Volume 3

KNOWLEDGENETWORK* Kimberly-Clark Health Care Education

FirstHAND

POTENTIAL CONSEQUENCES OF GLOVE POWDER

Medical gloves were introduced in the late 19th century. These gloves were thick, reusable, and difficult to don and remove. To facilitate donning and removal, powder was sprinkled into the glove. The primary types of powders used were Lycopodium spores (club moss) and talcum powder. In the 1930s, these powders were identified to cause severe adhesions, granulomas, and peritonitis. C.M. Lee published a paper in 1947 identifying chemically modified cornstarch as an alternative glove powder.[1] However, in 1952, Lee questioned that decision as evidence mounted regarding the adverse consequences from the continued use of modified cornstarch.[2]

Observe powder cloud created as glove is "snapped" in place.

Protection. For life.

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This publication will review the potential consequences of powdered glove use. Topics addressed are:

In 1971, the federal Food and Drug Administration (FDA) responded to this concern by requiring that a cautionary statement be placed on packaging for all synthetic and natural rubber latex powdered surgical gloves.[3] This cautionary statement, which is still required today, reads:

> *CAUTION:* After donning, remove powder by wiping gloves thoroughly with a sterile wet sponge, sterile wet towel or other effective method.[4]

Since initiating the use of this required statement, additional adverse consequences regarding the use of powder have come to light. In fact, glove powder has been implicated as a causative or contributing agent for such medical complications as granulomas, adhesions, delayed healing, increased scar formation, increased risk of infection, hand irritation, respiratory complications, the transport of allergens and potentially infectious microorganisms, and erroneous laboratory results.[5] Given this information, the healthcare provider should become more knowledgeable about potential complications associated with the use of glove powder.

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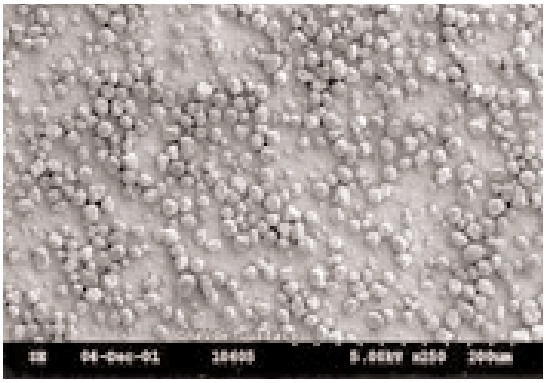
Description of USP Absorbable Dusting Powder

Now known as USP Absorbable Dusting Powder (ADP), modified cornstarch is still used today on powdered surgical and most powdered examination gloves.[3] In order to meet the specification for absorbable dusting powder for the United States Pharmacopoeia (USP), ADP must be capable of being boiled for 20 minutes and held in suspension for 24 hours without dissolving.[6] To prevent glove powder from dissolving, the cornstarch particles are treated with epichlorhydrin or phosphorous oxychloride. These chemicals cross-link the surface of the cornstarch particles making them resist most of the degrading effects of boiling and other processes.[7]

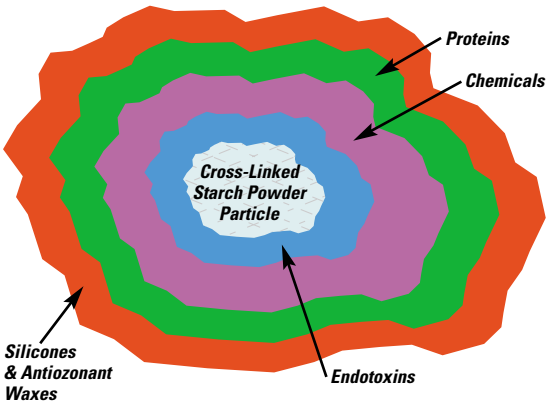
Figure 1



Microphotograph of Absorbable Dusting Powder on the surface of the glove.

Figure 2

USP Absorbable Dusting Powder (Post-Glove Manufacture)



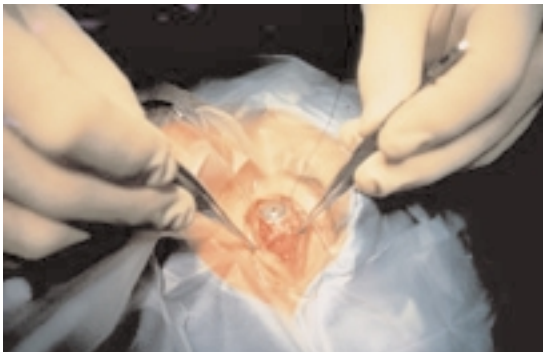
A diagrammatic representation of a powder particle with potential passengers absorbed during manufacturing.

Historically, the preferred method of sterilizing gloves was autoclaving and the intent of this stringent requirement for ADP was to ensure that glove powder did not become paste during this steam sterilization. Although autoclaving gloves is no longer the practice of choice, this specification of resisting dissolution when boiled is still required to qualify as ADP. The change in the method of surgical glove sterilization from steam sterilization to irradiation has been demonstrated to adversely affect the absorbability of glove powder as the powder no longer undergoes the partial breakdown of the autoclave pressure and steam.[8] For example, it has been demonstrated that powder sterilized by autoclaving was absorbed in 48 hours while powder sterilized by irradiation was still not fully absorbed after 70 days.[3] Moreover, powder has been isolated and identified in post-operative sites four years after surgery.[9]

Furthermore, during the manufacturing process of both synthetic and natural rubber latex (NRL) gloves, additional chemicals and endotoxin may bind to, or be absorbed by, the powder particles. The same is true of NRL proteins during the manufacture of NRL gloves.[10] To visualize this activity, first observe Figure 1, a microphotograph of ADP on the surface of the glove. Figure 2 is a diagrammatic representation of a powder particle after going through the glove manufacturing process where the various substances noted could potentially be absorbed. With variations, this represents the powder particle as the powdered glove is donned. Once the powdered glove is donned and in use, the particles may come in contact with other substances such as medications, disinfectants, and microorganisms that may be absorbed by the powder or bound to its surface.

Methods of Powder Dispersion

How is powder dispersed beyond the glove surface? And how does it come into contact with healthcare professionals and their patients? Before fully answering these questions, it must be noted that powder is not only present on the donning surface of surgical and examination gloves. Certain manufacturing steps may also result in the distribution of powder on the outside of the gloves as well. Methods of powder dispersion include direct contact, indirect transfer, torn or punctured gloves, and aerosolization.



Powder may be deposited directly from the gloves into the surgical site or other wounds.

Direct Contact

Dispersion by direct contact occurs when glove powder is deposited directly onto an individual. For example, glove powder is deposited from the gloves onto the hands of the wearer. Glove powder may also be deposited directly onto exposed tissues within the surgical site, thus the FDA cautionary statement requiring the wiping of surgical gloves after donning prior to surgery. However, it has been reported that compliance with this FDA requirement was adhered to by only 17% of surgeons.[11] Even when the exterior surface is scrupulously wiped, powder still remains on the glove and large amounts can still be found in patient wounds.[12] In fact, a study by D. G. Jagelman and H. Ellis found that attempts at powder removal may even increase powder-induced complications by causing the powder to clump, enlarging the size of the particles deposited into tissues.[13]

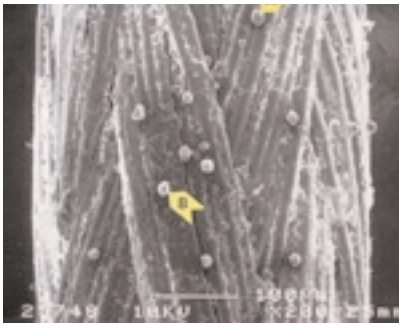
There are many areas outside of surgery where powder can directly contaminate the patient. The powder may be transferred to intact skin or mucous membranes when performing routine physical exams, as well as to more vulnerable areas including open wounds, post-operative sites, and burned skin surfaces.[5]

Indirect Transfer

Indirect transfer occurs any time powder from a glove is deposited onto an object which later may come in contact with a patient, caregiver, or other individual. Indirect transfer of powder may include such procedures as:

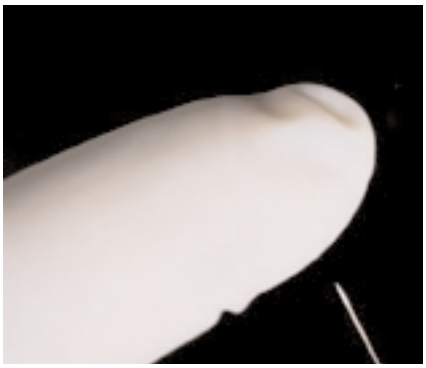
- *Using stethoscopes and blood pressure cuffs*
- *Letting down side rails*
- *Picking up a telephone or handling bed linens*
- *Manipulating intravenous ports or maintaining respiratory apparatus*
- *Touching x-ray screens or entering data on a keyboard*
- *Handling food or medications*
- *Changing wound dressings*
- *Cleaning, assembling and packaging surgical instruments*
- *Transferring instruments*
- *Handling donor organs and implants*
- *Handling sutures*
- *Inserting trocars*
- *Inserting catheters (e.g. cardiac, epidural, urinary)*

Powder may also be deposited onto clothing, skin, or hair where it can be carried outside the healthcare environment.



This photomicrograph shows powder deposited on a suture after one swipe with a powdered glove.

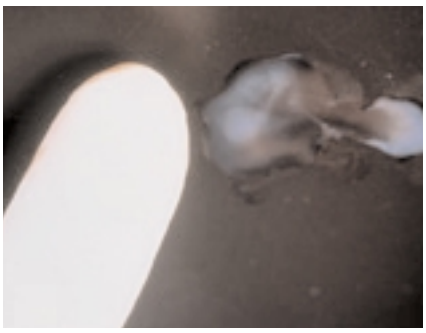
Methods of Powder Dispersion (continued)



Needle about to puncture glove

Torn or Punctured Gloves

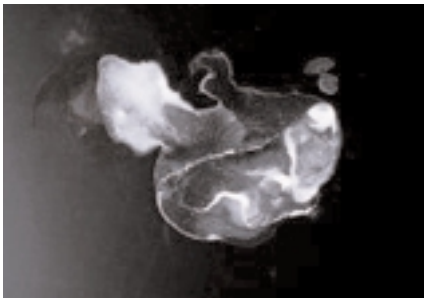
Even if powder were completely removed from the exterior of the glove, the donning powder on the inside of the glove may be released into open wounds or the general environment if the glove is torn or punctured. This may occur in operating rooms, patient wards, laboratories, pharmacies or anywhere else powdered gloves are worn. In those environments, the powder may contaminate various items including surgical wound sites, respiratory tubing, diagnostic specimens or injectable medications.



Powder plus sweat from within the glove is released into the environment.

Aerosolization

Powder may also be aerosolized when gloves are snapped in place or when they are removed. Once in the air, powder may be inhaled by caregivers and patients or may fall into wounds, onto medical devices or into the general environment.



Once dried, the amount of powder released is more obvious.

Powder can be released into the environment from powdered exam as well as surgical gloves.

Powder Concerns for the Wearer

Powdered gloves can be a concern for the wearer as powder may serve as an irritant and a vehicle for allergens and microorganisms. Lipids and natural moisture can be absorbed by powder leaving hands chapped, irritated and vulnerable to further injury or infection.

Powder can contribute to dermatitis, increasing vulnerability to cross infections.

Powder has been implicated in respiratory complications as well. Asthma, pneumonitis and other respiratory diseases are being experienced by a growing number of individuals. Exposure to powder in the hospital environment can be a contributing factor.[5] Once inhaled, powder may trigger nasal, throat and respiratory symptoms in some individuals.[5] This may merely be an irritant activity due to the particulate nature of the powder. Alternatively, the irritation may be due to the high pH of most glove powder or to chemicals from the glove manufacturing process. Additionally, chemicals from the hospital environment, including cytotoxic chemicals used in chemotherapy or disinfectants (e.g. glutaraldehydes, formaldehydes, phenolics, quaternary ammonias) may be absorbed by the powder and subsequently inhaled.[14]

As well as being an irritant, powder may contribute to allergic reactions. Chemical sensitizers, which may be absorbed by the powder, can trigger Type IV chemical allergy reactions[5](See Vol. 2 *FirstHAND: Glove-Associated Reactions)*. Such reactions could potentially vary from bronchial constriction to asthma-like attacks.[14] The specific symptoms, whether irritant or allergic in nature, depend on the substances transported, the individual's sensitivities and any pre-existing disease conditions. Similarly, natural rubber latex proteins can adhere to the powder particles and be released into the surrounding environment. This may precipitate a Type I, allergic reaction in latex allergic individuals.[5] Other allergens such as allergenic medications may similarly attach themselves to the powder.[14]

Microorganisms can attach to, and be transported by, powder particles.[15] These may be harmless environmental bacteria or infectious pathogenic microorganisms. This is especially a concern when treating patients with a known or suspected infection, collecting or processing specimens for diagnostic evaluation or when working with potentially infectious organisms in the laboratory.

As with the wearer, the patient may be at risk for powder-associated complications including irritation, allergic reactions and potential infection from powder-transported microorganisms. Additionally, there are well-documented complications of healing that can adversely affect the patient. These complications include prolonged inflammation, adhesion development, granuloma formation, and increased risk of infection.[5]

Potential Powder Complications for the Patient

Prolonged Inflammation

Whether deposited during surgery or in general wound care, powder can amplify and prolong the inflammatory process. This may result in increased swelling of the injured tissue, necessitating additional fibrin and other components of the healing process to bridge and close the expanded wound site. Ultimately, prolonged inflammation can delay healing and increase scar formation.[12, 16] Although scars are thicker, they tend to be weaker and not hold together as securely. If the enlarged scar is on a publicly exposed area of the skin, adverse aesthetic consequences may result. Function may be impaired if fine motor control centers, components of vision or moving joints are involved.[17, 18]

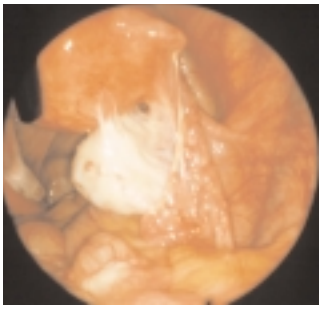
Adhesion Development and Granuloma Formation

Some of the most frequent powder complications in the wound are adhesions and granulomas.[5]

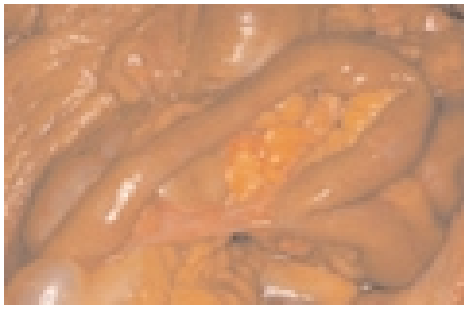
➤ *Adhesion Development*

When injured tissue begins to heal, a fibrin mesh forms a framework upon which repair cells can migrate to the place of injury. After the "scaffolding" has performed its function normally, it should dissolve to make way for the newly generated reparative tissue. If this process of fibrin breakdown or dissolution fails to take place, such as when a reaction to powder in the tissue occurs, adhesions will form along the scaffolding between the organs and tissues that are not meant to be attached.[19] Such adhesions may form around organs in what is termed band formation. Contracture of the band can then inhibit or block the normal functioning of the organ. For example, contracture of a band around a segment of intestine can cause intestinal blockage.

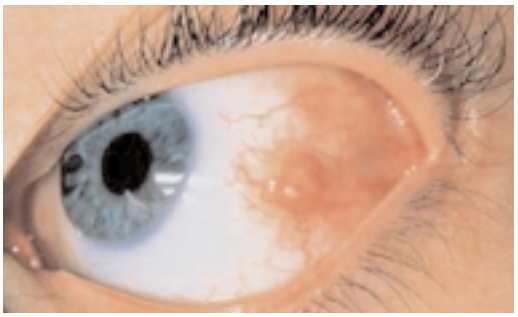
It is important to note that studies have demonstrated an increase in the predominance of greater and longer-lasting adhesions if iodophor preparations came in contact with the powder prior to deposition in the tissues.[20]



Adhesions of right fallopian tube and ovary.



Adhesion binding two segments of intestines to each other.



Granuloma on the surface of the eye surrounded by inflammation.

➤ *Granuloma Formation*

Granulomas form as a defense against the powder as foreign particles perceived to be invading the body. Initially, white blood cells surround the powder or other foreign body, then fibrin is set in place. If the situation becomes chronic, calcium may be deposited. The condition may finally dissolve within several months causing only minor pain and swelling or may persist for several years and require additional surgery for resolution.

It has been noted that starch induced granulomas and adhesions can also be secondary to delayed hypersensitivity (Type IV, chemical allergy) reaction to the powder or chemicals on the powder.[14] Such reactions may be amplified if endotoxin is also present[21] (See Vol. 2 *FirstHAND: Glove-Associated Reactions).*

Potential Powder Complications for the Patient (continued)

The presence of multiple granulomas in the abdominal cavity have been misdiagnosed as either milliary tuberculosis[22] or disseminated metastatic carcinoma.[23] Care must be taken not to depend on observation alone when widespread granulomas are discovered. Samples should be sent to the laboratory for histopathic confirmation. If determined to be granulomatous lesions, further efforts to identify powder at the nidus (nucleus of the disease process) can be undertaken by any of the following methods:[24]

- *Observation of Maltese Cross formation under polarized light*
- *Periodic Acid Schiff's (PAS) stain*
- *Lugol's stain*

Of course, the powder particle may be partially or completely dissolved by the time of re-section, making the cause of the granuloma production in the patient impossible to ascertain. Powder-induced granulomas may or may not resolve without surgery. Reduction may occur with steroid treatment.

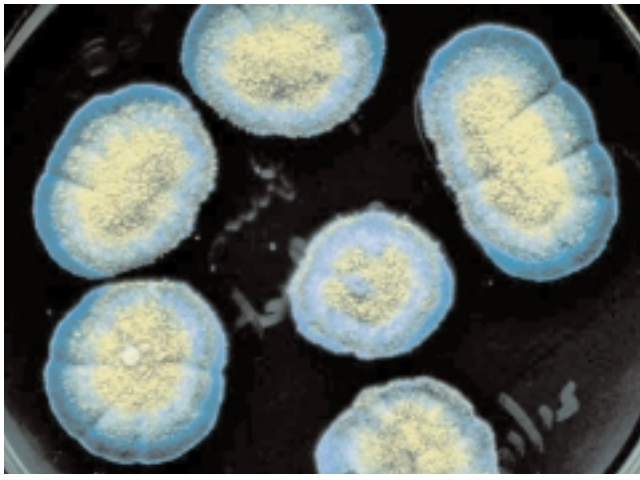
It is important to note, however, that adhesions and granulomas that require surgery for removal are usually not submitted for powder isolation as a causative agent.

Increased Risk of Infection

Increased risk of infection is a critical area of concern when considering the potential consequences of glove powder. When there are increasing numbers of immune-compromised patients, expanding numbers and varieties of antibiotic resistant microorganisms and more exotic infectious unknowns, we cannot afford to further increase the risk of infection.

Powdered gloves worn while treating infectious patients or handling specimens can actually provide a vehicle for organisms. Therefore, healthcare professionals must change gloves and wash their hands or use hand sanitizers before and after every procedure, as well as between a contaminated and clean site on the same individual.

Microorganisms can be present on unused, non-sterile powdered examination gloves when taken from the original packaging box.[14] This could cause opportunistic infections, especially in immune-compromised patients. Wet powder provides an excellent condition for microbial growth. It follows then that if boxes of powdered gloves become wet during transport or storage there is an increased probability for microbial contamination. Therefore, gloves should not be used if the box appears to have been wet.[14]



The fungus Aspergillus fumigatus *growing on a petri plate. Fungus may use cornstarch powder as a food source.*

Potential Powder Complications for the Patient (continued)

Studies have demonstrated that powder in a wound can significantly increase the risk of an infection. Powder can interfere with local immunological protection at the site of exposed tissues or wounds. The powder "distracts" the immunological defense mechanisms, allowing microorganisms to multiply that would otherwise have been stopped. This may allow an infection to develop.

Examples of Patient Powder Complications

The following examples are provided to further illustrate the types of glove powder complications found in patients:

➤ *Abdominal Complications*

Starch peritonitis syndrome[12] is a combination of cornstarch powder induced abdominal symptoms. Symptoms usually appear in the third or fourth week after surgery. The patient may be nauseous and/or have abdominal distention. There may be a low-grade fever,[25] although spiking temperatures have been noted. White blood cell counts are usually normal to slightly elevated.[26]

If aspiration or surgery is performed, the ascitic fluid is usually straw colored and may be speckled with granulomas. The granulomas may also be localized on specific organs or throughout the abdominal cavity. Fibrous adhesions are commonly present.[13] There have been deaths associated with starch peritonitis.[25]

➤ *Neurological Complications*

Powder-induced wound complications are not isolated to the abdominal cavity. For example, after cranial surgery, starch meningitis was diagnosed after clumps of powder, surrounded by polymorphonuclear and large phagocytic cells, were identified in the spinal fluid of a patient suffering post-surgical complications.[27] Cases of intracranial starch granuloma have also been identified after meningioma removal accompanied by inflammation and large amounts of sterile pus.[28]

In a 1995 study, it was reported that extradural catheters could be heavily contaminated with powder when handled with powdered gloves. It was stated that this occurs especially around the delivery holes. In one case, an extradural catheter was handled with powdered gloves, used and removed after 26 hours. Upon examination, fibrin was observed encasing the powder to the catheter. This evidence was determined to potentially increase the risk of infection and may be a factor in catheter occlusion.[29]

➤ *Cardiovascular Complications*

Powder-induced fibrosis, granulomatous endocarditis and thrombi, or clot formations, have been reported following cardiac catheterization[30] and auto-transfusion. Several deaths have been reported.[31]

Endotoxin has been identified as a glove powder contaminant. Endotoxins are pyrogenic substances that may cause muscle pain, fever, chills, headaches, nausea, increased inflammation, micro-thrombi and additional adverse physiological consequences including shock. Introduction of endotoxin into the cardiovascular system can be particularly detrimental. It is important to note that endotoxins are not destroyed by irradiation sterilization.

Potential Powder Complications for the Patient (continued)

➤ *Ophthalmic Complications*

Reports of glove powder complications after eye surgery[32, 5] include severe inflammation,[33] toxic lens syndrome,[32] chronic granulomas, fibrosis and adhesion formation.[18]

➤ *Orthopedic Complications*

Increased and prolonged inflammation with swelling and delayed healing has been associated with powder deposited during joint surgery.[17]

➤ *Organ Transplant Complications*

Powder-associated post-surgical complications can be introduced before the first incision is made by indirect methods. For example, when a donor kidney was perfused with sterile saline after harvest, prior to implantation, it was handled with sterile powdered gloves. The powder was present in sufficient quantities to become trapped in the glomeruli contaminating the organ before transplantation could occur.[34]

➤ *Fertility Complications*

It has been estimated that 15–20% of all female infertility is caused by post-surgical adhesions.[9] Powder has been isolated at the center of adhesions and scar tissue in and around the fallopian tubes and the body of the uterus resulting in infertility.[35] Powder was reported to have contaminated the uterine area not only during surgery,[11, 5] but also during vaginal examination for some patients who had never had surgical procedures.[28] Also of relevance in infertility cases, chemicals on gloves have been found to be cytotoxic and can kill cells used for in-vitro fertilization.[36, 39]

Powder Considerations for Laboratory Testing

A third area where glove powder may cause complications is in the laboratory. The laboratory is a prime target for powder-induced problems which can affect the assay and the technician. Powder can be responsible for physical interference, absorption, transport, and cross-contamination during the performance of a number of assays.

Powder from gloves may fall into lab assays contributing to erroneous results.

For example, polymerase chain reaction (PCR) is a diagnostic, forensic, genetic predictive and research tool. The discovery of this process for DNA amplification has provided scientists with a "quantum leap" technological resource. Nonetheless, it is susceptible to inaccurate results due to contamination by minute amounts of glove powder. Such contamination can cause non-specific interference with the PCR procedure.[37] This interference may occur even when powdered gloves are merely changed in the same room as the assay. Interference with the PCR amplification has resulted in false-negative determinations for HIV antibodies.[38] In another instance, a laboratory test result reported erroneously low cyclosporin blood concentrations for one sample. It was determined that glove powder that had fallen into the blood sample during preparation and absorbed cyclosporin from the sample. Thus the analyzer read only that which had not been absorbed.[39] Furthermore, false results of pregnancy tests have also been reported due to powder interference.[39]

Powder Considerations for Laboratory Testing (continued)

Additionally, it has been demonstrated that powder can adhere to the surfaces of optical reader plates. The plastic plates are thought to attract and hold the powder particles. When the plates are placed into the reader, the optical scanners "count" the particles.

X-ray diagnostics may be hampered when glove powder is trapped onto the films during development. The developer can be absorbed in the areas of powder contact presenting a negative penetration. Moreover, it has been demonstrated that powder prematurely ages developer solution and is not recommended even for mixing the solutions.[40]

As previously noted, chemicals and endotoxin can be absorbed and transported by glove powder.[10] Both substances can be cytotoxic to cell cultures, interfere with immunological assays, and contaminate other physiological determinations or studies.

Also, laboratory technicians may be vulnerable to potential powder complications. Powder should not be used when working with infectious microorganisms as they can bind to and be transported by the powder.[15] For instance, we discussed earlier that powder in a wound reduces the resistance to infection.[41] If a small cut on the hand of a technician is exposed to powder contaminated with microorganisms, an infection is more likely to occur than if the wound were exposed to the microorganism alone. Thus, powder does not belong where there is a potential for infection. Furthermore, powder should not be used where it could absorb and transport cytotoxic or chemotherapeutic drugs.[42] When working with radioactive substances, hazardous spills or other toxic materials, avoid using powdered gloves.

Summary

It is essential for healthcare professionals to understand the components of USP Absorbable Dusting Powder and the methods by which it is dispersed. The potential consequences associated with glove powder are well-documented and can affect the health of patients, healthcare providers and laboratory personnel. Therefore, it is important to limit the amount of glove powder exposure in the hospital environment and to select powder-free latex or synthetic gloves whenever possible.

Authors and References

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KNOWLEDGENETWORK *Kimberly-Clark Health Care Education*

Potential Consequences of Glove Powder: Possible Concerns for Specialty Areas

Intensive Care

- Complications for patients with compromised physical conditions:
  - Endotoxin: fever, inflammation and other endotoxic responses
  - pathogenic cross-infections
  - opportunistic infections
  - reduced resisitance to infection

Intravenous Solutions

- Contamination of solutions during reconstitution and preparation with:
  - microorganisms
  - Type I latex protein allergens
  - Type IV chemical contact sensitizers
  - endotoxin
  - particulates

Laboratory: Diagnostic or Research

- Inaccurate lab results due to absorption, agglutination and precipitation
- Interference with polymerase chain reaction process (PCR)
- Microbial contamination from micro-organisms supported by or transported on powder
- Interference of analytical instrument performance
- Assay contamination by protease, DNAse and/or RNAse transported by powder
- Contamination with endotoxin
- Interference with tape and labels sticking to tubes

Obstetrics and Gynecology

- Scarring of fallopian tubes
- Adhesions
- Infertility
- Granulomas
- Increased risk of infection

Neonatology

- Fragile lungs (esp. premature neonates) susceptible to powder-transported:
  - pathogenic microorganisms
  - endotoxin
- Irritant-induced respiratory inflammation
- Drying of the skin

Phlebotomy

- Powder transport of microorganisms, latex protein allergens, chemical additives
- Interference with tape and labels sticking to tubes
- Inaccurate lab results due to absorption, agglutination and precipitation if powder in samples

Post Surgery

- Delayed wound healing potential when powder contamination occurs while cleaning and dressing wounds potentially causing:
  - additional inflammation
  - edema
  - increased scar formation
  - microbial contamination
  - decreased number of organisms required to initiate an infection
- Delayed healing due to Type IV reaction to absorbed chemicals
- Reaction of latex allergic patients to latex protein allergens
- Implant, transplant and graft rejection

Pulmonary and Respiratory Therapy

- Irritant asthma initiation
- Increased risk of infection
- Acute inflammation of lung mucosa from endotoxin and glove chemicals bound to powder
- Reaction of latex allergic patients to latex protein allergens bound to powder

Surgery

- Endoscopes and other instruments cleaned, prepared or assembled with powdered gloves may deposit powder in the wound causing:
  - abrasion
  - irritation
  - lowered threshold for infection
  - endotoxin contamination
  - granulomas
  - adhesions
  - acute inflammation
  - delayed wound healing
  - increased scar formation
- The same adverse reactions may occur by touch transfer or aerosol deposition of powder during wound care
- Handling or preparation of transplant organs and implants can precipitate the same adverse consequences as those noted above
- Potential for auto-transfusion induced capillary blocking
- Transport of microorganisms

See **Employee Health** for personnel issues in all specialty areas.

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Potential Consequences of Glove Powder: Possible Concerns for Specialty Areas

Anesthesiology

- Pulmonary irritation
- Acute inflammatory response to endotoxin
- Allergic reaction to powder bound:
  - latex protein allergens
  - glove chemical additives

Blood Bank

- Interference with tape and labels sticking to tubes
- Inaccurate lab results due to absorption, agglutination and precipitation

Burn Units

- Potential delayed wound healing due to:
  - added inflammation
  - edema
- Increased scar formation
- Airborne microbial contamination
- Decreased number of organisms required to initiate an infection
- Delayed healing due to Type IV reaction to chemicals on powder
- Potential Type I allergic reaction to latex protein allergens on powder
- Implant, transplant and graft rejection

Central Processing and Supply

- Potential powder transfer to supplies cut, folded, wrapped or assembled with powdered gloves:
  - fine instruments
  - implants
  - gauze dressings
  - sponges
  - endoscopes
  - surgical instruments
  - custom packs due to loose powdered gloves in kit

Chemotherapy

- Aerosolization of powder-absorbed chemotherapeutic and cytotoxic drugs—risk to healthcare provider and patient

Dialysis

- Reprocessing, priming and initiating dialysis with gloved hands may contaminate the dialyzer potentially causing:
  - clogging
  - enhanced immunologic response: Type III hypersensitivity, basement membrane attack, accelerated Type I reactions to latex/EtO, and a Type IV response to contaminating accelerators or other chemical additives
  - renal failure

Emergency Department

- Wound contamination with powder:
  - acute inflammation
  - delayed wound healing
  - increased scar formation
  - increased risk of infection
- Increased risk of inhaled aerosolized powder:
  - Type I allergic reactions to bound latex protein allergens
  - Type IV allergic reactions to bound glove chemicals
  - cross contamination of infectious agents

Employee Health

- Hands:
  - lipid absorption
  - dermal abrasion
  - contact dermatitis (irritant or Type IV allergic)
  - Type I reaction to powder-transported latex protein allergens
  - breach of dermal protective barrier
- Lungs:
  - inhalation and mucosal contact
  - Type I reaction to powder-transported latex protein allergens
  - Type IV reaction to powder absorbed chemicals
  - Endotoxin-induced inflammation of lungs
  - irritant asthma trigger

Eye, Ear, Nose and Throat

- Migration of contaminated powder may contribute to:
  - clogged sinuses
  - increased risk of infected sinuses
  - otitis media

Gastrointestinal

- Glove starch deposited during gastrointestinal procedures may cause:
  - irritation
  - glove powder peritonitis syndrome
  - Type IV tissue reaction to powder absorbed chemicals
  - Type I reaction to powder-absorbed latex proteins
  - granuloma formation
  - adhesion formation

Immune-Compromised Patients

- Further reduction in resistance to infection
- Pathogenic microorganisms carried on powder may result in nosocomial infections
- Powder on non-sterile gloves may sustain microorganisms to be inhaled or be deposited in open wounds

In-Vitro Fertilization

- Physical interference of in-vitro conception
- Contamination of powder with the following embryo-toxic substances:
  - endotoxin
  - chemical additives from gloves
- Microorganisms bound to powder may contaminate sterile nutrient media

Infectious Diseases

- Aerosolized spread of disease by contaminated powder
- Touch transfer of disease by contaminated powder
- Decreased number of microorganisms required to initiate an infection

See **Employee Health** for personnel issues in all specialty areas.

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