Investigation of a Prolonged Group A Streptococcal Outbreak Among Residents of a Skilled Nursing Facility, Georgia, 2009–2012

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Background. Group A Streptococcus (GAS) is an important bacterial cause of life-threatening illness among the elderly. Public health officials investigated a protracted GAS outbreak in a skilled nursing facility in Georgia housing patients requiring 24-hour nursing or rehabilitation, to prevent additional cases.

Methods. We defined a case as illness in a skilled nursing facility resident with onset after January 2009 with GAS isolated from a usually sterile (invasive) or nonsterile site (noninvasive). Cases were “recurrent” if >1 month elapsed between episodes. We evaluated infection control practices, performed a GAS carriage study, emm-typed available GAS isolates, and conducted a case-control study of risk factors for infection.

Results. Three investigations, spanning 36 months, identified 19 residents with a total of 24 GAS infections: 15 invasive (3 recurrent) and 9 noninvasive (2 recurrent) episodes. All invasive cases required hospitalization; 4 patients died. Seven residents were GAS carriers. All invasive cases and resident carrier isolates were type emm 11.0. We observed hand hygiene lapses, inadequate infection documentation, and more frequent wound care staff turnover on wing A versus wing B. Risk factors associated with infection in multivariable analysis included living on wing A (odds ratio [OR], 3.4; 95% confidence interval [CI], .9–16.4) and having an indwelling line (OR, 5.6; 95% CI, 1.2–36.4). Cases ceased following facility-wide chemoprophylaxis in July 2012.

Conclusions. Staff turnover, compromised skin integrity in residents, a suboptimal infection control program, and lack of awareness of infections likely contributed to continued GAS transmission. In widespread, prolonged GAS outbreaks in skilled nursing facilities, facility-wide chemoprophylaxis may be necessary to prevent sustained person-to-person transmission.

Keywords. group A Streptococcus; emm type; Active Bacterial Core surveillance; skilled nursing facility; infection control.

Group A Streptococcus (GAS) is an important bacterial cause of severe, life-threatening illness, especially among residents of long-term care facilities (LTCFs) [1]. In 2010, an estimated 12 500 invasive cases of GAS and 1250 deaths occurred in the United States [2]. In adults, the risk of both acquiring invasive GAS illness and dying from a GAS infection increases with age [2, 3]. Moreover, the burden of invasive GAS among persons ≥65 years of age is almost 6 times higher in LTCF residents compared with people of the same age group who are living in the community [1].

Past investigations of GAS outbreaks among LTCF residents have identified both host and environmental risk factors [4]. Host factors associated with an increased risk for developing GAS disease include chronic illness, nonintact skin, and preceding viral respiratory infections [5–7]; institutional factors include having a roommate with GAS disease or carriage, staff carriage of GAS, and poor hand hygiene [7, 8].
From June to August 2009, 3 invasive GAS infections were identified among 2 residents of skilled nursing facility A (SNFA) in metropolitan Atlanta and were reported to the Georgia Department of Public Health. SNFA is a 240-bed for-profit single-building facility with approximately 200 employees covering general care, dementia, and dialysis wards. Each room houses 2–3 residents; some adjacent rooms share toilet facilities. Residents of a skilled nursing facility require either 24-hour nursing or rehabilitation [9]. Many patient care staff are assigned to specific halls, but some rotate to cover other wards as needed.

In January 2010, a brief investigation of 3 cases identified no additional cases or sources of infection. After 15 months with no cases, 8 invasive GAS infections occurred between December 2010 and October 2011. In November 2011, an interdisciplinary team consisting of local, state, and federal public health staff convened to investigate the outbreak.

The objectives of the investigation were to determine the extent of the outbreak, identify and eradicate GAS carriage in residents and staff, identify risk factors for GAS infection, understand modes of transmission within the facility, and make recommendations to prevent further infections. We also sought to determine if the 2 clusters of GAS infections were due to continued transmission of the bacteria within the facility.

**METHODS**

**Case Definitions and Case Finding**

We defined an invasive case patient as a resident of SNFA from whom GAS was isolated from a normally sterile site. We defined a noninvasive case patient as a resident from whom GAS (and no other pathogen) was isolated from a nonsterile site and who developed a clinical syndrome consistent with GAS infection (eg, pharyngitis, wound infection). GAS infections occurring after January 2009 were considered cases. Recurrent case patients were defined as individuals who had >1 episode of GAS infection diagnosed at least 1 month apart.

To identify any additional invasive cases, we reviewed 2 Georgia surveillance systems: the State Electronic Notifiable Disease Surveillance System (SendSS) and Active Bacterial Core surveillance (ABCs). SendSS is a passive surveillance system to which invasive GAS and other notifiable diseases are reported. ABCs is an active population and laboratory-based surveillance system that captures all culture-confirmed invasive GAS infections among residents of the greater Atlanta metropolitan surveillance area. SNFA and its 2 main referral hospitals are located within Georgia’s 20-county ABCs catchment area.

We reviewed SNFA’s infection log and pharmacy records from January 2009 through November 2011, and microbiological results from SNFA since February 2011 (earlier results were unavailable). We requested all positive GAS culture results from patients aged >40 years, beginning January 2009 (from both sterile and nonsterile sites) from the 2 acute care hospitals that most commonly admit residents from SNFA. Each hospital patient with a GAS-positive culture was cross-checked against the SNFA census from the corresponding time to determine if he/she was a resident.

**Assessment of Infection Control Practices**

We reviewed the infection control program policies and practices and conducted overt and covert observations of hand hygiene, wound care nursing, and housekeeping practices throughout the facility. We obtained a list of all wound care nurses, the duration of their tenure, and locations of work during the outbreak period. We reviewed SNFA charts for any records informing the facility that a GAS infection had been diagnosed and treated by the referral acute care hospital.

**Carriage Survey**

We screened for GAS carriage among patients and staff (with and without direct patient care) at SNFA. We defined a carrier as a resident or staff member from whom GAS was cultured in the absence of clinical GAS infection. Among residents, we swabbed the oropharynx, wounds, and indwelling lines (other than urinary catheters). Among staff, we swabbed the oropharynx and any self-identified wounds.

**GAS Typing**

The Georgia State Public Health Laboratory cultured all specimens obtained during the carriage survey using enhancement enrichment broth and forwarded all GAS-positive cultures to the Streptococcal Laboratory at the Centers for Disease Control and Prevention (CDC) for antimicrobial susceptibility testing and emm sequence subtyping. Subtypes were identified according to the 180 bp region defined within the CDC database (ftp://ftp.cdc.gov/pub/infectious_diseases/biotech/tsemmb/), and subtype variants were described using selected analysis of longer (>600 bp) emm gene DNA sequences using standard methods [10]. All invasive GAS cultures collected from patients residing in metropolitan Atlanta are routinely sent to the CDC for emm typing and susceptibility testing as part of ABCs.

**Case-Control Study**

We conducted a case-control study to identify risk factors associated with GAS infection. Controls were defined as residents with no documented GAS infection or carriage. For each case, 3 controls were randomly selected from a census of residents present at the facility during the month prior to and including the case’s GAS culture date.

We reviewed case and control charts to abstract information on resident demographics, bed location and roommates, activities
of daily living, comorbid conditions, wound care, recent infections, and receipt of antibiotics or immunosuppressive therapy. We analyzed the data using SAS software, version 9.3, and assessed risk factors for infection using univariate and multivariable conditional logistic regression.

RESULTS

Investigation 1
In January 2010, county health officials investigated the 2009 cluster of 3 (1 recurrent) invasive GAS infections among 2 residents (Figure 1). No additional cases were identified and no screening of staff or residents for GAS carriage was undertaken. The local investigative team recommended improvements in hand hygiene and infection control.

Investigation 2
Between December 2010 and November 2011, 8 (2 recurrent) invasive GAS infections occurred in 6 residents. A multidisciplinary team investigated these and prior cases. Review of referral hospital records dating back to January 2009 identified 7 (2 recurrent) noninvasive GAS infections among 5 SNFA residents (Table 1). Four of 5 residents with recurrent infections had chronic nonsurgical wounds, and the median time between recurrent infections was 6 months (range, 2–13 months).

Assessment of Infection Control Practices
No wall-mounted alcohol-based hand rub dispensers were found in the hallways or nursing stations, and some dispensers in resident rooms were empty. Only 4 of the 21 (20%) instances of covertly observed staff/resident contact included appropriate hand cleaning. During direct observation of the 2 wound care nurses on rounds, all 70 hand hygiene opportunities observed were compliant with best practices.

Communication between the referral hospitals and SNFA regarding GAS-infected patients was suboptimal: among the 5 case patients with recurrent infection, only 1 SNFA chart had documentation of the initial GAS infection.

Carriage Survey
Specimens were collected from the oropharynx of 189 (79%) residents and 166 (81%) staff, and from wounds of 15 residents. Three (2%) residents and 1 (1%) staff member had GAS-positive swabs (1 wound, 3 oropharyngeal). One resident carrier had survived recurrent invasive infections and suffered from chronic wounds. Group B Streptococcus was isolated from pharyngeal swabs of 11 (6%) residents and 8 (5%) staff.

GAS Typing
All available isolates from invasive GAS episodes (n = 9) and resident carriers (n = 3) were type emm 11. Staff carriage was not with the outbreak type. No GAS isolates from noninvasive infections were available for emm typing. Sequence analysis of the entire emm gene amplicon from the invasive emm 11 isolates revealed that all were variant alleles 1 or 2 of the most common emm 11 subtype, emm 11.0. Variant 1 differs from variant 2 by the precise deletion of 42 internal codons. Otherwise, these 2 amplicons shared sequence identity over their entire 763 bp overlap. All emm 11.0 isolates were tetracycline resistant and fully or intermediate erythromycin resistant; 10 of 12 isolates had inducible clindamycin resistance.

Case-Control Study
We analyzed risk factors for invasive, noninvasive, and all GAS episodes (Table 2). In the univariate analysis of total GAS
episodes, case residents were more likely than control residents to be bedbound, have a nonsurgical wound, have an indwelling line, and reside on wing A. In multivariable analysis, the best-fit model included living on wing A (odds ratio [OR], 3.4; 95% confidence interval [CI], 0.9–16.4) and having an indwelling medical line (eg, central line; OR, 5.6; 95% CI, 1.2–36.4).

Control Measures

We emphasized hygiene through reminders, educational inservices, and placement of additional alcohol-based hand rub dispensers. Other recommended infection control measures included adequate cleaning and disinfection of multiple-use equipment, and documentation processes for infection logs. An interfacility transfer form was developed to improve communication between SNFA and acute care hospitals. The form, to be completed for each patient transferred to SNFA from a hospital, documented infections diagnosed during hospital admission, as well as medical devices and isolation precautions in place at discharge to SNFA. GAS carriers were treated with clindamycin for 10 days [11], and the facility was advised to re-screen carriers 1 month after treatment and to continue active surveillance for new GAS infections for 2 months from the time of the investigation. No additional GAS cases were reported from November 2011 to March 2012.

Table 1. Characteristics of Patientsa With Invasive and Noninvasive Group A Streptococcal Infection, Skilled Nursing Facility A, Georgia, 2009–2011b

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Patients With Invasive GAS Disease (n = 8)</th>
<th>Patients With Noninvasive GAS Disease (n = 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic culture specimen</td>
<td>Blood</td>
<td>Wound, sputum, abscess</td>
</tr>
<tr>
<td>Age, y, median (range)</td>
<td>78 (58–93)</td>
<td>63 (51–76)</td>
</tr>
<tr>
<td>Female sex</td>
<td>4 (50%)</td>
<td>1 (20%)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>1 (12%)</td>
<td>2 (40%)</td>
</tr>
<tr>
<td>Black</td>
<td>6 (75%)</td>
<td>3 (60%)</td>
</tr>
<tr>
<td>Other</td>
<td>1 (12%)</td>
<td>0</td>
</tr>
<tr>
<td>Location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wing A</td>
<td>7 (87%)</td>
<td>3 (60%)</td>
</tr>
<tr>
<td>Wing B</td>
<td>1 (12%)</td>
<td>2 (40%)</td>
</tr>
<tr>
<td>Recurrence</td>
<td>3 (38%)</td>
<td>2 (40%)</td>
</tr>
<tr>
<td>Hospitalization</td>
<td>8 (100%)</td>
<td>5 (100%)</td>
</tr>
<tr>
<td>Death</td>
<td>4 (50%)</td>
<td>3 (60%)</td>
</tr>
<tr>
<td>Underlying conditions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>5 (62%)</td>
<td>4 (80%)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>6 (75%)</td>
<td>5 (100%)</td>
</tr>
<tr>
<td>BMI &lt;18 kg/m²</td>
<td>3 (37%)</td>
<td>2 (40%)</td>
</tr>
<tr>
<td>Dialysis</td>
<td>3 (37%)</td>
<td>0</td>
</tr>
<tr>
<td>Nonsurgical wound</td>
<td>7 (87%)</td>
<td>4 (80%)</td>
</tr>
<tr>
<td>Indwelling linec</td>
<td>5 (62%)</td>
<td>2 (40%)</td>
</tr>
</tbody>
</table>

Abbreviations: BMI, body mass index; GAS, group A Streptococcus.

aData had experienced a total of 18 discrete infections. No patient had both invasive and noninvasive disease.
bIncludes cases from investigations 1 and 2.
cIncludes central and peripheral venous lines, urinary catheters, feeding tubes.

Investigation 3

Between 24 March and 19 May 2012, 4 additional cases of invasive GAS in SNFA residents were reported. In June 2012, review of referral hospital records also revealed 2 additional noninvasive GAS infections (Figures 1 and 2). All invasive GAS isolates were subtype emm 11.0, variant 1 or variant 1914, and had similar antibiotic susceptibility profiles as previous SNFA cases. The recommended interfacility transfer form had not been used; SNFA personnel were unaware of GAS infections diagnosed by referral hospital laboratories.

In June 2012, in addition to reinforcement of infection control recommendations, we swabbed wounds and collected oropharyngeal cultures on all residents with either GAS illness onset in 2012 or GAS carriage in November 2011. We also completed facility-wide prophylaxis to eradicate carriage: all
Table 2. Univariate Analysis of Risk Factors for Invasive and Noninvasive Group A Streptococcal Episodes* Compared to Time-Matched Controls, Skilled Nursing Facility A, Georgia, 2009–2011b

<table>
<thead>
<tr>
<th>Risk Factor†</th>
<th>Invasive GAS Episodes (n = 11)</th>
<th>Noninvasive GAS Episodes (n = 7)</th>
<th>All GAS Episodes (n = 18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resident in</td>
<td>9 (81)</td>
<td>11 (33)</td>
<td>1 (143)</td>
</tr>
<tr>
<td>Wing A</td>
<td>10 (90)</td>
<td>13 (39)</td>
<td>4 (57)</td>
</tr>
<tr>
<td>Nonsurgical</td>
<td>9 (81)</td>
<td>6 (18)</td>
<td>6 (86)</td>
</tr>
<tr>
<td>Wound</td>
<td>5 (46)</td>
<td>2 (6.1)</td>
<td>4 (57)</td>
</tr>
<tr>
<td>Indwelling</td>
<td>7 (64)</td>
<td>7 (21)</td>
<td>4 (57)</td>
</tr>
<tr>
<td>Dementia</td>
<td>3 (27)</td>
<td>0 undefined</td>
<td>3 (14)</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; GAS, group A Streptococcus; OR, odds ratio; SNFA, skilled nursing facility A.

* The 18 GAS episodes occurred among 13 patients.

† Includes cases from investigations 1 and 2.

‡ Age, sex, and race were not significantly associated with GAS infection.

§ Includes central and peripheral venous lines, urinary catheters, feeding tubes.

consenting residents (98%) and employees (98%) were treated with an intramuscular dose of benzathine penicillin G and a 4-day course of rifampin or a 10-day course of cephalexin. Residents who did not receive empiric antibiotic prophylaxis were placed on contact precautions until negative cultures were documented and nonprophylaxed staff were furloughed until negative cultures were documented. Wound cultures from 4 of 16 residents grew GAS subtype *emm* 11.0, variant 1 or 1914, and all were treated. All swab cultures performed on staff and residents who refused or had contraindications to antibiotics were negative.

Approximately 5 weeks following completion of antibiotic treatment, swabs were repeated on residents who had had positive wound cultures, who refused antibiotics, and who were admitted to the facility during the chemoprophylaxis period. All follow-up swabs were negative for GAS. There have been no further reported cases at the time of acceptance of this manuscript (15 months).

**DISCUSSION**

In SNFA, 24 discrete GAS infections due to a single *emm* subtype occurred in 19 residents over 36 months—the longest LTCF outbreak of GAS in the published literature. The rate of disease recurrence in this outbreak was also unexpectedly high. Historically, the annual frequency of recurrent invasive GAS infections recorded by ABCs is <2%, in contrast to 25% during this outbreak. Colonization of susceptible elderly residents and continued person-to-person transmission through lapses in infection control likely contributed to the long duration and high recurrence rate. Lack of effective communication between acute and long-term care institutions hampered recognition of the problem.

All available isolates from invasive cases and resident carriers were type *emm* 11 and had similar antibiotic resistance patterns. While reintroduction of GAS from the community is possible, genetic typing supports the hypothesis of sustained GAS transmission of a progenitor strain within the facility for at least 36 months. Excluding isolates from this outbreak, subtype *emm* 11.0 caused only 15 of 500 (3%) invasive cases in 2009–2011 in the greater Atlanta metro area (ABCs data, unpublished). Moreover, all (n = 13) outbreak case isolates were variant 1, 2, or 1914. The differences between these particular *emm* 11.0 variants are minimal and similar *emm* deletion variants have been documented within the same culture [12].

Having an indwelling line and residing in wing A of the facility were risk factors for infection in the multivariable model. Moreover, at least 80% of cases had a nonsurgical wound—an established risk factor for GAS infection. Residents with skin breakdown and GAS colonization may have provided a “wound reservoir” from which contact spread proceeded due to breaches in infection control. SNFA employs 1 wound care nurse for each wing. The nurse on wing B had 10 years of wound care experience at the facility; in contrast, 4 different wound nurses provided wound care on wing A over the outbreak period. Lack of experience in the position may have contributed to lapses in
wound care infection control on wing A. Moreover, the high proportion of bedbound case patients supports the hypothesis that healthcare workers were integral to continued transmission within the facility. Staff colonization with the outbreak strain has been found in previous outbreaks [7, 13]; however, none was found at SNFA and no self-treatment was suspected.

Unfortunately, 2 investigations failed to halt GAS transmission at SNFA. The first investigation recommended improved infection control whereas the second included facility-wide screening followed by targeted chemoprophylaxis. This approach may have failed because carriers were missed (only 3 identified) or because they carried GAS with inducible clindamycin resistance. Finally, facility-wide chemoprophylaxis appears to have interrupted transmission.

Our investigation has several limitations. Isolates and emm typing were unavailable for noninvasive cases. Inclusion of noninvasive cases in the analysis, assuming they were related to the outbreak, may have introduced misclassification bias. Additional cases may have been missed given that diagnostic specimens are sometimes not collected among ill nursing home residents and treatment is often empiric. Furthermore, if a patient was diagnosed at a facility other than the 2 principal referral hospitals, we may not have linked it to the outbreak; this is especially true for noninvasive cases. Also, SNFA had a lower than expected rate of GAS carriage [4], which may have been due to technical difficulties in performing correct swabbing technique in uncooperative, physically and mentally disabled patients, or may reflect a true low carriage rate. Finally, overt observation of infection control, as performed with the wound care nurses, may not reflect usual practice.

In summary, we describe a GAS outbreak characterized by high mortality, high recurrence of disease, and prolonged duration that ceased upon facility-wide chemoprophylaxis. The outbreak proceeded undetected by SNFA, emphasizing the need for communicable disease surveillance within the facility and communication with external facilities during care transitions as part of a robust infection control program. Even 1 case of invasive GAS infection in an LTCF should trigger an investigation for additional cases and a critical assessment of the facility’s infection control practices.

Notes

Acknowledgments. We thank colleagues at Skilled Nursing Facility A for their cooperation during successive phases of outbreak investigation and intervention; the Georgia State Public Health Laboratory for culturing specimens and the Centers for Disease Control and Prevention’s Streptococcal Laboratory for antimicrobial susceptibility testing, emm typing, and variant characterization; and the Greater Atlanta Metropolitan

Financial support. This work was supported by the Respiratory Diseases Branch, CDC; Division of Healthcare Quality Promotion, CDC; and the Georgia Department of Public Health.

Disclaimer. The findings and conclusions in this publication are those of the authors and do not necessarily represent the official position of the CDC.

Potential conflicts of interest. J. B. held a 1-year fellowship in applied epidemiology at the CDC, which was made possible by a public/private partnership supported by a grant to the CDC Foundation from External Medical Affairs, Pfizer Inc. All other authors report no potential conflicts.

All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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