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ORIGINAL ARTICLE

Outbreak of *Pseudomonas aeruginosa* Surgical Site Infections after Arthroscopic Procedures: Texas, 2009

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SETTING. Seven organ/space surgical site infections (SSIs) that occurred after arthroscopic procedures and were due to *Pseudomonas aeruginosa* of indistinguishable pulsed-field gel electrophoresis (PFGE) patterns occurred at hospital X in Texas from April 22, 2009, through May 7, 2009.

OBJECTIVE. To determine the source of the outbreak and prevent future infections.

DESIGN. Infection control observations and a case-control study.

METHODS. Laboratory records were reviewed for case finding. A case-control study was conducted. A case patient was defined as someone who underwent knee or shoulder arthroscopy at hospital X during the outbreak period and subsequently developed organ/space SSI due to *P. aeruginosa*. Cultures of environmental and surgical equipment samples were performed, and selected isolates were analyzed by PFGE. Surgical instrument reprocessing practices were reviewed, and surgical instrument lumens were inspected with a borescope after reprocessing to assess cleanliness.

RESULTS. The case-control study did not identify any significant patient-related or operator-related risk factors. *P. aeruginosa* grew from 62 of 388 environmental samples. An isolate from the gross decontamination sink had a PFGE pattern that was indistinguishable from that of the case patient isolates. All surgical instrument cultures showed no growth. Endoscopic evaluation of reprocessed arthroscopic equipment revealed retained tissue in the lumen of both the inflow/outflow cannulae and arthroscopic shaver handpiece. No additional cases occurred after changes in instrument reprocessing protocols were implemented. After this outbreak, the US Food and Drug Administration released a safety alert about the concern regarding retained tissue within arthroscopic shavers.

CONCLUSIONS. These SSIs were likely related to surgical instrument contamination with *P. aeruginosa* during instrument reprocessing. Retained tissue in inflow/outflow cannulae and shaver handpieces could have allowed bacteria to survive sterilization procedures.

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Pseudomonas species are aerobic gram-negative bacteria that are found in the environment, especially in water sources. They can be a cause of healthcare-associated infection, including surgical site infection (SSI), bloodstream infection, and pneumonia. However, *Pseudomonas* species are an uncommon microbiologic cause of SSI after arthroscopic procedures.¹

Observations without control patients have implicated several factors in SSI after arthroscopic procedures, including receipt of intraoperative intraarticular corticosteroids, increased surgery time, undergoing an increased number of procedures during surgery, having undergone previous arthroscopic procedures, and performance of chondroplasty or

soft-tissue debridement.¹ However, controlled studies have only demonstrated statistical significance for length of surgery and receipt of intraarticular corticosteroids.²⁻⁴ Although septic arthritis after arthroscopic procedures generally occurs sporadically, clusters and outbreaks have been reported.^{1,3,5-9} Factors implicated in these outbreaks have included contaminated arthroscopy inflow/outflow cannulae received in sterile packages, air vents with increased microbial burden over instrument trays in an operating room, contaminated electrocardiogram wires placed over sites of shoulder arthroscopy, routine use of flash sterilization for arthroscopic instruments, and inadequate arthroscope disinfection.^{3,5-9}

Hospital X in Texas identified a cluster of organ/space SSIs

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due to pansusceptible *Pseudomonas aeruginosa* that occurred after arthroscopic procedures performed from April 22, 2009, through May 7, 2009.

METHODS

Epidemiologic Investigation

A case patient was defined as a person who developed organ/space SSI with pansusceptible *P. aeruginosa* after knee or shoulder arthroscopic procedures performed at hospital X from April 22, 2009, through May 7, 2009. Organ/space SSI was defined as the diagnosis of joint space infection by an attending physician at hospital X with positive results of culture from a joint fluid specimen.

All persons who underwent arthroscopic procedures at hospital X during the outbreak period were contacted. Laboratory reports of all *Pseudomonas* isolates at hospital X from January through September 2009 and a listing of all surgical procedures performed from April 22, 2009, through May 7, 2009, were reviewed.

The case patient medical charts were reviewed. Data abstracted included patient information, preoperative process data, operative data, and postoperative data. The abstractions were performed using a form developed for this investigation.

A case-control study was conducted. Control patients were defined as persons who underwent knee or shoulder arthroscopic procedures at hospital X from April 22, 2009, through May 7, 2009, who did not develop SSI as of September 14, 2009. Control patients were randomly selected using a proportional sampling strategy to achieve an equal distribution of patients with knee and shoulder surgical procedures among the case patient and control patient groups. Three control patients were included for every case patient. Data for the control patients were abstracted in the same manner as for the case patients described above.

Patient characteristics tested were sex, age at hospital admission, zip code of residence, race/ethnicity, date of surgery, indication for surgery (20 different indications evaluated), medical comorbidities (27 conditions evaluated), body mass index (BMI, defined as weight in kilograms divided by the square of height in meters), smoking status, American Society of Anesthesiologists score, and recent receipt of systemic corticosteroids (Table 1). Preoperative and operative variables tested were type of antimicrobial prophylaxis received; receipt of preoperative antimicrobials within 1 hour of initial incision; method of preoperative hair removal; type of preoperative surgical site preparation; surgical procedure performed, as indicated by Current Procedural Terminology or *International Classification of Diseases, 9th Revision, Clinical Modification* code (28 procedures evaluated); tourniquet duration; surgical procedure duration; intraarticular irrigant used; intraarticular anesthetic used; operating room (OR) used ($n = 8$); case number of the day in the OR; method of wound closure; and dressing type. Hospital personnel evaluated for association were primary surgeon ($n = 12$), assis-

TABLE 1. Characteristics of Case Patients and Control Patients

| Variable | Case patients ($n = 7$) | Control patients ($n = 21$) |
|------------------------------------|------------------------------|----------------------------------|
| Male sex | 3 (43) | 8 (38) |
| Age, mean years | 49 | 45 |
| Race/ethnicity | | |
| White | 5 (71) | 8 (38) |
| African American | 0 (0) | 5 (24) |
| Hispanic | 0 (0) | 3 (14) |
| Unknown | 2 (29) | 5 (24) |
| BMI, mean value | 26 | 30 |
| Indication for surgery | | |
| Anterior cruciate ligament tear | 2 (29) | 4 (19) |
| Meniscal tear | 2 (29) | 13 (62) |
| Other knee indication ^a | 2 (29) | 1 (5) |
| Rotator cuff tear | 1 (14) | 3 (14) |
| Duration of surgery, mean min | 53 | 69 |

NOTE. Data are no. (%) of patients unless otherwise indicated. Testing for statistical significance was performed using the Student's *t* test for mean age, BMI, and duration of surgery and Fisher's exact test for all other variables. With a *P* value less than .05 being considered statistically significant, there were no statistically significant differences between case patients and control patients for all variables tested. BMI, body mass index, calculated at the weight in kilograms divided by the square of height in meters.

^a Derangement of medial meniscus, chondromalacia, patellar dislocation, loose body in knee, and arthropathy lower leg unspecified.

tant surgeon ($n = 21$), anesthesiologist ($n = 18$), certified registered nurse anesthetist ($n = 14$), scrub technician ($n = 17$), circulator ($n = 24$), other surgical personnel ($n = 14$), and postanesthesia care unit nurse ($n = 35$). Analysis was also performed to evaluate the association of infection with the 156 different types of surgical instruments used to treat case patients and control patients, as derived from operative billing data. Individual instrument-level data were not available, because individual instruments used in surgical procedures were not tracked by hospital X before the outbreak.

Data were analyzed using SAS, version 9.2, to determine potential associations between exposures and infections that occurred after arthroscopic procedures. Testing for statistical significance was performed using the Student's *t* test for continuous variables and Fisher's exact test for categorical variables.

Infection Control Investigation

Surgical procedures were observed in their entirety, including infection-prevention processes, such as preoperative cleaning of the OR following the previous procedure, preparation of the patient in the OR for the surgical procedure, preparation of instruments in the OR for the surgical procedure, and the surgical procedure itself. Surgical procedures were selected such that a procedure similar to each case patient procedure was observed at least once. Instrument reprocessing was ob-

served from the time that the instruments left the OR, through each reprocessing step, to packaging and storage for reuse (Table 2). Arthroscopic instrument lumens were visualized using a borescope (a 3-mm clinical endoscope was used for this investigation). Autoclave and reprocessing logs from the main reprocessing areas and from each surgical pod (for flash autoclaving) were reviewed. Hospital X personnel interviewed included surgeons, circulators, scrub technicians, instrument reprocessing personnel, infection preventionists, microbiologists, and administrators. A simulation of knee arthroscopy using a cadaveric leg was arranged by hospital X to allow for closer inspection and manipulation of the surgical process without risking patient safety.

Environmental samples (388 in total), including samples obtained from sink drains in ORs and instrument reprocessing areas, samples of water sources in ORs and in instrument reprocessing areas, and samples from equipment, such as the suction channels of shaver handpieces, were collected for culture from May 11, 2009, through June 5, 2009, by hospital X personnel. Subsequent pulsed-field gel electrophoresis (PFGE) analysis was performed at the Texas Department of State Health Services using Xba I restriction enzyme, 2.2-second initial switch time, 54.2-second final switch time, 18.0-hour run time, 6.0-V/cm² voltage, and 120° included angle.

RESULTS

Epidemiologic Investigation

Seven joint (organ/space) SSIs were identified following 1 shoulder and 6 knee arthroscopies. The 7 procedures were performed by 6 different surgeons in 5 different ORs, including 1 in a different building. All surgical instruments originated from the same reprocessing and storage areas within the facility. The microbiology laboratory listing of all *P. aeruginosa* isolates was compared with the listing of all surgical procedures performed at hospital X, and no other *P. aeruginosa* deep or organ/space SSIs were found during the outbreak period (April 22, 2009, through May 7, 2009). Review of microbiology data from January through September 2009 found 10 instances of *P. aeruginosa* orthopedic wound infection in addition to the 7 previously identified case patients. Four patients had prosthetic joint infection: 3 were already infected at the time of transfer to hospital X (January

and February 2009), and 1 was found to have infection shortly after the outbreak period (May 13, 2009). However, PFGE patterns of isolates from these infections and those from the case patients were dissimilar. Five patients had orthopedic hardware infections: 2 before the outbreak period (in January and March 2009, respectively) and 3 after the outbreak period (in June, July, and August, respectively). One patient had a primary wound infection (on May 7, 2009, during the outbreak period) after trauma sustained while scuba diving. None of these 10 patients underwent arthroscopic procedures, and none had hardware implantation at hospital X during the outbreak period. Furthermore, review of microbiology data from January through September 2008 found a comparable number of *P. aeruginosa* orthopedic wound infections (7 cases, none of which were associated with arthroscopic procedures). It was thus unlikely that the 10 *P. aeruginosa* orthopedic wound infections that were not associated with arthroscopic procedures and that were identified from January through September 2009 were related to the 7 identified case patients.

Of the 6 case patients who underwent arthroscopic procedures involving the knee, 2 had anterior cruciate ligament (ACL) reconstruction with anterior tibialis tendon allografts and 4 had knee debridement, such as meniscectomy. For the patient who underwent shoulder surgery, the surgical procedure was an arthroscopic rotator cuff repair. The case patients presented with infection 4–19 days after their initial surgery (median time to presentation, 8 days) and required treatment with arthroscopic debridement (some up to 4 times), hospitalization for 3–16 days (mean duration of hospitalization, 9 days), and 6 weeks of systemic antimicrobial therapy. The 2 patients who had ACL reconstruction underwent tendon allograft removal as part of the treatment of infection. Joint fluid obtained either by arthrocentesis before incision and drainage or during incision and drainage from each case patient grew pansusceptible *P. aeruginosa* with indistinguishable PFGE patterns. One case patient, whose initial procedure was an arthroscopic knee debridement, also had an intraoperative culture that grew methicillin-resistant *Staphylococcus aureus*.

The attack rate was calculated as the number of knee or shoulder infections that occurred after arthroscopic procedures (7 cases) per the total number of arthroscopic proce-

TABLE 2. Summary Arthroscopic Instrument Reprocessing Methods at Hospital X

| Instrument type | Final reprocessing step | Specific method of reprocessing |
|--|----------------------------|---------------------------------|
| General surgical instruments (eg, scalpels and probes) | Sterilization | Steam autoclave |
| Arthroscopic instruments | | |
| Arthroscopic inflow/outflow cannulae | Sterilization | Steam autoclave |
| Arthroscopic shaver handpieces | Sterilization | Steam autoclave |
| Rigid arthroscopes | High-level decontamination | Hydrogen peroxide gas plasma |
| Camera/power cords | High-level decontamination | Hydrogen peroxide gas plasma |
| Light cords | High-level decontamination | Hydrogen peroxide gas plasma |

dures involving the knee or shoulder that were performed from April 22, 2009, through May 7, 2009 (67 procedures; Figure 1). The attack rate at hospital X was 1,045 cases per 10,000 procedures, compared with attack rates ranging from 1 to 48 cases per 10,000 procedures published in the literature.^{2,3,10-12} None of the exposure variables tested was found to be significantly associated with infection after an arthroscopic procedure.

Infection Control Investigation

Two flash autoclaves were located in the surgical pod where the majority of the case procedures were performed. These 2 autoclaves were used up to 6 times daily during the outbreak period. Two of the case patients and 4 of the control patients had instruments that required flash autoclaving during their procedures. These included surgical rulers, reamer sets, and a meniscal repair set. The logs of the flash autoclaves were not always complete with regard to the patient name, OR number, and instrument name. Interviews of OR and instrument-reprocessing personnel revealed that the flash autoclaves had been used on rare occasions for routine sterilization.

Low-temperature sterilization with hydrogen peroxide gas plasma was used by hospital X for reprocessing of the arthroscope, the arthroscope light cord, and the arthroscope camera/power cord in accordance with manufacturer instructions for the recommended duration. The sterilizer logs from April 17, 2009, through May 7, 2009, revealed deficiencies in the documentation of biologic and chemical indicators that were performed on each load.

After sterilization, packaged instrument sets were stored in a designated room adjacent to the instrument-reprocessing area at hospital X. Before and during the outbreak period, it was common practice to place instruments on a rack within the OR pod on the evening before the procedures.

The procedures for reprocessing of the shaver handpiece at hospital X were consistent with the manufacturer's instruc-

tions, including brushing of the suction tube channel with a disposable bristled brush, immersion of the handpiece in enzymatic solution for over 1 minute (per enzymatic solution manufacturer recommendation), and autoclave sterilization. However, endoscopic examination of the shaver handpiece suction channel after reprocessing revealed remnant tissue and brush bristles that were not visible on routine visual inspection in each of the evaluated handpieces (Figure 2). Endoscopic examination of shaver handpieces from a different manufacturer that were obtained from another hospital within the hospital X health system also revealed remnant bioburden. Of note, reflux of irrigant solution through the shaver handpiece during surgery at times of suction tube compromise as a result of kinking of the tube or external compression was noted by surgeons at hospital X and documented during a simulated arthroscopic procedure that was performed using a cadaveric knee. More easily compressible suction tubing had been substituted into the arthroscopy kit, without notice to the facility, before the spring of 2009 by the medical supply company.

Boroscopic visualization of the inflow/outflow cannulae lumen revealed remnant bioburden (Figure 2). The manufacturer-recommended gross decontamination protocol included brushing of the lumen. Before and during the outbreak, the cleaning process consisted of running tap water through the cannulae lumen.

The arthroscopy-cleaning procedure at hospital X involved wiping down the instrument following a brief submersion of the instrument in enzymatic solution before high-level disinfection. The manufacturer-recommended procedure for arthroscopy reprocessing included gross decontamination with submersion in enzymatic solution for 10–15 minutes before low-temperature sterilization.

The distal ends of the shaver handpiece and the camera/power cord were wiped down with enzymatic solution. The manufacturer-recommended reprocessing instructions for gross decontamination included capping the distal end (with

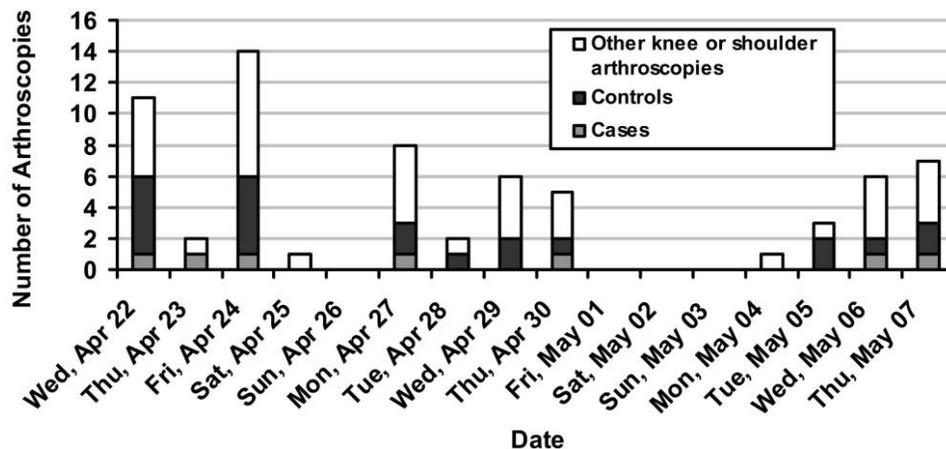


FIGURE 1. Number of arthroscopic procedures involving the knee or shoulder performed at hospital X during the outbreak.

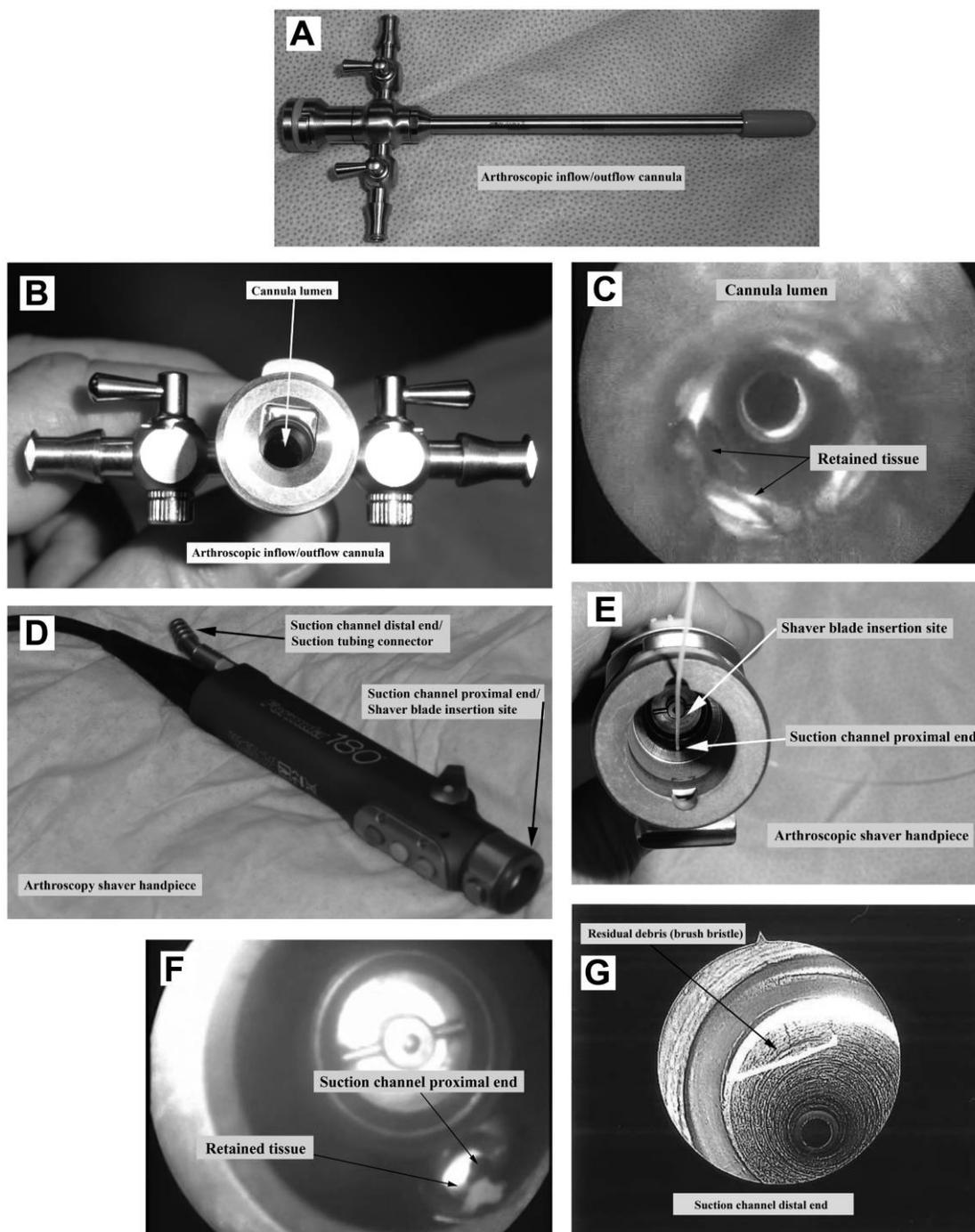


FIGURE 2. Figure 2. Annotated photographs of inflow/outflow cannula and shaver handpiece. *A*, External view of an inflow/outflow cannula. *B*, External view of an inflow/outflow cannula lumen. *C*, Internal view of an inflow/outflow cannula taken using a borescope demonstrating residual bioburden. *D*, External view of an arthroscopic shaver handpiece. *E*, External view of an arthroscopic shaver handpiece showing the shaver blade insertion site and the proximal end of the suction channel. *F*, Internal view of an arthroscopic shaver handpiece taken using a borescope and demonstrating residual bioburden. *G*, Internal view of an arthroscopic shaver handpiece distal suction channel taken using a borescope and demonstrating residual debris from a bristled brush used in cleaning. A color version of this figure is in the online edition.

the electrical contact points) and submerging the entire device in enzymatic solution for 10–15 minutes.

Microbiologic Investigation

Sixty-two *Pseudomonas* species isolates were obtained from 388 environmental samples by hospital X as part of the initial outbreak response, including 54 of 206 sink swabs, 4 of 90 water samples (obtained by soaking culture swabs in running water), and 4 of 92 swab samples from surgical equipment (all 4 equipment cultures that were positive for *Pseudomonas* species were from suction canisters or wall suction devices). All cultures from reprocessed orthopedic equipment, including shaver handpieces, inflow/outflow cannulas, arthroscopes, and arthroscope light sources, showed no growth. Fourteen of the 62 environmental *Pseudomonas* isolates were pansusceptible *P. aeruginosa* (2 from suction bottles and 12 from sink drains). Except for 1 nonviable OR sink drain isolate, all remaining pansusceptible *Pseudomonas* isolates were sent to the Texas Department of State Health Services for strain typing. Three of the isolates (1 from the decontamination room sink drain and 2 from suction bottles) had PFGE patterns that were indistinguishable from the case patient isolates. The remaining 10 isolates were different from the case patient isolates.

Outbreak Response

The response to this outbreak by hospital X included closing the OR pod where the majority of arthroscopic procedures were performed, replacing the arthroscopic instruments, returning to use of more rigid suction tubing for arthroscopy, and changing the instrument reprocessing protocols. Instrument reprocessing protocols were adjusted to include (1) routine endoscopic evaluation of reprocessed shaver handpieces to ensure that the suction channel did not contain residual bioburden, (2) use of a nonbristled brush to clean the lumen of the arthroscopic inflow/outflow cannulae, (3) submerging the shaver handpiece in enzymatic solution for 10–15 minutes during gross decontamination, (4) capping the distal end of the arthroscope camera and shaver handpiece power cord before submersion in enzymatic solution, (5) prohibiting the storage of surgical instruments in areas outside of the designated storage room, and (6) reinforcing policies restricting flash autoclave use to instances when a surgical instrument becomes contaminated during a procedure and needs to be quickly reprocessed for use in that procedure. In addition, the gross decontamination room was redesigned to improve workflow, instrument reprocessing staff received annual training and certification, and tracking of the individual instruments used in each surgery was initiated. No further cases occurred among patients who underwent arthroscopic procedures after these interventions.

DISCUSSION

A cluster of 7 organ/space SSIs due to *P. aeruginosa* occurred after arthroscopic procedures at hospital X from April 22, 2009, through May 7, 2009. The resultant SSI rate of 1,045 cases per 10,000 procedures was elevated, compared with the national rates ranging from 1 to 48 cases per 10,000 procedures.^{2,3,10–12}

Evidence from the investigation suggests that this outbreak was most likely the result of inadequate instrument reprocessing that led to retained tissue in the arthroscope inflow/outflow cannulae and in the shaver handpiece suction channel. The latter occurred despite cleaning according to the manufacturer's instructions. Bacterial contamination of surgical instruments likely survived the sterilization process because of residual tissue within the lumens of arthroscopic equipment, which was discovered only later under direct visualization with an endoscope. Routine use of flash sterilization of arthroscopic instruments has been implicated in the report of an earlier outbreak; however, only 2 of the 7 case patients at hospital X had surgical instruments that underwent flash sterilization.⁷

Pseudomonas species are commonly cultured from moist environmental sources, and the growth of these organisms from sources such as sinks is expected. Because suboptimal water-sampling techniques were used for culture of tap water during the initial investigation by hospital X, the microbiologic results likely underestimated the presence of *Pseudomonas* from these environmental sources. Because the PFGE pattern of the *P. aeruginosa* isolate from the decontamination room sink drain was indistinguishable from that of the case patient isolates, instrument contamination most likely occurred during the gross decontamination steps of reprocessing. *Pseudomonas* species can form biofilms on sink surfaces even in the presence of dilute enzymatic solution.¹³ Biofilm formation on the decontamination room sink may have contributed to *Pseudomonas* contamination of surgical instruments. The identification of *P. aeruginosa* with a PFGE pattern indistinguishable from that of the case isolates from the wall suction canisters was likely attributable to the collection of irrigation fluid contaminated by an instrument, rather than being a cause of instrument contamination. The reuse of brushes that may have become contaminated during the cleaning process could have resulted in cross-contamination of subsequent instruments.

For the 7 cases of organ/space SSI in this cluster, *P. aeruginosa* was most likely introduced into the joint space at the time of the surgical procedure by one or more contaminated instruments. Because individual instruments were not tracked at the time of the outbreak, the risk of infection associated with any individual piece of surgical equipment could not be evaluated. The lack of culture growth from instruments, such as the shaver handpiece suction channel, also limited our ability to make direct associations with the instruments, but

may have been attributable to techniques used in specimen collection.

For the arthroscopic inflow/outflow cannula, rinsing the lumen rather than brushing it likely contributed to the residual bioburden. For the shaver handpiece, cleaning in accordance with the manufacturer's recommendations was not sufficient to remove tissue from the suction channel and also led to retained brush bristles in the channel. With dried bioburden providing a sanctuary for bacterial contamination, disinfection or sterilization processes can be less effective or even ineffective.^{6,8,13} *Pseudomonas* species were likely introduced into the case patients' joint spaces by direct insertion of contaminated instruments or by infusion of fluid through the contaminated lumen. For arthroscope inflow/outflow cannulae, irrigation fluid passed directly through the lumen into the joint space. For the shaver handpiece, retrograde flow of effluent through the suction channel could have occurred during times of suction compromise.

It is a possibility that the 10 *P. aeruginosa* orthopedic wound infections that were not associated with arthroscopic procedures and were identified at hospital X from January through September 2009 were part of this outbreak; however, this is unlikely, because (1) a comparable number of *P. aeruginosa* orthopedic wound infections occurred during the similar time period the year before (none of which occurred after arthroscopic procedures), (2) only 1 of these 10 nonarthroscopic orthopedic procedures was performed during the outbreak period, and (3) none of the available *P. aeruginosa* isolates from these patients, including the isolate identified during the outbreak period, matched the outbreak strain according to PFGE.

Two previously reported outbreaks of infection associated with arthroscopic procedures have been attributed to residual bioburden within lumens of arthroscopic equipment. Blevins et al⁶ described 3 patients who underwent meniscus repair within a 4-day period who developed organ/space SSI due to coagulase-negative *Staphylococcus* (CoNS) after arthroscopic procedures. Inspection of reprocessed arthroscopic inflow/outflow cannulae revealed dried organic matter within the lumen. A report by Parada et al⁸ described an outbreak of 5 cases of septic arthritis after ACL reconstruction within a 14-week period. CoNS was the etiologic agent for 2 of the patients, and the other 3 case patients had negative culture results. The outbreak was attributed to residual bioburden in the cannulated portion of a tibial fixation hex driver.

The most consequential aspect of this outbreak, however, was the discovery of retained bioburden in the suction channel of arthroscopic shaver handpieces despite reprocessing according to the manufacturer's instructions. The bioburden was not apparent on routine examination and was detected only through endoscopic visualization of the suction channel. Hospital X performed endoscopic evaluation of the shaver handpieces by other manufacturers at other facilities within their system and found retained bioburden, which suggests that this

problem is not specific to this institution or to a specific manufacturer. This prompted collaboration between the Centers for Disease Control and Prevention and the US Food and Drug Administration (FDA) to protect patients undergoing arthroscopic procedures at other facilities across the country. On July 7, 2009, the FDA released a safety alert about the concern for retained tissue within arthroscopic shavers despite reprocessing according to the manufacturer's recommendations.¹⁴ In this and a subsequent safety alert, the FDA encouraged facilities that use arthroscopic shavers to consider inspecting the inside of these devices (eg, with a 3-mm video scope) after cleaning to ensure that they have been cleared of any tissue or fluids.^{14,15} Facilities finding retained tissue in arthroscopic shavers after performing the manufacturer-recommended cleaning procedures may file a voluntary report with MedWatch at 1-800-FDA-1088 or online at <https://www.accessdata.fda.gov/scripts/medwatch/medwatch-online.htm>.¹⁵

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The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

REFERENCES

1. Babcock HM, Carroll C, Matava M, L'Ecuyer P, Fraser V. Surgical site infections after arthroscopy: outbreak investigation and case control study. *Arthroscopy* 2003;19:172–181.
2. Armstrong RW, Bolding F, Joseph R. Septic arthritis following arthroscopy: clinical syndromes and analysis of risk factors. *Arthroscopy* 1992;8:213–223.
3. Armstrong RW, Bolding F. Septic arthritis after arthroscopy: the contributing roles of intraarticular steroids and environmental factors. *Am J Infect Control* 1994;22:16–18.
4. D'Angelo GL, Ogilvie-Harris DJ. Septic arthritis following arthroscopy, with cost/benefit analysis of antibiotic prophylaxis. *Arthroscopy* 1988;4:10–14.
5. Ajemian E, Andrews L, Hryb K, Klimek JJ. Hospital-acquired infections after arthroscopic knee surgery: a probable environmental source. *Am J Infect Control* 1987;15:159–162.
6. Blevins FT, Salgado J, Wascher DC, Koster F. Septic arthritis following arthroscopic meniscus repair: a cluster of three cases. *Arthroscopy* 1999;15:35–40.
7. Lopansri B, Taylor C, Anderson V, Pombo D, Burke J. Protracted outbreak of postarthroscopy infections associated with flash sterilization of instruments. In: *Program and abstracts of the Fifth Decennial International Conference on Healthcare-Associated In-*

- fections*. Atlanta: Society for Healthcare Epidemiology of America, 2010. Abstract 400.
8. Parada SA, Grassbaugh JA, DeVine JG, Arrington ED. Instrumentation-specific infection after anterior cruciate ligament reconstruction. *Sports Health* 2009;1:481–485.
 9. Viola R, Marzano N, Vianello R. An unusual epidemic of *Staphylococcus*-negative infections involving anterior cruciate ligament reconstruction with salvage of the graft and function. *Arthroscopy* 2000;16:173–177.
 10. Johnson LL, Shneider DA, Austin MD, Goodman FG, Bullock JM, DeBruin JA. Two per cent glutaraldehyde: a disinfectant in arthroscopy and arthroscopic surgery. *J Bone Joint Surg Am* 1982; 64:237–239.
 11. McAllister DR, Parker RD, Cooper AE, Recht MP, Abate J. Outcomes of postoperative septic arthritis after anterior cruciate ligament reconstruction. *Am J Sports Med* 1999;27: 562–570.
 12. Sherman OH, Fox JM, Snyder SJ, et al. Arthroscopy—“no-problem surgery”: an analysis of complications in two thousand six hundred and forty cases. *J Bone Joint Surg Am* 1986; 68:256–265.
 13. Rutala WA, Weber DJ; Healthcare Infection Control Practices Advisory Committee. *Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008*. http://www.cdc.gov/hicpac/Disinfection_Sterilization/toc.html.
 14. US Food and Drug Administration. *Arthroscopic Shavers: Ongoing Safety Review*. <http://www.fda.gov/Safety/MedWatch/SafetyInformation/SafetyAlertsforHumanMedicalProducts/ucm170730.htm>. July 7, 2009. Accessed December 3, 2010.
 15. US Food and Drug Administration. *Ongoing Safety Review of Arthroscopic Shavers*. <http://www.fda.gov/MedicalDevices/Safety/AlertsandNotices/ucm170639.htm>. 2009. Accessed December 3, 2010.