



AEROSOLIZED DRUGS

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PURPOSE.

Healthcare workers risk exposure to exhaled aerosolized drugs along with infectious airborne pathogens during administration and routine care of patients receiving aerosol therapy. This technical information paper describes the engineering and administrative controls, safe work practices, and personal protective equipment (PPE) used to protect healthcare workers from such exposures.

POINTS OF MAJOR INTEREST AND FACTS.

Anti-infective drugs are used to treat a variety of respiratory infections and diseases. Patients benefit from aerosol therapy with these drugs since the aerosolized doses are generally smaller than systemic (injection, oral) doses, the drug is delivered directly to the target organ (lungs), the onset of the drug action is more rapid, and the systemic side effects are reduced compared with other routes of administration. Aerosolized drugs include pentamidine, ribavirin, tobramycin, aztreonam, and zanamivir.

BACKGROUND.

Pentamidine. Aerosolized pentamidine is used to prevent *Pneumocystis* pneumonia (PCP) in patients with acquired immunodeficiency syndrome (AIDS). It is also used to treat patients with acute episodes of PCP.

Ribavirin. Ribavirin is the only aerosolized drug currently listed on the 2016 National Institute of Occupational Safety and Health (NIOSH) List of Antineoplastic and Other Hazardous Drugs in Healthcare Settings. Aerosolized ribavirin is used to treat hospitalized infants with severe lower respiratory tract infections caused by respiratory syncytial virus (RSV).

Tobramycin. Aerosolized tobramycin is used to manage chronic *Pseudomonas aeruginosa* infections in cystic fibrosis (CF) patients over 6 years of age.

Aztreonam. Aerosolized aztreonam is used to improve pulmonary symptoms in CF patients 7 years of age and over with a *Pseudomonas aeruginosa* infection.

Zanamivir. Aerosolized zanamivir is used to treat influenza in children 7 years and older and in adults. It is also used prophylactically in children 5 years and older against the influenza virus.

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Hospitals commonly use nebulizers to convert liquid solutions or suspensions of the anti-infective drugs into aerosols for delivery to the patient's lower respiratory tract. Nebulizers are easy to use in all types of patients, and the same nebulizer can be used to administer a variety of drugs and drug mixtures when the drugs are compatible. Also, nebulizers can be adapted for use with a mouthpiece, adult or pediatric face mask, tracheostomy collar, T-piece, hood, or ventilator circuit.

Compared to patients receiving treatment, healthcare workers' exposure to aerosolized drugs is fairly low. Yet, some healthcare workers have experienced adverse health effects following occupational exposure. Some examples of these health effects include adverse reproductive effects (ribavirin and pentamidine), asthma-like symptoms (tobramycin), and bronchospasm and conjunctivitis (aztreonam).

Neither the Occupational Safety and Health Administration (OSHA), the NIOSH, nor the American Conference of Governmental Industrial Hygienists have established occupational exposure limits for these anti-infective drugs. Also, many of these drugs lack specific guidelines designed to protect the healthcare workers who administer them. Consequently, best practices must focus on the use of appropriate controls to keep all occupational exposures as low as possible. Administrative, engineering, and work practice controls are the primary means of reducing worker exposure to aerosolized drugs. Personal protective equipment (PPE) must be used where primary control methods are not adequate.

ENGINEERING CONTROLS.

Engineering controls minimize worker exposure by either reducing or removing the hazard at the source or isolating the worker from the hazard. Engineering controls include enclosing work processes and general and local ventilation systems. The following engineering controls should be used to prevent worker exposures to aerosolized drugs:

- Administer aerosolized drugs in an airborne infection isolation (AII) room. The Centers for Disease Control and Prevention provides criteria for the design and maintenance of AII rooms. Some critical requirements include (1) making sure that the room is under negative pressure relative to the corridor and other areas connected to the room, (2) the directional airflow within the room flows from cleaner areas to less clean areas, (3) the room has a minimum of 12 air changes per hour, and (4) the air from inside the room is exhausted directly to the outdoors.
- If AII rooms are not available, use portable negative pressure equipment. This equipment must filter the room air through High Efficiency Particulate Air (HEPA) filters before it is recirculated back into the treatment room. Procedures should be in place to inspect the HEPA filters routinely.
- Use isolation booths or hood assemblies with an exhaust fan with the contaminated air directed through a HEPA filter to capture and remove aerosols.

- Use nebulizing systems that are equipped with one-way valves, an expiratory filter, and a cut-off switch actuated by the patient and/or automatic shut-down when the mouthpiece is removed from the patient's mouth.
- Use booths, hoods, and nebulizers in combination with All rooms to further protect healthcare workers from occupational exposure to aerosolized drugs.

ADMINISTRATIVE CONTROLS.

Administrative controls are changes in work procedures such as written safety policies and rules, supervision, schedules, and training to reduce the duration, frequency, and severity of worker exposure. The following administrative controls should be used to minimize occupational exposures:

- Always follow the drug manufacturer's detailed instructions for administering aerosolized drugs, including using the recommended nebulizer system.
- Periodically provide medical screening examinations to healthcare workers who administer aerosolized drugs to patients known or suspected to be immunosuppressed, known to have tuberculosis, or have other respiratory infections.
- Give pregnant workers, workers wishing to become pregnant, and nursing mothers the option to be transferred to other comparable duties that do not involve handling aerosolized drugs.
- Train workers who administer aerosolized drugs on the potential risks of exposure to aerosolized drugs and their safe handling procedures.
- Allow only trained workers wearing the appropriate PPE to enter a patient room when aerosolized drugs are being administered.
- Maintain nebulizing systems and scavenging systems according to the manufacturer's directions.
- Request industrial hygienists determine the effectiveness of engineering, administrative, and work practice controls by conducting air sampling using NIOSH Method No. 5032 (pentamidine) and NIOSH Method No. 5027 (ribavirin) periodically and when changes in engineering controls, work practices, administration procedures, or equipment occur. [Maxxam](#), a Bureau Veritas Group Company, provides sampling methods and analytical services for tobramycin, aztreonam, and zanamivir.
- Maintain safety data sheets for each aerosolized drug administered at the healthcare facility.

SAFE WORK PRACTICES.

Safe work practices alter the manner in which a task is performed. Some fundamental and easily implemented work practice controls include (1) changing existing work practices to procedures that minimize exposures, (2) inspecting and maintaining equipment on a regular basis, (3) implementing good housekeeping procedures, (4) providing good supervision, and (5) prohibiting eating, drinking, smoking, chewing

tobacco or gum, and applying cosmetics in patient care areas. Safe work practices that will minimize occupational exposures are:

- Evaluate patients for airborne infectious disease before administering aerosolized drugs. Healthcare workers should administer aerosolized drugs to these patients only when it is deemed medically necessary.
- Use standard, contact, and airborne precautions when performing aerosol-generating procedures on patients with a suspected or known airborne infectious disease.
- When performing aerosol-generating procedures on patients with a suspected or known airborne infectious disease, verify that treatment rooms are under negative pressure before administration is started by using pressure-sensing devices, non-irritating smoke trails, or some other indicator to demonstrate that direction of airflow is from the corridor into the administration room with the door closed. If an anteroom exists, direction of airflow must be demonstrated at the inner door between the administration room and the anteroom.
- Verify nebulizers are properly assembled before use.
- Inspect scavenging equipment to verify that it is operational before use.
- Post a “DO NOT ENTER” warning sign at the entrance to the treatment room during administration of aerosolized drugs.
- Keep treatment room doors closed while administering aerosolized drugs.
- Educate patients in the correct use of the nebulizer.
- Instruct patients to turn off the nebulizer when talking or taking the mouth piece out of the mouth.
- Wait a minimum of 5 minutes after the nebulizer is turned off before entering the room to provide routine care (unless urgent or emergent problems require immediate access to the patient).
- Perform housekeeping in treatment rooms between patients. Housekeeping procedures should be consistent with the healthcare facility’s infection control policy.
- Allow adequate time for the local exhaust ventilation system to eliminate 99% of the aerosol before allowing unprotected healthcare workers and the next patient to enter the treatment room. A ventilation engineer or industrial hygienist should assess the ventilation system and determine the length of time needed to eliminate 99% of the airborne contaminant after the patient leaves the administration area.
- Sterilize, change or clean nebulizing systems, including filters and scavenging systems between patients. Cleaning procedures should be consistent with the manufacturer’s directions and the facility’s infection control policy.
- Never take contaminated PPE and work clothing home to launder.
- Consider patient gowns and linens contaminated and change them after treatment.
- Place contaminated linen in specially marked laundry bags and then place the laundry bags in a labeled and impervious bag. The laundry bags and their contents should be prewashed at the laundry, and then the linens may be added

to other laundry for a second wash. Laundry personnel should wear gloves and gowns while handling prewashed linens.

- Seek guidance from infection control for the proper disposal of filters, nebulizers, and other contaminated disposable components of the aerosol delivery system that was used on patients with a suspected or known airborne infectious disease.

PERSONAL PROTECTIVE EQUIPMENT.

Personal protection devices should be used to reduce worker exposure when engineering controls do not adequately eliminate the hazard. To be effective, PPE must be individually selected, properly fitted and periodically refitted; properly worn; regularly maintained; and replaced, as necessary. The recommended PPE includes:

- Nitrile or natural rubber gloves.
- A water-resistant gown worn over work clothing.
- Chemical splash goggles and a face shield when a splash hazard exists.
- A NIOSH-approved N95 respirator or a more protective respirator before entering a treatment room during drug administration. The use of respirators must comply with OSHA Standard 29 Code of Federal Regulations 1910.134, Respiratory Protection, and Army Regulation 11-34, The Army Respiratory Protection Program.
- Head and shoe covers (aerosols may be deposited on skin and environmental surfaces).

CONCLUSION

While aerosolized anti-infective drugs are beneficial to the patients receiving them, there have been reports of adverse health effects in the healthcare workers who were occupationally exposed. The authorities have not designated exposure limits for any of these drugs. To date, only ribavirin has been identified as a hazardous drug by the NIOSH. Until more research is completed, healthcare facilities should take a defensive approach and keep occupational exposures to aerosolized anti-infective drugs as low as possible through the use of administrative and engineering controls, safe work practices, and PPE.

POINT OF CONTACT FOR FURTHER INFORMATION

For more information, contact the U.S. Army Public Health Center, Industrial Hygiene Program Management at commercial 410-436-2439 or DSN 584-2439.

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