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Precautionary Practices of Respiratory Therapists and Other Healthcare Practitioners Who Administer Aerosolized Medications

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Abstract

Introduction—Respiratory therapists and other healthcare workers are potentially exposed to a variety of aerosolized medications. The NIOSH Health and Safety Practices Survey of Healthcare Workers describes current exposure control practices and barriers to using personal protective equipment during administration of selected aerosolized medications.

Methods—An anonymous, multi-module, web-based survey was conducted among members of healthcare professional practice organizations representing respiratory therapists, nurses and other healthcare practitioners. A module on aerosolized medications included submodules for antibiotics (amikacin, colistin, tobramycin), pentamidine and ribavirin.

Results—The submodules on antibiotics, pentamidine and ribavirin were completed by 321, 227 and 50 respondents, respectively, who were mostly respiratory therapists. The relatively low number of ribavirin respondents precluded meaningful interpretation of these data and may represent the rare use of this drug. Consequently, analysis focused on pentamidine, classified by NIOSH as a hazardous drug, and antibiotics amikacin, colistin, and tobramycin which currently lack authoritative safe handling guidelines. Respondents who administered pentamidine were

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Location of Study Headquarters

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Presentations

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Author Contributions

Rebecca Tsai contributed to the manuscript in the following ways: literature search, analysis and interpretation of data, and manuscript preparation.

Jim Boiano, Andrea Steege and Marie Sweeney contributed to all aspects of the study (i.e., study design, literature search, data collection and analysis, and manuscript preparation)

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more likely to adhere to good work practices compared to those who administered these antibiotics. Examples included: training received on safe handling procedures (75% vs 52%), availability of employer standard procedures (82% vs 55%), use of aerosol delivery devices equipped with an expiratory filter (96% vs 53%) or negative pressure rooms (61% vs 20%), and always using respiratory protection (51% vs 13%).

Conclusions—Despite the availability of safe handling guidelines for pentamidine, implementation was not universal, placing workers, co-workers, and even family members at risk of exposure. Although the antibiotics included in this study lack authoritative safe handling guidelines, prudence dictates that appropriate exposure controls are used to minimize exposure to the antibiotics as well as other aerosolized medications. Employers and employees share responsibility for ensuring that precautionary measures are taken to keep exposures to all aerosolized medications as low as practicable.

Keywords

aerosolized medications; respiratory therapists; exposure controls; pentamidine; antibiotics; web-based survey

INTRODUCTION

Aerosolized medications are used to treat respiratory infections and other pulmonary ailments via inhalation therapy. Nebulizers are commonly used to deliver a fine spray or mist containing one or more medications which can be directly inhaled from the mouthpiece of the device.[1] Aerosol generators have also been used to treat pediatric patients (e.g., ribavirin) inside containment hoods or tents. Aerosolized medications may be preferred over systemic therapy for several reasons: the medication can be delivered to a specific site, lower dosage can achieve high drug concentrations in the lungs, and the potential for systemic side effects are reduced.[2, 3] Despite their inherent benefits, aerosolized medications may pose an occupational hazard to respiratory therapists and other healthcare workers who administer them. Unintentional inhalation of fugitive aerosols can occur when the nebulizer mouthpiece or mask is improperly fitted or separated from the patient's mouth (e.g. coughing).[4–6] Although exposure to aerosolized medications among caregivers is relatively low compared to the patients receiving treatment, adverse effects in occupationally exposed workers have been reported. [1, 7]

The following aerosolized medications were included in this study: antibiotics (amikacin, colistin, tobramycin); anti-protozoal (pentamidine), and anti-viral (ribavirin). The targeted aerosolized antibiotics have been associated with respiratory irritation, ototoxicity and nephrotoxicity (amikacin); rhinitis, asthma and dyspnea (colistin); and eye irritation and asthma-like symptoms (tobramycin). [8–10] Primary health effects associated with occupational exposure to pentamidine include dyspnea, chest tightness, cough, conjunctivitis, hematologic abnormalities, perinasal paresthesia and numbness. [11, 12] Aerosolized pentamidine also has been shown to be embryotoxic in animals.[13] Respiratory irritation, shortness of breath, ocular irritation, asthma, and skin rash have been reported by healthcare workers administering aerosolized ribavirin.[14] Ribavirin has also been shown to be teratogenic (in rodents) which has prompted precautionary guidelines for healthcare

workers of child-bearing age.[15] Evidence of pentamidine and ribavirin exposure has been detected in the urine of exposed healthcare workers.[4, 16, 17] Surveys of respiratory therapists have reported an increased risk of occupational asthma and other respiratory symptoms.[18, 19,20]

The National Institute for Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA) consider pentamidine and ribavirin hazardous drugs and have developed guidelines for the safe handling of both medications.[15, 21] These guidelines provide information on recommended exposure controls to protect healthcare workers from exposure and adverse health effects. Unless a hazard can be eliminated or substituted by a substance less toxic (which is not feasible with respect to aerosolized medications), exposure controls should be systematically implemented in the following decreasing order of efficacy: 1) engineering controls, 2) administrative controls, 3) work practice controls, 4) personal protective equipment (PPE).[22] Authoritative guidelines for safe handling of the targeted aerosolized antibiotics do not exist; they have not been linked to serious health effects.

Training and standard procedures, often part of a comprehensive health and safety program, are important for reducing exposure to aerosolized medications.[23] A NIOSH Alert recommends the implementation of such a program for handling hazardous drugs.[21] Additionally, the American Society of Health-System Pharmacists (ASHP) guidelines state that only trained workers should administer hazardous drugs.[24] Standard procedures should stipulate the use of appropriate engineering and administrative controls and PPE to minimize exposure of healthcare personnel to aerosolized medications during treatment of patients. [5, 24] Engineering controls are effective at removing fugitive aerosols at the source.[25] These may include continuous aerosol delivery systems equipped with expiratory filters or ventilated booths equipped with HEPA filters.[1, 5] Multiple engineering controls including the use of negative pressure rooms in combination with these devices may also be used to further protect healthcare workers.

The primary objective of this study was to describe self-reported work practices of respiratory therapists and other healthcare workers who administer aerosolized amikacin, colistin, tobramycin, pentamidine, and ribavirin. This national survey is the first to examine use of engineering, administrative and work practice controls and PPE by healthcare workers administering the targeted aerosolized medications.

METHODS

Survey Methodology

Data used in this study are from the NIOSH Health and Safety Practices Survey of Healthcare Workers, an anonymous, multi-module, web-based survey conducted from January 28 through March 29, 2011. The study population included members of professional practice organizations representing healthcare occupations which routinely use or come in contact with several classes of chemical agents prominently found in healthcare. Practices around the administration of aerosolized medications were addressed by one of seven hazard modules targeted to members of the American Association for Respiratory Care, the largest

professional practice organization representing respiratory therapists. Other healthcare workers who administered aerosolized medications were also invited to complete the survey module. Methods used in the design, testing, and implementation of the survey, and strengths and limitations were described elsewhere.[26]

Survey Instrument

The hazard module addressing aerosolized medications consisted of three submodules: 1) antibiotics amikacin, colistin, tobramycin; 2) pentamidine, and 3) ribavirin. The topic areas covered by this module can be found in the online supplement. The submodules for antibiotics and pentamidine contained 29 questions each, while the submodule for ribavirin contained 31 questions. Question format included yes/no, multiple choices and multiple options (check all that apply). In cases where responses were not exhaustive, respondents could select “other” and type in a response.

The modular survey was programmed to present the most relevant hazard module first based on screening questions, then the core module, and then a second hazard module, if indicated. It was possible for respondents to complete the aerosolized medications module and not the core module. In those cases, demographic information is unavailable.

Data Analysis

Data were analyzed using SAS 9.3 (Cary NC: SAS Institute, Inc). Simple frequencies and prevalences are presented for questions in the aerosolized medications submodules and selected questions in the core module that describe demographic, employer and occupation characteristics. We compared responses from all respondents and from respiratory therapists to questions addressing training, availability of employer procedures, use of aerosol delivery equipment/engineering controls, and use of PPE to determine if prevalence changed substantively; because no differences were observed, the data for all respondents are reported. Either the Pearson chi-square test or the Fisher’s exact test (at least one cell with an expected value <5) was used to assess differences in healthcare practices between antibiotics and pentamidine.

The time frame for most questions on aerosolized antibiotics and ribavirin was “the past 7 calendar days,” while for pentamidine, it was “the past 30 calendar days.” A longer time period for pentamidine was used to maximize the number of respondents because it was administered less frequently than the other medications, based on input from practitioners. For a question addressing use of engineering controls, the survey was programmed to present two response scenarios: “yes” or “no” when the aerosolized medication was administered only one time in the past 7 calendar days, or “every time,” “sometimes,” or “never,” when administered more than one time. For analysis, frequencies of “yes” and “every time” and “sometimes” were combined as “yes” responses; frequencies of “no” and “never” were combined as “no” responses. Additionally, respondents were asked to select reason(s) for not always using each of four types of PPE (i.e., protective gloves, water-resistant gowns or outer garment, eye/face protection, and respirator). Each reason for not always wearing PPE was subsequently summarized across all four types of PPE. The percentage of respondents was obtained by calculating the number of respondents who did

not always use any one of the four types of PPE due to a specified reason divided by the total number of respondents (including those who reported always wearing PPE). Each respondent was counted once for each reason, even if the same reason was given for more than one type of PPE. Age of respondent was estimated by subtracting year of birth from the year the survey was administered. States where respondents worked were aggregated into four U.S. Census regions (Northeast, Midwest, South and West) for reporting purposes. Because the primary intent of this survey was to provide descriptive information on precautionary practices around administration of aerosolized medications, no a priori hypotheses were proposed.

Human Subjects Review

The NIOSH Institutional Review Board determined that the activities in this project were surveillance and did not meet the criteria of research according to 45 CFR 46.1101(b)(2) and CDC guidelines for defining public health research and public health non-research.[27]

RESULTS

Respondent Characteristics

A total of 491 respondents completed one or more submodules of the aerosolized medications hazard module. Submodules on antibiotics, pentamidine, and ribavirin were completed by 322, 231, and 50 respondents, respectively. The core module was completed by 285 (89%), 201 (89%) and 40 (80%) of these respondents, respectively, and can be characterized by demographic data. The relatively low number of respondents to the ribavirin submodule precludes meaningful interpretation of the data; therefore, no additional data on ribavirin practices will be presented. We provide descriptive information on respondent demographic and administration characteristics for aerosolized antibiotics and pentamidine in Online Supplemental Tables 1 and 2.

Demographic, occupation and employer characteristics for respondents of the antibiotics and pentamidine submodules were similar with respect to many characteristics (Online Supplemental Table 1). Most respondents of the antibiotics and pentamidine submodules were female (65%, 70% respectively), white (88%, 91%), over 40 years of age (83%, 88%), possessed at least an associate's degree (92%, 92%), spent over 50% of their time in direct patient care (82%, 72%), had 11 or more years in their current occupation (79%, 81%) and with their employer (55%, 64%), and did not belong to a labor union (90%, 89%). Respiratory therapists represented 87% and 76% of the antibiotics and pentamidine submodules, respectively; with nurses comprising most of the remaining respondents. Employers were best characterized as hospitals having >1,000 employees (>56%), non-profit (>61%), located in a large city (>65%), and fairly equally distributed across four U.S. geographical regions.

Administration Characteristics

Antibiotics and pentamidine administration characteristics are presented in Online Supplemental Table 2. Administration practices of respondents to the antibiotics submodule were best characterized as follows: 70% administered for six or more years; 85%

administered three or fewer days in the past seven days; nearly 70% administered fewer than four times in the past seven days; over 60% spent fewer than 15 minutes with a patient during a single administration; and over 90% delivered aerosol therapy in patient's hospital rooms. Administration practices of respondents to the pentamidine submodule were best characterized as follows: over 70% administered for six or more years; 75% administered no more than two days in the past 30 days; over 90% administered only up to five times in the past 30 days; over 60% spent 15 minutes or more with a patient during a single administration; and nearly 75% administered the medication in a clinic/department treatment room or area. Respondents administered pentamidine for more years and spent more time with patients per treatment than respondents who administered antibiotics. Both respondent groups reported that the number of times they had administered the medication was about the same as usual.

Training and Employer Standard Administration Procedures

Respondents were much less likely to receive training on the safe handling of antibiotics than pentamidine (52% vs 75%; $P < 0.01$) (Table 1). This difference was further magnified (45% vs 75%; $P < 0.01$) when respondents who administered both antibiotics and pentamidine were excluded from the analysis. However, of those who had received training, a slightly higher proportion of pentamidine respondents (66% vs 59%; $P = 0.21$) reported being trained more than 12 months ago. Respondents administering antibiotics also reported their employer was less likely to have standard administration procedures compared to those who administered pentamidine (55% vs 82%; $P < 0.01$).

Use of Aerosol Delivery Equipment and Engineering Controls

In some cases, the aerosol delivery equipment and engineering controls were unique to one medication (e.g., ventilated booth or treatment station equipped with a high efficiency particulate air (HEPA) filter for pentamidine). In other cases, the same devices/controls were applicable to both medications (e.g., negative pressure room, nebulizer with expiratory filter) and comparisons were made. Where the same controls/devices were used, 80% of respondents administering antibiotics and nearly 40% of respondents administering pentamidine never used a negative pressure room ($P < 0.01$). Additionally, nearly half (47%) of the respondents administering antibiotics never used a hand-held, continuous aerosol delivery system with an expiratory filter compared to only 4% of pentamidine respondents ($P < 0.01$). About 46% of respondents administering pentamidine never used a ventilated booth or treatment station equipped with a HEPA filter. For engineering controls unique to antibiotics, nearly 60% of respondents never used a ventilator equipped with an expiratory HEPA filter, and 48% never used a continuous aerosol delivery system attached to a face mask, face tent or tracheostomy collar (Table 2).

Personal Protective Equipment

Frequency of use and reasons for disuse—Respondents of both antibiotics and pentamidine submodules reported that they did not always use protective gloves (21% vs 22%; $P = 0.79$) and water-resistant gowns or outer garments (66% vs 69%; $P = 0.47$). Nearly 88% respondents administering antibiotics did not always use eye/face protection or

respirators. By comparison, a smaller proportion of respondents administering pentamidine did not always use respirators (49%; P < 0.01) or eye/face protection (75%; P < 0.01) (Table 3). Approximately 90% of respondents of both submodules who used a respirator reported that they were fit-tested.

Respondents who reported that they did not always wear PPE when administering antibiotics and pentamidine were asked to select from a list of 10 reasons (including "other, please specify") all applicable reasons for not always wearing PPE (Table 4). The reason most reported by respondents was "not part of our protocol". Statistically significant differences between those administering antibiotics and those administering pentamidine were found for the following reasons: "an engineering control was being used" (P <0.01), "not part of our protocol" (P <0.01), "no one else who does this work uses them" (P <0.01), "not provided by employer (P=0.02), "not readily available in work area" (P=0.01), and "Other" (P=0.01). Other reasons primarily included "never trained to wear gloves/gowns" and "not aware gloves or gowns were needed." Please see Online Supplemental Table 3 for results separated by type of PPE.

Glove use: activities where cross-contamination may occur (done while wearing gloves that were used to handle medications)—Four percent of respondents who administered pentamidine and 3% of respondents who administered antibiotics reported that they had removed and later re-used gloves that had been worn during treatments (P=0.72) (Table 5). Respondents were also asked whether they performed selected activities while wearing gloves that had been used during administration. Activities most frequently reported by respondents who administered pentamidine included "touch door knobs, cabinets, or drawers" (41%), "use pens/pencils" (36%), and "use a non-disposable stethoscope" (36%). Activities most frequently reported by respondents who administered antibiotics included "touch I.V. pump or bed controls" (54%), "touch door knobs, cabinets, or drawers" (52%), and "use pens/pencils" (51%). Respondents who administered antibiotics reported higher frequencies for all activities with the exception of "handle files or charts."

Took home clothing—Sixty percent (n=175) of respondents administering antibiotics and 43% (n=85) of respondents administering pentamidine took home clothing that came in contact with these medications (P <0.01), additionally, 12% and 16%, respectively, did not know whether they had.

Exposure Monitoring

Exposure monitoring (i.e., air and/or surface wipe sampling) was not common. Only 9% of respondents reported that monitoring had been conducted by their employer for pentamidine and a few percent for the antibiotics tobramycin and colistin. Amikacin was not included as a response option because it lacked a monitoring method. Approximately 40% of respondents reported that they did not know whether monitoring had been done for pentamidine or the two antibiotics.

DISCUSSION

The NIOSH Health and Safety Practices Survey of Healthcare Workers is the first national survey to describe self-reported use of safe handling precautions by respiratory therapists and other healthcare workers who administer aerosolized medications. This study provided an opportunity to compare exposure control practices for a hazardous drug (pentamidine) where rigorous safe handling guidelines have been available for many years and selected antibiotics which currently lack comparable guidance. This study also showed that the number of ribavirin respondents was relatively low compared to the other studied medications possibly indicating that ribavirin therapy has diminished.

Overall, survey findings showed that respondents who administered pentamidine were more likely to adhere to good work practices compared to those who administered antibiotics. Those who administered pentamidine were more likely trained, familiar with employer standard procedures, have engineering controls in place, and use eye/face protection and respirators. They were also less likely to touch various objects in the work area while wearing gloves that had been used to handle medications, but more likely to take home potentially contaminated clothing. Despite the longstanding availability of safe handling guidelines for pentamidine, adherence to these guidelines was not universal.

A quarter of respondents administering pentamidine were never trained. Of those who had received training, 66% reported that it was more than 12 months ago. Of those trained, a greater proportion of pentamidine respondents had received initial training but not annual refresher training when compared to respondents who administered antibiotics. The latter was unexpected since refresher training is specified in safe handling guidelines.[15] There are no specific training guidelines for antibiotics; however, the OSHA Hazard Communication standard mandates initial training for all hazards in the workplace.[28] Respondents who administered both pentamidine and antibiotics were more likely to be trained than those who administered antibiotics alone. It is very likely that the training on safe handling of pentamidine would be relevant to antibiotics.

Our findings show that 32% of respondents who administered antibiotics did not always use any of four engineering controls; raising concerns that respiratory therapists and others may be exposed to fugitive aerosols. Information regarding the concurrent use of multiple engineering controls and reasons for disuse was not collected which limits full interpretation of these findings.

Personal protective equipment should be worn to provide additional protection from exposure to aerosolized medications. Both the NIOSH and ASHP guidelines state that protective gloves and gowns should be worn while handling hazardous drugs.[21, 24] However, protective gloves and gowns were not always worn by over 20% and nearly 70% of respondents, respectively, while administering pentamidine. Also, a small percentage (3–4%) of respondents who handled pentamidine and/or antibiotics reported reusing gloves which may result in exposure and/or contamination of work area. Additionally, respirators, eye and face protection should be worn when handling hazardous drugs.[24] A previous study found that most workers did not wear respirators during the administration of pentamidine

when local exhaust ventilation is available.[29] This survey also found that respondents report not using respirators when an engineering control is in place, but documented that there are many additional reasons respondents do not use respirators when administering pentamidine.

Barriers to using each type of PPE most reported by respondents who administered pentamidine and antibiotics ("not part of our protocol," "skin exposure was minimal") suggests a perception among respondents that aerosolized medications pose a minimal exposure risk, or that employers do not fully appreciate the potential adverse health effects associated with exposure to these drugs. The differences in reported reasons for not using PPE by respondents who administer pentamidine vs. antibiotics may be attributable to the presence of safe handling guidelines for hazardous drugs which currently only apply to pentamidine. The lack of information on potential synergistic effects of exposure to multiple medications, which are biologically active by nature, underscores a need for precautionary practices to minimize exposures.

This survey targeted a few of the many medications delivered as aerosols to patients. Without appropriate controls in place to minimize the likelihood of exposure to fugitive aerosols, respiratory therapists, nurses and others who administer these and other aerosolized medications may be exposed unnecessarily. Data from this survey indicate that not all employers and employees are handling pentamidine in accordance with OSHA guidelines. Although the antibiotics included in this study lack authoritative guidelines, prudence dictates that appropriate safe handling precautions be taken for antibiotics as well as other aerosolized medications. This comprehensive precautionary approach should minimize the risk of exposure to fugitive aerosols to healthcare practitioners and bystanders during care of patients receiving aerosol therapy.

The limitations of this survey have been described elsewhere.[26] However, there are three limitations specific to this hazard module. First, information on impediments to using aerosol delivery equipment and engineering controls was not collected and is recommended for future studies. Second, the relatively low number of respondents administering ribavirin prohibited meaningful interpretation of those data. Last, demographic information was unavailable for approximately 10% of respondents who chose not to complete the core module.

CONCLUSIONS

Findings from this survey show that precautionary practices are not universally used during administration of aerosolized medications. Training, availability of employer standard procedures, and use of engineering controls and PPE were more prevalent for pentamidine than the targeted antibiotics, most likely because of the longstanding safe handling guidelines for hazardous drugs including pentamidine. However, adherence to precautionary guidelines for pentamidine was not universal which is concerning. Research is needed to determine whether aerosolized antibiotics pose a health risk to workers. Until then, a precautionary approach should apply. The most commonly reported barriers associated with not using PPE suggest that employers and healthcare workers are not aware of the hazards or believe that exposures are inconsequential or are so rare as to not warrant their use.

Employers and employees share responsibility for ensuring that precautionary measures, including development and adherence to relevant standard procedures, are taken to keep exposures to all aerosolized medications as low as practicable.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Training and Employer Standard Procedures for Administering Aerosolized Antibiotics and Pentamidine

Training/Standard Procedures	Antibiotics*		Pentamidine		P-value†
	n§	Percent‡ Yes	n§	Percent‡ Yes	
Received Training	317	52	213	75	< 0.01
Never received training	317	48	213	25	
Time period for training					
Within last 12 months	165	41	160	34	0.21
>12 months ago	165	59	160	66	
Standard procedures	307	55	214	82	< 0.01

*Antibiotics include tobramycin, amikacin and colistin.

†The chi-square test was used to calculate p-values.

‡Percents may not add to 100 percent due to rounding.

§Number of respondents varied for individual items (i.e., number of eligible respondents less number who elected not to answer).

Table 2

Use of Aerosol Delivery Equipment and Engineering Controls for Aerosolized Antibiotics and Pentamidine

When you administered aerosolized (antibiotics, pentamidine) to patients during the past 7 calendar days, did you…	Antibiotics*		Pentamidine		
	n‡	Percent Never Using	n‡	Percent Never Using	P-value†
…administer in a negative pressure room§	295	80	194	39	< 0.01
…use a hand-held, continuous aerosol delivery system (nebulizer, T-piece, mouth piece) with an expiratory filter	293	47	195	4	< 0.01
…use a ventilator equipped with an expiratory high efficiency particulate air (HEPA) filter	297	59	–	–	
…use a continuous aerosol delivery system attached to a face mask, face tent or tracheostomy collar)	297	48	–	–	
…use a ventilated booth or treatment station equipped with a high efficiency particulate air (HEPA) filter	–	–	194	46	

Dash (–) indicates question was not asked for this aerosolized medication.

*Antibiotics include tobramycin, amikacin and colistin.

†The chi-square test was used to calculate p-values.

‡Number of respondents varied for individual items (i.e., number of eligible respondents less number who elected not to answer).

§A room with a ventilation system that creates negative pressure and prevents air contaminates from escaping to other rooms/areas

Table 3

Percent of Respondents Not Always Using PPE When Administering Aerosolized Antibiotics and Pentamidine

	Antibiotics*		Pentamidine		
Type of PPE	**n‡**	**Percent Not Always Using**	**n‡**	**Percent Not Always Using**	**P-value†**
Protective gloves	291	21	197	22	0.79
Water-resistant gown or outer garment	293	66	199	69	0.47
Eye/face protection§	290	88	192	75	< 0.01
Respirator–	287	87	190	49	< 0.01

*Antibiotics include tobramycin, amikacin and colistin.

†The chi-square test was used to calculate p-values.

‡Number of respondents varied for individual items (i.e., number of eligible respondents less number who elected not to answer).

§Examples include goggles and face shields.

Includes N95 respirator, half-facepiece air-purifying respirator with particulate filter(s), and powered air-purifying respirator with particulate filter(s).

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Table 4

Reasons for Not Always Wearing PPE When Administering Aerosolized Antibiotics and Pentamidine

Reason	Antibiotics* n=290 %‡	Pentamidine n=191 %‡	P-value†
An engineering control was being used§	8	27	< 0.01
Not part of our protocol	77	64	< 0.01
(Skin) exposure was minimal–	29	31	0.62
No one else who does this work uses them	20	10	< 0.01
Not provided by employer	19	11	0.02
Not readily available in work area	20	11	0.01
Too uncomfortable or difficult to use	4	4	0.66
Cross contamination to other areas is not a concern¶	3	5	0.49
Concerned about raising the patient's anxiety	1	2	0.39**
Other	21	13	0.01

*Antibiotics include tobramycin, amikacin and colistin.

†Unless otherwise stated, the chi-square test was used to calculate p-values.

‡Percents add to more than 100 percent because respondents could select more than one reason.

§This reason was not included as an option for protective gloves.

Response for eye/face protection and respirator was “exposure was minimal.”

¶This reason was not included as an option for eye/face protection and respirator.

**Fisher’s exact test was used to calculate p-value.

Table 5

Non-Recommended Practices Associated with the Use of Protective Gloves

Practices While Wearing Protective Gloves	Antibiotics* Percent Yes	Pentamidine Percent Yes	P-value†
Reused gloves previously worn while administering aerosolized medications	n=264‡	n=164‡	
	3	4	0.72
Activity performed while wearing gloves used to administer aerosolized medications§	n=265‡	n=163‡	
Touch I.V. pump or bed controls	54	19	< 0.01
Use pens/pencils	51	36	< 0.01
Touch waste basket/garbage bags	28	22	0.18
Touch door knobs, cabinets, or drawers	52	41	0.03
Use of computer/calculator	34	23	0.01
Handle files or charts	9	13	0.25
Used a non-disposable stethoscope	50	36	< 0.01
Use of phone/cell phone or pager	25	15	0.02
Eat, drink, chew gum or smoke	5	3	0.45
Use restroom	2	2	0.29–
Apply cosmetics	<1	1	0.47–

*Antibiotics include tobramycin, amikacin and colistin.

†Unless otherwise stated, the chi-square test was used to calculate p-values.

‡Number of respondents varied for individual items (i.e., number of eligible respondents less number who elected not to answer).

§Percents add to more than 100 percent because respondents could select more than one activity.

Fisher's exact test was used to calculate p-value.