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Antibiotic Resistance in Non-Major Metropolitan Skilled Nursing Facilities: Prevalence and Inter-Facility Variation

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Keywords

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Skilled nursing facilities (SNFs) represent ideal environments for the emergence and spread of antibiotic resistance.[1] Studies have found that residents in Veterans Administration (VA) SNFs[2,3] and non-VA SNFs in major metropolitan areas[4,5] are frequently colonized with antibiotic-resistant bacteria (ARB). The extent to which residents of non-urban SNFs are colonized with ARB remains poorly understood. Intrinsic differences in patient populations, referral patterns as well as other contextual factors may fuel very different patterns of antibiotic resistance in non-urban SNFs. Our group recently completed a longitudinal study to document patterns of antibiotic resistance in several SNFs located in non-urban counties of South Central Wisconsin. Herein, we present the colonization results of surveillance cultures performed at the inception of the study cohort in 2008–2009.

The University of Wisconsin's Institutional Review Board approved this study. A potential pool of 39 SNFs (size, ≥ 60 beds) located in 9 South Central Wisconsin counties was constituted from a directory of licensed facilities maintained by the State of Wisconsin. A randomly assigned number was used to determine the order in which facilities were approached by the research team. Six of the first 10 facilities approached agreed to participate. Variables describing characteristics of the facility and resident population were constructed from annual data collected during the state survey process as well as data collected from medical records of subjects at study entry.

Residents of participating SNFs over the age of 18, including those with cognitive impairment, were eligible to participate. After obtaining written informed consent, multi-anatomical screening for colonization with methicillin-resistant *Staphylococcus aureus* (MRSA) and fluoroquinolone-resistant gram-negative bacteria (FQRGNB) was performed. Cultures of nares, skin of the axilla and groin, and perianal skin (or stool) were obtained

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from all subjects to detect MRSA colonization. Additional cultures of wounds, the insertion site of non-urinary indwelling medical devices, and urine collected from indwelling urinary device were obtained, when applicable. The same body sites, exclusive of nares and axilla/groin, were sampled to detect FQRGNB colonization. MRSA specimens were enriched in trypticase soy broth supplemented with 6.5% NaCl for 24 hours before plating onto selective media -- Mannitol Salt agar (Remel, Lenexa, KS) containing 4 μg/mL of cefoxitin. FQRGNB specimens were plated directly onto MacConkey agar (Remel, Lenexa, KS) containing 4 μg/mL of ciprofloxacin. All plates were incubated aerobically for 48 hours at 37°C and were identified to the species level using standard techniques. Cefoxitin and ciprofloxacin resistance was confirmed using the Kirby Bauer disk diffusion method.

Point estimates and 95% confidence intervals of the proportion of residents colonized with MRSA and FQRGNB were calculated. Pearson chi-square tests were performed to identify if a significant difference in the proportion of subjects colonized with MRSA and FQRGNB across study locations was present. When applicable, visual inspection of confidence limits was performed to identify facility pairs accounting for those differences.

The characteristics of the participating facilities, including characteristics of participating subjects in aggregate, are presented in Table 1. 449 of the 851 (53%) residents in the 6 participating SNFs were screened at baseline. An equal proportion of subjects were colonized with MRSA (22.3%; 95% CI 13.7 – 30.9%) and FQRGNB (21.3%; 95% CI 13.3 – 29.3%). Approximately 5% of participating subjects were co-colonized with MRSA and FQRGNB (95% CI 2.8 – 7.1%). Overall, 38.7% (95% CI 32.9 – 44.5%) of subjects screened were colonized with either MRSA and/or FQRGNB.

Significant variation in the proportion of subjects colonized with MRSA (Pearson chi-square = 14.6, $P = 0.012$) and FQRGNB (Pearson chi-square = 13.2, $P = 0.022$) was identified across the 6 facilities. Significant differences in the prevalence of MRSA were identified between Facility #3 (13.0%) and Facility #4 (33.7%). Significant differences in the prevalence of FQRGNB were identified between Facility #2 (29.1%) and Facility #6 (11.3%). The characteristics of facilities with the highest prevalence of MRSA or FQRGNB were not qualitatively different from facilities with a lower prevalence of MRSA or FQRGNB (Table 1).

The generalizeability of our findings may be limited by the method in which study facilities were selected. Our study facilities, while representative of non-urban SNFs that cater to long-term stay residents requiring nursing services of low complexity, may not be representative of urban SNFs that provide a more complex level of nursing care.[6] Nevertheless, the prevalence of MRSA in facilities in our study are not substantively different from those recently described for SNFs in a highly urbanized county in California.[7] Comparable data on the prevalence of FQRGNB in other SNFs are not available. However, recently published studies describing sharp increases in the proportion of clinical isolates obtained from residents of Northeastern SNFs that were resistant to fluoroquinolone antibiotics[8] as well as a high prevalence of FQRGNB colonization among SNF residents with an indwelling medical device[9] support the generalizeability of our findings. In combination, these data suggest that a post-fluoroquinolone era has begun to emerge in U.S. SNFs.

Few studies have attempted to measure the variation in antibiotic resistance across SNFs within the same geographic region.[7,10] The twofold variation in FQRGNB prevalence and threefold variation in MRSA prevalence seen among SNFs in our study raise questions that require further study. Specifically, is variation being driven by differences in referral patterns, intra-facility antibiotic prescribing, intra-facility adherence to transmission-based

precautions or some combination thereof? Pursuing the answers to these questions will be important for developing and implementing interventions to reduce the regional spread of antibiotic resistance.

In summary, our study affirms the notion that residents of SNFs are commonly colonized with MRSA and FQRGNB, even in non-urban facilities that provide relatively low complexity of nursing care. Considerable variation in the prevalence of MRSA and FQRGNB in SNFs in the same geographic region exists. The explanations for this degree of inter-facility variation remain poorly understood and deserve further study.

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Table 1

Facility Characteristics and Prevalence of Antibiotic-Resistant Bacteria for 6 Skilled Nursing Facilities in South Central Wisconsin.

	Skilled nursing facility, by identifier					
Variable	**1**	**2**	**3**	**4**	**5**	**6**
Facility Characteristics						
No. of beds	130	120	97	123	97	83
County urbanization *	Small Metropolitan	Non-Metropolitan	Small Metropolitan	Non-Metropolitan	Non-Metropolitan	Non-Metropolitan
Demographics	Freestanding, Non-Profit	Freestanding, Non-Profit	Freestanding, Non-Profit	Hospital Based, Non-Profit	Freestanding, Non-Profit	Freestanding, For Profit
Medicare per diem (%) **	3.7	19.0	19.6	7.4	11.5	10.3
Dementia unit	Yes	No	No	No	No	No
Rehab unit	No	No	No	No	No	No
Resident Characteristics §						
LOS (months)	61.4	25.9	28.5	28.5	25.8	19.6
Hospitalization, prior 3 mo (%)	11.1	43.7	51.9	26.5	30.2	37.1
Antibiotic use, prior 3 mo (%)	37.0	42.7	37.7	39.8	53.5	59.7
Indwelling medical device (%) ¶	9.9	17.5	6.5	12.1	11.6	17.7
Wound or ostomy (%)	3.7	14.6	7.8	14.5	9.3	4.8
Colonization Data						
MRSA prevalence (%)	16.0	18.5	13.0	33.7	30.2	22.6
FQRGNB prevalence (%)	24.7	29.1	28.6	13.3	20.9	11.3
Co-colonization prevalence (%)	4.9	6.8	1.3	4.8	7.0	0.5
Either MRSA or FQRGNB (%)	35.8	40.8	40.3	42.2	44.2	29.0

LOS, length of stay; MRSA, methicillin-resistant *Staphylococcus aureus*; FQRGNB, fluoroquinolone-resistant gram-negative bacilli

* The level of county urbanization for each of the participating facilities was determined using U.S. Department of Agriculture urban influence codes.

** Derived from cross-sectional census data collected during the facility's 2008 annual state survey.

§ Aggregate baseline characteristics of subjects enrolled in the study.

¶ Counted as present when any of the following were present: 1) indwelling urinary catheter (either foley or suprapubic); 2) percutaneous feeding tube; or 3) tracheostomy.