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Bronchoscope Reprocessing and Infection Prevention and Control: Bronchoscopy-Specific Guidelines Are Needed

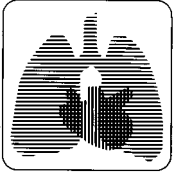
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bronchoscopy

Bronchoscope Reprocessing and Infection Prevention and Control*

Bronchoscopy-Specific Guidelines Are Needed

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Background: It has been recommended that bronchoscopists familiarize themselves with national recommendations for bronchoscope reprocessing practices, but the extent of guideline awareness is unclear.

Methods: We distributed a survey to practicing bronchoscopists at two meetings. Questions addressed infection control issues related to bronchoscopy and specific reprocessing recommendations.

Results: A total of 46 surveys were completed by medical directors of bronchoscopy suites (26%) and attending bronchoscopists (74%) who had graduated from medical school a median of 22 years ago and performed a median of 19 procedures per month. Sixty-five percent of respondents, including 55% of directors, were not familiar with national reprocessing recommendations, and 39% did not know the approach to reprocessing at their own institution. Respondents who did > 20 procedures per month trended toward being more likely to be aware of guidelines (54% vs 26%, $p = 0.09$) and were less likely to answer "do not know" to more than one question about specific reprocessing details (25% vs 70%, $p = 0.003$). Seventy-eight percent of respondents did not know local practices for at least one of the reprocessing details. Forty-six percent of respondents stated their institutions followed recommendations that records be kept of the specific bronchoscope used in each case.

Conclusions: Many experienced bronchoscopists are unfamiliar with national guidelines and local practices related to bronchoscope reprocessing. Publication of bronchoscope-specific, comprehensive reprocessing guidelines in the pulmonary literature may help increase familiarity with this crucial process. (CHEST 2004; 125:307-314)

Key words: bronchoscopy; infection control; reprocessing

Though infectious complications of flexible bronchoscopy are considered to be relatively rare, endoscopes, including bronchoscopes, are the medical devices most commonly linked to nosocomial

outbreaks.¹ A recent, large, highly publicized outbreak of *Pseudomonas aeruginosa* associated with bronchoscopes has prompted a reexamination of the procedures used to clean these delicate and complicated instruments.² Though the cause of that outbreak was attributed to bronchoscope contamination because of a manufacturing defect, there are numerous examples in the literature³⁻⁹ of bronchoscopy-associated infections and pseudoinfections caused by faulty reprocessing procedures.

A decade ago, Prakash¹⁰ queried whether the bronchoscope propagated infection and comprehensively outlined approaches to prevent this problem. National guidelines^{11,12} have been established concerning endoscope and bronchoscope reprocessing

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in an attempt to standardize procedures and ensure optimal cleaning between procedures. Though it has been recommended previously that bronchoscopists familiarize themselves with optimal reprocessing practices to “minimize the risk of transmitting infection in the bronchoscopy suite,”¹³ there is little information available on how widely such guidelines are followed. During the investigation of an outbreak at our institution, anecdotal input from numerous, experienced bronchoscopists from around the country suggested that there were important practice variations in and unfamiliarity with procedures to recognize and prevent bronchoscopy-associated infections and pseudoinfections. To assess how familiar bronchoscopists are with national guidelines and their local reprocessing and surveillance procedures, we developed and distributed a bronchoscope reprocessing survey.

MATERIALS AND METHODS

A 22-question survey was developed (Appendix). The first part of the survey included demographic questions on the experience and roles of the respondent as well as questions about the settings of bronchoscopic procedures at the institution. The second part of the survey consisted of detailed questions on the reprocessing procedures at the bronchoscopist’s facility, with a focus on steps that are recommended in national guidelines. The survey concluded with four questions regarding the types of surveillance of bronchoscopy culture results that are performed at the institution where the bronchoscopist practices. The survey was distributed to participants in two bronchoscopy courses that were attended by pulmonologists from around the country. These included bronchoscopists attending a symposium on bronchoscopy-related infections at the World Association of Bronchoscopy meeting (June 2002) and at a hands-on bronchoscopy course hosted by our Pulmonary and Critical Care Division (August 2002). All surveys were anonymous, and the project was approved by the Institutional Review Board of the Johns Hopkins Hospital.

Data were analyzed using STATA version 7.0 (Stata Corporation; College Station, TX). Continuous variables (number of procedures) were grouped into categories, and all variables were then compared using a two-sided Fisher exact test; $p < 0.05$ was considered significant.

RESULTS

Demographic Information

Overall, 50 surveys were completed at least in part. One survey was completed by a fellow, and 3 surveys were completed by nonphysician bronchoscopy staff, leaving 46 surveys completed by medical directors of bronchoscopy suites ($n = 12$, 26%) or attending bronchoscopists ($n = 34$, 74%). Only responses on these 46 surveys were included in this report. Medical directors had graduated from medical school a median of 22 years ago, compared to 21 years for attendings.

General Bronchoscopy Information

On average, survey respondents estimated that they performed 19 bronchoscopies a month (range, 0 to 130 procedures), with 35 respondents (76%) doing procedures mainly at one location and 11 respondents (24%) performing them in multiple sites. Sixteen respondents (35%) indicated that > 50 procedures were done at their institution each month, 27 respondents (59%) indicated < 50 procedures, and 3 respondents (7%) did not specify how many were done. Thirty-seven respondents (80%) performed bronchoscopies in hospital-based suites, while 6 respondents (13%) had no designated suite and used an operating room. One respondent (2%) worked primarily in a suite that was in a medical office building, and two people (4%) left this question blank. With respect to the nature of the bronchoscopy suites, 27 respondents (59%) reported that GI endoscopies were done in the same suite, 17 respondents (37%) reported that their suites were dedicated to bronchoscopy, and 2 respondents (4%) left this question blank.

Awareness of Reprocessing Guidelines and Local Practices

When asked “Are you familiar with national guidelines regarding the reprocessing of endoscopes?” 30 respondents (65%) said they were not, 15 respondents (33%) indicated they were familiar, and 1 respondent (2%) left the question blank. Fifty-five percent of those who performed > 20 procedures per month (6 of 11 respondents) were aware of these guidelines compared to 26% (9 of 34 respondents) of those who did < 20 procedures per month ($p = 0.09$, Fig 1); 1 respondent left this question blank. Medical directors of bronchoscopy suites were no more likely than attending physicians to be aware of the guidelines (45% vs 31%, $p = 0.52$).

Twenty-eight respondents (61%) indicated that

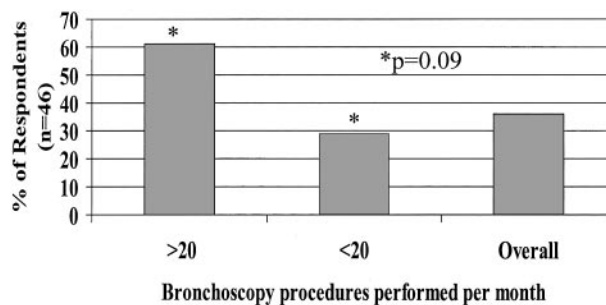


FIGURE 1. Percentage of respondents who reported being aware of any national guidelines regarding the reprocessing of endoscopes. Responses of those performing < 20 procedures a month are compared to those who did > 20 per month.

bronchoscopes were reprocessed in the suite where the procedures were done, while 11 respondents (24%) sent their bronchoscopes to a central reprocessing location, 2 respondents sent their bronchoscopes to the operating room to be reprocessed, 4 respondents (9%) stated bronchoscopes were reprocessed in multiple locations, and 1 respondent did not know where bronchoscopes were reprocessed. Nineteen respondents (41%) stated that their institution uses an automated disinfection system, 7 respondents (15%) reported that a manual system was used, 18 respondents (39%) did not know, and 1 respondent each (2%) indicated that both were used or left the question blank. With respect to the agent used in reprocessing, 16 respondents (35%) reported they did not know; their responses are summarized in Table 1. The responses to other, specific questions pertaining to recommended components of bronchoscope reprocessing are summarized in Table 2.

Overall, 26 respondents (58%) answered "do not know" to one of the specific questions concerning local reprocessing practices. Three of the 12 bronchoscopists who performed > 20 procedures per month replied "do not know" to more than one of these specific questions, compared to 23 of 33 of those who did < 20 procedures per month (17% vs 74%, $p = 0.003$). One person who did < 20 procedures per month left the question blank. Two of 12 medical directors (17%) replied "do not know" to more than one of these specific questions, compared to 24 of 34 attendings (71%) [$p = 0.001$].

Bronchoscope Tracking

Twenty-one respondents (46%) stated they kept records of the specific bronchoscope that was used in each case, 21 respondents (46%) reported no such documentation, and 4 respondents (9%) did not know if such records were kept. Eight of 12 respondents (67%) who did > 20 procedures per month reported keeping such records, compared to 13 of 34 (38%) of those who did fewer ($p = 0.09$). Four respondents who did < 20 per month procedures left this question blank.

Table 1—Agent Used for High-Level Disinfection or Sterilization

Method	Responses, No. (%) [*]
Orthoformaldehyde	19 (41)
Peracetic acid	6 (13)
Glutaraldehyde	4 (9)
Hydrogen peroxide	1 (2)
Ethylene oxide gas sterilization	6 (13)
Do not know	16 (35)

^{*}Total exceeds 46, as some respondents reported more than one method.

Table 2—Responses to Questions on Specific Recommended Reprocessing Steps^{*}

Question	Yes	No	Unknown
Do you preclean with an enzymatic cleaner?	12 (26)	5 (11)	32 (70)
Do you use a final sterile or filtered water rinse?	19 (35)	6 (13)	25 (54)
Do you do a final alcohol rinse?	12 (26)	11 (24)	26 (57)
Do you purge with air at the end of the process?	24 (52)	5 (11)	21 (46)
Are bronchoscopes stored hanging?	36 (78)	5 (11)	8 (17)

^{*}Data are presented as No. (%). Adapted from Alvarado and Reichelderfer.¹¹

Bronchoscope Cultures and Surveillance

Fourteen respondents (30%) reported that routine cultures of the bronchoscopes used at their institutions are performed periodically to check for contamination, compared to 18 respondents (39%) who indicated such culturing was not done. Thirteen respondents (28%) did not know the answer to this question, and 1 respondent (2%) left it blank. Eight of 27 respondents (30%) at institutions that did < 50 procedures a month reported that routine cultures of bronchoscopes were done, compared to 4 of 16 respondents (25%) from institutions where > 50 procedures were performed each month ($p = 0.7$). Six respondents in each group (> 50 procedures and < 50 procedures) replied they did not know the answer to this question, and three people did not indicate how many procedures were done at their institution. Of the 14 respondents who reported that surveillance cultures were done, 7 respondents (50%) did not know the frequency with which they were performed, 4 respondents (29%) reported that cultures were done quarterly, and 1 respondent each (7%) reported cultures were done weekly, biweekly, and monthly.

Fifteen respondents (32%) reported that, at their institution, surveillance of bronchoscopy culture results was performed, 18 respondents (39%) stated no such surveillance was done, and 13 respondents (28%) did not know if this surveillance of results was done. The approaches to surveillance at their institutions are summarized in Table 3. Nine of 27 respondents (33%) at institutions that did < 50 procedures a month reported that surveillance of bronchoscopy culture results was done, compared to 5 of 16 respondents (31%) from institutions where > 50 procedures were performed each month ($p = 0.8$). Six respondents from institutions that did < 50 procedures per month and five respondents from institutions that did more did not know if

Table 3—Approaches to Surveillance of Bronchoscopy Culture Results

Surveillance Method	Number of Responses, No. (%)
Culture results reviewed by infection control	11 (24)
Culture results reviewed by designated nurse	5 (11)
Culture results reviewed by designated bronchoscopists	1 (2)
Culture results reviewed by automated computer system	0 (0)
No surveillance	16 (35)
Do not know if surveillance is done	16 (35)
Surveillance is done but not sure how	1 (2)

surveillance of culture results was done, and three respondents did not indicate how many procedures were done at their institution.

DISCUSSION

Guideline Awareness

Previous surveys and investigations have revealed variations in endoscope reprocessing practices,^{14–16} but there is limited published information addressing multiple, specific details of bronchoscope reprocessing procedures. Our survey was completed by a group of relatively experienced bronchoscopists who have a wide range of practical and administrative experience. We found that 65% of respondents, including 55% of bronchoscopy suite directors, were not familiar with national guidelines regarding reprocessing, and that 39% were unfamiliar with the general practices at their own institution.

National guidelines^{11,12} from well-respected associations (Association for Professionals in Infection Control, Association of periOperative Registered Nurses, and British Thoracic Society) address the reprocessing of flexible endoscopes, including bronchoscopes. Our survey revealed that only 35% of bronchoscopists overall and 45% of medical directors of bronchoscopy suites were familiar with any national reprocessing guidelines. Moreover, 58% of respondents were unfamiliar with their own institutional practices at more than one of the specific, recommended reprocessing steps. Bronchoscopists who performed > 20 procedures per month trended toward being more likely to be familiar with guidelines than those who did fewer procedures and were significantly more knowledgeable about specific reprocessing procedures at their own facility. Interestingly, our results contrast with those reported by Colt et al¹⁷ in 1999, where all 744 respondents to a

survey by the American Association for Bronchology knew how their flexible bronchoscopes were cleaned. However, that survey differed from ours in that it did not address specific details of reprocessing methods, and the question relating to cleaning did not include a “do not know” option. In their comprehensive survey of bronchoscopists in the United Kingdom, Honeybourne and Neumann¹⁸ concluded that “national guidelines on good practices [for bronchoscope disinfection] are not being followed.”

Institutional Procedural Details

The specific steps that were queried in our survey (Table 2) are all recommended in endoscope reprocessing guidelines, as they have been shown to reduce bacterial contamination.¹¹ The majority of respondents who were familiar enough with procedures at their institution to answer the questions did indicate that they were in compliance with the guidelines. Unfortunately, about half of respondents simply did not know the answers to the questions. Moreover, there were some instances where important steps in the guidelines were not being followed. The single step that was not followed by the most institutions was the final alcohol rinse at the end of the cleaning process. Moisture collecting in the lumen of endoscopes has been associated with increased risk of bacterial contamination, and studies^{19,20} have documented the effectiveness of an alcohol rinse in facilitating drying of the internal lumen and preventing contamination. Despite this evidence and guideline recommendations, 22% of respondents stated that their institutions did not perform a final alcohol rinse, and 52% did not know whether this occurred.

Endoscope reprocessing guidelines¹¹ state that “for monitoring of adverse events, it is useful to maintain a logbook in the unit listing for each procedure the patient’s name and medical record number, the procedure, the endoscopist, and the serial number or other identifier of the endoscope used.” Though this practice may have been initially recommended because of concerns of transmission of viral hepatitis with GI endoscopes, a recent outbreak of *P aeruginosa* associated with bronchoscopes demonstrates the importance of such record keeping in bronchoscopy procedures.² Only approximately 50% of our respondents reported such records were kept at their institutions. Given the minimal time and effort required to keep a logbook of procedures and the potential utility of the records in the event of a problem, we believe that institutions should be more strongly encouraged to track and document which instruments are used in which patients.

Two potential strategies to monitor for possible bronchoscope contamination might be considered.

The first is to conduct a systematic review of the microbiology results of all procedures in order to detect unexpected increases in the recovery of a particular organism. The other is to perform periodic cultures of the bronchoscopes themselves. Currently, neither of these procedures is recommended in national guidelines, as infectious complications of bronchoscopy are thought to be too low to merit such efforts and costs. Cultures of bronchoscopes are currently only recommended as part of outbreak investigations. The variety of approaches reported by our respondents highlights the controversy surrounding this type of surveillance. While the majority reported that their institutions did not perform routine equipment cultures or surveillance of results, there was a substantial minority of institutions where these were done, with 28% doing equipment cultures and 36% doing surveillance of culture results.

Potential difficulties with culturing bronchoscopy equipment were underscored during a recent outbreak where two different culturing techniques yielded different results.² It is important to note that the standard method of simply flushing sterile saline solution or broth through the biopsy port of the instrument and collecting it at the distal end does not simulate a BAL procedure and does not adequately sample parts of the instrument that are proximal to the biopsy port. Furthermore, detection of contamination may be variable depending on culture technique and the level of contamination at the time of culturing. The difficulties with performing and interpreting equipment cultures are reflected in the wide variation in culturing frequencies that respondents reported in our survey. Given these challenges, it would appear that surveillance of culture results is probably the most reliable method for monitoring potential infectious complications of bronchoscopy. Unfortunately, this type of surveillance is also very labor intensive, especially at high-volume bronchoscopy laboratories, and is thus impractical for many institutions. Until automated systems for microbiologic surveillance are more widely available, routine culturing of bronchoscopes may still have some role in detecting bronchoscope contamination, but this role requires clarification. Even more challenging is the determination of whether increases in recovery of specific organisms or positive cultures of the bronchoscopes themselves reflect any real risk to individual patients and whether these practices improve patient outcomes.

Limitations

Though the results of this survey are intriguing and suggest that more attention should be devoted to bronchoscope reprocessing practices, these observa-

tions must be interpreted carefully in light of several limitations. First and foremost, because many respondents did not know whether their institutions followed recommended steps of endoscope reprocessing, it is impossible to know for sure the relationship of the responses on this survey to actual bronchoscope reprocessing practices. However, the simple finding that many bronchoscopists are unaware of local practices is, in and of itself, important. Another major limitation of this study was the small number of surveys that were completed and resultant sampling bias and lack of information about those who did not return the surveys. Respondents were self-selected individuals who were attending bronchoscopy courses and thus may not be representative of the entire pulmonary community. While a larger survey sample will help better define general awareness of reprocessing and infection control issues, the consistency of responses in this small sample did indicate that many bronchoscopists are not familiar with reprocessing protocols at their institutions. The timing of this survey, which followed widely publicized outbreaks of bronchoscopy-associated infections and pseudoinfections, should have favored heightened awareness of bronchoscope reprocessing, and makes these findings especially noteworthy. Because survey respondents often overreport, rather than underreport, optimum practices, our observation may actually represent "best behaviors" and be an overestimate of guideline awareness and adherence.

Some aspects of survey questions may also have been confusing to respondents. For example, when asked about a "final" alcohol rinse, the survey did not directly specify whether this was referring to the last step of the reprocessing after each procedure or to a final alcohol rinse at the end of the day. Our survey also did not differentiate between initial instrument cleaning and high-level disinfection. Likewise, participants might have misunderstood the question on surveillance of bronchoscopy culture results, assuming this was referring to follow-up of cultures of the instruments themselves and not follow-up of culture results from the individual procedures, which is what the question was intended to address. A more accurate question would have asked respondents whether they performed surveillance for new lung infections after bronchoscopy. Related questions might also address the duration of surveillance, who is responsible for the surveillance, and how the results are managed. The brevity of our survey precluded other inquiries about all aspects of bronchoscope reprocessing. A lengthier instrument could have explored other important issues including performance of a leak test, approaches to reprocessing of accessory equipment (eg, biopsy forceps and cleaning brushes),

and also could have examined aspects of staffing and training issues of reprocessing personnel. These areas represent important components of future, bronchoscopy-specific infection control guidelines.

Implications and Opportunities

Despite these limitations, our findings identify opportunities to improve patient care and have important implications for individual bronchoscopists, national organizations, and clinical investigators. There are at least two major reasons why all bronchoscopists should become familiar both with national guidelines for endoscope reprocessing and with procedures at their institutions. First, familiarity with both the guidelines and local practices may help bronchoscopists identify potential problems before they lead to bronchoscope contamination and patient infections and pseudo-infections. Second, though uncommon, outbreaks related to bronchoscopy have been well described and are frequently related to problems with equipment reprocessing.²¹ While our survey indicates that high-volume practitioners were more likely to be familiar with both the national endoscope reprocessing guidelines and with specific practices at their institution, a recent bronchoscopy related outbreak in Tennessee demonstrates that even institutions performing fewer procedures are not immune from problems related to contaminated bronchoscopes.²² As the people who are most familiar with the procedures and equipment, bronchoscopists are in a unique position to help facilitate outbreak investigations related to bronchoscopy. Clearly, individual bronchoscopists' knowledge of national guidelines and local practices may promote identification of potential problems and development of realistic prevention strategies. In particular, an ongoing dialogue with colleagues in infection control is an important resource in this regard.

On the national level, we believe that there is an urgent need for clear and succinct specific guidelines for cleaning and disinfection of bronchoscopes and accessories. Unfortunately, most published literature addressing endoscope infection control focuses on GI endoscopes, with extrapolation of the recommendations to bronchoscopy. We suspect that suboptimal dissemination of existing general endoscope reprocessing guidelines was an important factor in our respondents' unfamiliarity with their applications to bronchoscopy. To address this issue, the British Thoracic Society recently published guidelines on several aspects of bronchoscopy, including reprocessing procedures.²³ The development and publication of separate guidelines in the pulmonary litera-

ture in this country should enhance awareness among US bronchoscopists. The results of our brief survey certainly suggest that such guidelines would be useful and well received. Present general endoscopy guidelines and previous comprehensive recommendations by Prakash,¹⁰ Mehta and Minai,¹³ and others^{23,24} provide a valuable core for evidenced-based, bronchoscopy-specific guidelines. In parallel with this educational initiative, we believe that further clinical research is needed in this area. As more procedures are performed in increasingly fragile patients by an expanding cohort of bronchoscopists, definition of the true extent of the problems regarding bronchoscope reprocessing and delineation of optimum practices, for institutions as well as individual bronchoscopists, are essential to help prevent bronchoscopy-associated pseudo-infections and infections.

APPENDIX

Bronchoscope Reprocessing Practices Survey

We greatly appreciate your taking the time to fill out this brief questionnaire that will take 5 min. The purpose of this survey is to learn about bronchoscopy practices throughout the country. All responses are anonymous.

1. Please tell us your position:

___ Medical director of bronchoscopy suite → year graduated medical school: 19__ __

___ Attending physician → year graduated from medical school: 19__ __

___ Fellow → year graduated from medical school: 19__ __

___ Non-physician: please specify:

___ Other

2. Do you perform bronchoscopies at one location or more than one?

___ Mainly one location

___ Multiple locations

If you perform bronchoscopies at various sites, please answer the following questions pertaining to the site where you perform most bronchoscopies.

3. Where is your bronchoscopy suite located?

___ Inside a hospital, in a dedicated suite or room

___ In a medical office building

___ In a surgical operating room

___ Other: please specify:

___ Don't know

4. Are GI endoscopies performed in the same location?

___ Yes

___ No

5. Approximately how many bronchoscopies do you perform in a typical month?

Fill in the number: ___

6. Approximately how many bronchoscopies are performed at your institution each month?

___ < 20

___ 20–29

___ 30–39

___ 40–49

___ ≥ 50

___ Don't know

7. If your suite is in a hospital, where else are bronchoscopies performed? Please check all that apply.

- My suite is not in a hospital
 ICUs
 Operating rooms
 Other: please specify:

The following questions pertain to the cleaning of bronchoscopes.

8. All bronchoscopes are reprocessed (cleaned) in your institution in (please check all that apply):

- Bronchoscopy suite
 Operating room
 A central reprocessing location
 Other: please specify:
 Don't know

9. If bronchoscopes are reprocessed in multiple locations, do all the locations use the same cleaning method?

- Yes
 No
 Don't know

10. What high-level disinfectant/sterilization process is used for bronchoscopes?

- Glutaraldehyde
 Orthophthaldehyde
 Peracetic acid
 Hydrogen peroxide
 Ethylene oxide gas sterilization
 Don't know

11. Do you preclean with an enzymatic cleaner?

- Yes
 No
 Don't know

12. Do you use a _____ manual or _____ automated disinfection system? Check one or: _____ Don't know

13. Do you use a sterile tap or filtered water rinse (final)?

- Yes
 No
 Don't know

14. Do you do a final alcohol rinse?

- Yes
 No
 Don't know

15. Do you blow air through the channel at the end of the process?

- Yes
 No
 Don't know

16. Are the bronchoscopes stored _____ hanging or in a _____ case? Check one or: _____ Don't know

17. Do you document which bronchoscope is used on which patient?

- Yes
 No
 Don't know

18. Are you familiar with national guidelines regarding the reprocessing of bronchoscopes?

- Yes
 No

19. Are routine cultures of bronchoscopes you use performed periodically to check for contamination?

- Yes
 No
 Don't know

20. If you answered yes to above, how often are they cultured?

_____ Specify frequency: (#) _____ times each (circle one): week month year
 Don't know

21. Does the institution where you mainly perform bronchoscopies conduct any sort of surveillance of bronchoscopy culture results?

- Yes
 No
 Don't know

22. If you answered yes to above, what type of surveillance do you do?

- Infection control reviews all culture results
 A designated bronchoscopist reviews all culture results
 A designated nurse reviews all culture results
 An automated computer system reviews all culture results
 Other: please specify:
 Don't know

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