2$
Neuro suction tubing	Neuro-Frazier Suction Connecting Tubing (Davol # 3100)
Medications	
Intravenous irrigation solutions	Do not puncture rubber ports, use stopcocks
Multiple medicine vials	Remove the rubber stoppers
Penrose drains	Jackson Pratt (Davol) drains, Hemovacs
Power cords	Drape with Cireon Camerce cover
Rubber bands	Steri Strips
Syringes with black latex stopper	Glass syringes
Tapes, elastic bandages (Elastoplast, Ace), adhesive bandages (Band-Aids),	Paper or sirk tapes only
Tourniquets	Nonlatex glove
Urometer	Remove rubber tip, use straight connector
Utility drapes (stickers)	Linen towels

Disease, Centers for Disease Control.[35,36]

In the health care setting, the two major strategies for management are (1) prevention and treatment of occupational latex allergy in employees, and (2) the safe care of the latex-allergic patient. The cornerstone of latex allergy treatment is avoidance. Many persons who are constantly exposed to the powdered latex glove are likely to become sensitized. Workplace decisions should be made to reduce cumulative exposure to latex, including the widespread purchase of nonlatex gloves or nonpowdered, low-protein latex gloves.

Covering skin cuts on hands with adhesive bandages before donning latex gloves might help prevent increased IgE production. In addition, putting on powdered gloves cautiously will help prevent inhalation of the aerosolized latex proteins. Some newer glove products have very low soluble and aerosol titers of proteins, but wide variation remains between brands. For health care workers and patients who are allergic to latex, nonlatex gloves should be used (Table 4). The National Institute of Occupational Safety and Health (NIOSH) recently published an advisory document on natural latex rubber in the workplace. It recommends that nonlatex gloves be used for all activities that are not likely to involve contact with infectious materials (eg, food preparation, routine housekeeping and maintenance).[37]

In caring for the patient with latex sensitivity, the distinctions between a true type 1 and irritant and allergic contact dermatitis reactions caused by other factors must be considered. Any evidence of a history of type 1 reactions necessitates a latex-free environment. In the hospital setting protocols for the emergency department, operating room, in-patient rooms, and other areas where patients might come into contact with latex should be established and should be available to all hospital staff, including housekeeping staff (Tables 5 and 6). At the time of admission, latex allergy status should be established by the history or screening questionnaire. Status should be documented and prominently displayed at the door, at the bedside, and on wristbands. Emergency department, operating department, and crash cart supplies should include nonlatex products. Note that so-called hypoallergenic latex gloves are not necessarily latex-free; they can contain considerable amounts of latex allergens and should not be worn in the vicinity of persons who are allergic to latex.

Table 6. Items Contained in Latex-Free Box.

Item or Product Name	Manufacturer
Nonsterile examination gloves (Nitrile Plus)	Biosafety Systems
Duraprene sterile synthetic surgeon's gloves (size 6 $^1/_2$ to 8)	Baxter Healthcare
AstroScope disposable stethoscope	Omron Healthcare
Large adult personal cuff (blood pressure cuff)	Technol
Adult personal cuff	Technol
Small adult personal cuff	Technol
Child cuff	Technol
Child cuff (size 5)	Technol
Pediatric cuff (size 4)	Technol
Infant cuff (size 3)	Technol
Neonate cuff (size 1)	Technol
Uniquet single-use latex-free tourniquet	Vacutainer brand, Becton Dickinson
Insyte intravenous catheter and needle unit, 18- & 20-gauge, 1 $^1/_4$ in; 22-gauge, 1 in	Becton Dickinson, Vascular Access
Interlink injection site	Baxter
Intravenous loops	Polymicro Technologies
Microbore extension tubing	Baxter Healthcare
Glass syringes	
LifeCare 5000 Plumset LifeShield primary intravenous pump set - OL 15 gtt/mL tubing	Abbott Laboratories
Transpore 1-in tape	3M/Baxter
Steri-Strips $^1/_8$ in × 3 in	3M/Baxter
Bioclusive transparent dressing, 4 in × 5 in, 5 in × 7 in	Johnson & Johnson Medical
Bardex all-silicone Foley catheter, 16F and 18F	Bard Urological Division

During regular physical examinations and preoperative history taking and physical examinations, patients who report a history of vague allergic reactions should be queried further for evidence of latex allergy (Table 3). Latex-sensitive patients undergoing surgery should be scheduled as the first case of the day, when aerosolized latex particles are the lowest. Larger hospitals should have a designated latex-free operating suite. If blood pressure cuffs and tubing are made of latex, the patient's extremities should be wrapped to prevent contact.

Although it has been recommended that medications not be drawn up through rubber-stoppered vials or allowed to sit in preloaded syringes that contain latex rubber, and that latex ports

Table 7. Websites for Latex Allergy Information.

Organization	Address
PALS (Physicians Against Latex Sensitization)	e-mail: bzpmd@aol.com http://www.pals.net/
Latex Allergy Links page	http//www.netcom.com/~nam1/latex_allergy.html
Delaware Valley Latex Allergy	http://www.latex.org/
ELASTIC (Education for Latex Allergy/Support Team & Information Coalition)	e-mail: ecbdmd@ix.netcom.com http://www.netcom.com/~ecbdmd/elastic.html
NIOSH (National Institute for Occupational Safety and Health)	http://www.cdc.gov/niosh/latexall.html

should not be used for intravenous injections, these precautions appear to be impractical for all but the most exquisitely latex-sensitive patient and are likely not necessary.[38] Patients have been premedicated with antihistamines, steroids, and histamine H_2-blockers, but anaphylactic reactions have occurred despite such pretreatment.[38] Because the FDA has established rules for labeling all medical devices that contain natural rubber latex,[39] the process of recognizing these products in the medical setting should be simplified.

Persons with latex hypersensitivity should possess epinephrine autoinjection kits and wear a medic alert identification. They should also carry diphenhydramine with them. Carrying extra pairs of nonlatex gloves for emergency medical or dental care is also advisable. Wearing a medic alert identification is important for the following reason: if an accident were to occur that would render the patient unconscious, the patient might be exposed to numerous medical products containing latex in the emergency department, including blood pressure cuff, urinary catheter, face mask, tourniquets, gloves, intravenous tubing, and so on, that could worsen the patient's symptoms and result in anaphylaxis.

Many household items, everyday products, and sports equipment are made of latex. Latex-allergic patients should allergy proof their homes and environment and be ready to recognize potential latex-containing products. In addition, patients should be educated about the cross-sensitivity between latex and certain fruits. They should also be aware that these cross-reactive fruits can be hidden in meals, such as in juice, liqueur, wine, fruit salad, ice cream, jam, chewing gum, potato chips, and cereal.[32] With the increasing use of computers and Internet access, patients can be referred to several Websites to be informed about latex allergy (Table 7).

Conclusion

When caring for patients with latex allergy, the physician should educate patients about the potential hazards of latex-containing products. Health care providers should also develop a plan for protecting patients and health care workers from latex exposure and be able to manage allergic reactions when they occur.

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