CIVIL MONEY PENALTY (CMP) FUNDED PROJECT

FINAL REPORT

Grantee

Board of Regents
of the
University of Wisconsin System
Office of Research & Sponsored Programs

Project Title

Antibiotic Use in Nursing Homes Research Project

Award Amount

$86,285

Grant Period

April 1, 2013 - September 30, 2014

Additional Information and Resources

Department of Health Services / Division of Quality Assurance
Quality Assurance and Improvement Committee

This project report has been prepared by the author under a research grant from the Department of Health Services (DHS) Quality Assurance and Improvement Committee. The views expressed in the report/training are personal to the author and do not necessarily reflect the view of the Department of Health Services or any of its staff and do not bind the Department in any manner.

F-01593 (08/2015)

Summary of Project Objectives:

Residents of Wisconsin nursing homes are commonly colonized with antibiotic-resistant bacteria. Research has demonstrated that antibiotic use is one of the major modifiable risk factors responsible for antibiotic resistance in this setting. Previous work by our group has demonstrated antibiotic utilization in Wisconsin nursing homes is high but little is known about the appropriateness of prescribing patterns in these facilities and the factors that promote inappropriate antibiotic use in this setting. The current project has three specific objectives that we expect to achieve at the conclusion of the funding period:

1) Better understand the antibiotic start process in Wisconsin nursing homes.

2) Assess the frequency of inappropriate antibiotic use in Wisconsin nursing homes

3) Identify the major non-clinical factors that promote inappropriate antibiotic use in Wisconsin nursing homes

To achieve these objectives, we plan to prospectively collect data on antibiotic utilization in five Wisconsin nursing homes and use both explicit and implicit criteria for determining appropriateness of prescribed antibiotics. Interviews and focus groups with nursing staff and prescribing providers in study nursing homes are performed and grounded dimensional analysis will be used to develop a comprehensive understanding of the antibiotic start process as well as identify the major non-clinical factors that promote inappropriate use in these facilities.

Notable Project Events (July, 2013 – December, 2014)

- Data collection has completed in five Wisconsin nursing homes. A total of 1442 antibiotic prescribing events have been captured since study initiation on July 1, 2013.
- A portion of the project results were presented as an oral scientific abstract at the 2015 Spring Meeting of the Society for Healthcare Epidemiology of America (a pdf copy of the slide presentation is included with this report). Our team is in the process of submitting these data for publication.
- Our team has completed an analysis of the non-clinical factors associated with higher risk of inappropriate antibiotic prescribing (see narrative below). Our team is in the process of submitting these data for publication.
- We have developed an archetype flow map of the initial and follow-up) antibiotic decision-making process in nursing homes (see narrative below). Our team is in the process of analyzing interview and observational data to identify contextual variations to this archetype across the different study nursing homes.

Narrative of Project Progress (July – December, 2014)

As noted, we have completed data collection in five nursing homes. We have collected data on 1442 antibiotic starts since project initiation. Of the 1442 antibiotic start events that have been captured as part of this research, 729 (50.56%) were initiated in the nursing home, 594 (41.19%) were initiated in the hospital, and 119 (8.3%) were initiated in the emergency room. The most commonly prescribed antibiotics belonged to the beta-lactam (e.g., penicillin) class (prescribed in 558 events; 38.7% of all antibiotic courses) followed by the fluoroquinolones (prescribed in 387 events; 26.84% of all antibiotic courses), sulfonamides (prescribed in 136 events; 9.43% of all antibiotic courses) and macrolides (prescribed in 124 events; 8.6% of all antibiotic courses). All other antibiotic classes combined accounted for the remaining 16.43% of prescribing in study facilities (237 of 1442 events).

Our group has also developed an automated process to assess the appropriateness of antibiotic prescribing in study facilities using explicit criteria that have been published in the scientific literature (Loeb et al. *Infect Control Hosp Epidemiol* 2001; 22[2]: 120-4 / Stone et al. *Infect Control Hosp Epidemiol* 2012; 33[10]: 965-77). The two sets of explicit criteria – referred here as the “Loeb” and “Revised McGeer” criteria – require that nursing home residents manifest specific signs (e.g., fever) and symptoms (e.g., pain with urination) in order for a specific infection to be identified (e.g., urinary tract infection). Criteria were applied only to prescribing events that were initiated in the nursing home or emergency room (n = 848) and to those events in which the provided justification for the antibiotic fell into one of three categories – urinary tract infection, skin/soft tissue infection, or lower respiratory tract infection (n = 717). 131 (15.45%) prescribing events were not included in

this final analysis as the justification for the antibiotic was either not provided or was for an infection other than the three major categories under study (e.g., antibiotic was prescribed for *Clostridum* difficile). Applying these criteria to the data collected on eligible antibiotic events through September 30, 2014 we found that a majority of prescribing events in our four study facilities did not meet explicit criteria for prescribing (Figure). Overall concordance between the two criteria was good, however, differences were seen when criteria were compared for specific types of infection. For example, the Revised McGeer criteria were met more frequently in residents who were prescribed an antibiotic for a urinary tract infection indication while the Loeb criteria were more frequently satisfied for residents who were prescribed an antibiotic for a skin/soft tissue infection indication (Figure 1).

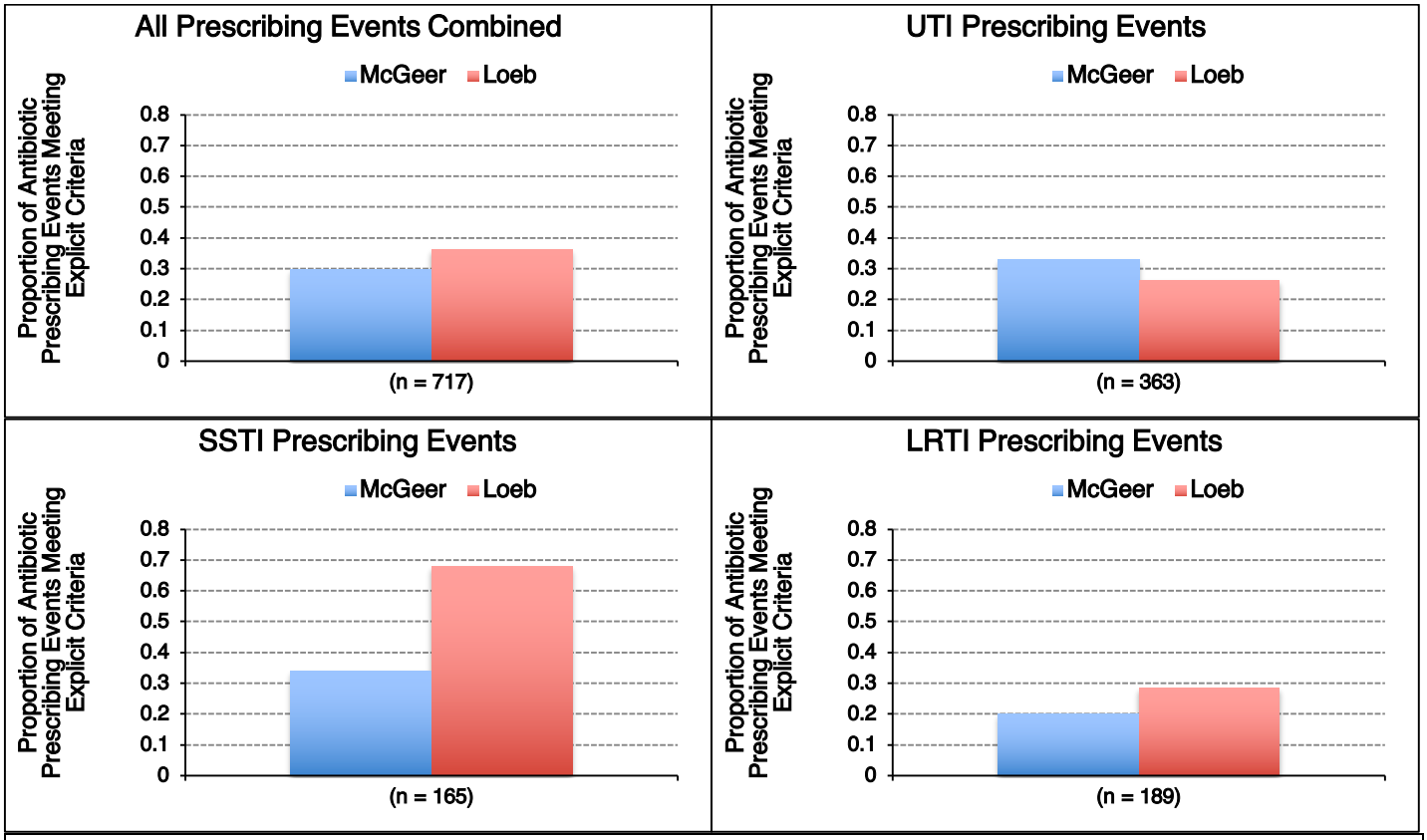

Figure 1: Proportion of antibiotic events initiated in the nursing home or emergency room (n = 717) that met explicit criteria for appropriateness. The upper left cell is the proportion of all prescribing events initiated in the nursing home or emergency room, as defined by the Revised McGeer (blue bar) and Loeb Minimum Criteria (red bar). The remaining cells represent the proportion of the prescribing events that met these two sets of explicit criteria for urinary tract infection (UTI; upper right cell), skin and soft tissue infection (SSTI; lower left cell) and lower respiratory tract infection (LRTI; lower right cell). The Revised McGeer Criteria (Stone et al. *Infect Control Hosp Epidemiol* 2012; 33[10]: 965-77) were designed for surveillance purposes and are not necessarily intended for clinical decision-making. The Loeb Minimum Criteria (Loeb et al. *Infect Control Hosp Epidemiol* 2001; 22[2]: 120-4) were designed to guide decisions regarding initiation of antibiotic therapy in nursing homes.

We submitted a scientific abstract to the 2015 Spring Meeting of the Society for Healthcare Epidemiology of America which was accepted as one of five oral presentations at the meeting. The research presented in this abstract was focused on the relative predictive value of two commonly employed explicit criteria for determining appropriateness of antibiotic prescribing in nursing homes. Our findings showed that: 1) a majority of antibiotic prescribing in our first study facility do not meet explicit criteria for appropriateness regardless of which criteria are employed and 2) there is surprisingly low levels of correlation between the two sets of explicit criteria used. This suggests that studies focused on inappropriate antibiotic use in nursing homes may reach different conclusions depending on which appropriateness criteria are employed. Our group is in the process of submitting this study for publication in *Infection Control and Hospital Epidemiology*. A pdf version of the oral presentation is included with this report.

We have completed an analysis examining the influence of non-clinical factors on likelihood of appropriate antibiotic therapy in nursing homes. Data on antibiotic use in five Wisconsin NHs were collected prospectively. Appropriateness of prescribing events was determined using Loeb criteria. Multivariable analyses using generalized estimating equations (GEE) were employed to assess relationships between antibiotic appropriateness and several "fixed" resident characteristics, including age, gender, life-sustaining treatment preferences, cognitive and functional status, comorbidity, and presence of a chronic wound or indwelling medical device. Sub-group analyses stratified by type of infection were also explored. Complete data on 1108 prescribing events were available for this analysis. 534 (48%) antibiotic courses were prescribed for UTI, 321 (29%) for RTI, and 253 (23%) for SSTI. Overall, 447 (40%) antibiotic courses were appropriate by Loeb criteria (slightly higher than observed in the study described above). Factors associated with appropriateness of antibiotic therapy, both overall and by infection type are shown in tables 1 and 2.

Table 1. Patient Factors Predicting Appropriateness Based on Loeb Criteria-Estimates-Odds Ratios

	OR	95% CI		*p*-value
Age	1.009	0.988	1.030	0.406
Gender (M=0, F=1)	**1.328**	**1.059**	**1.665**	**0.014**
Cognitive Impairment† (N=0, Y=1)	12.762	0.966	168.663	0.053
Katz Physical Function	1.016	0.975	1.059	0.460
Charlson Comorbidity Index	**1.155**	**1.023**	**1.304**	**0.020**
Presence of Chronic Wound (N=0, Y=1)	1.101	0.955	1.268	0.185
Presence of Device (N=0, Y=1)	1.231	0.634	2.391	0.539
Activated Do Not Resuscitate Order (N=0, Y=1)	**1.719**	**1.442**	**2.049**	**<0.0001**
Cognitive Impairment†*Age	0.976	0.948	1.004	0.091
Cognitive Impairment†*Charlson Comorbidity Index	**0.886**	**0.819**	**0.958**	**0.002**

†based on activated Power of Attorney

Table 2. Patient Factors Predicting Appropriateness Based on Condition Specific Loeb Criteria-Odds Ratios

	OR	95% CI		*p*-value
Urinary Tract Infection				
Gender (M=0, F=1)	1.183	1.131	1.238	<0.0001
Charlson Comorbidity Index	1.174	1.065	1.294	0.001
Activated Do Not Resuscitate Order (N=0, Y=1)	1.948	1.672	2.270	<0.0001
Cognitive Impairment (N=0, Y=1)†*Charlson Comorbidity Index	0.832	0.743	0.933	0.002
Skin and Soft Tissue Infection				
Katz Physical Function	1.054	1.042	1.066	<0.0001
Charlson Comorbidity Index	1.206	1.026	1.417	0.023
Presence of Chronic Wound (N=0, Y=1)	0.569	0.448	0.723	<0.0001
Presence of Device (N=0, Y=1)	0.484	0.238	0.986	0.046
Activated Do Not Resuscitate Order (N=0, Y=1)	3.087	1.897	5.022	<0.0001
Respiratory Infection				

No factors were identified with a *p*-value<0.05

†based on activated Power of Attorney

On multivariable analyses, female gender (OR=1.3, 95% CI=1.1-1.7, p=0.01), increasing comorbidity (OR=1.2, 95% CI=1.0-1.3, p=0.02), and active DNR order (OR=1.7, 95% CI=1.4-2.1, p<0.01) were associated with a higher likelihood of receiving appropriate antibiotic therapy. The combination of impaired cognition and increasing comorbidity (OR=0.9, 95% CI=0.8-0.9, p<0.01) was associated with a lower likelihood of appropriate antibiotic therapy. When stratified by infection, similar relationships were identified for UTI. For SSTI cases, increasing comorbidity (OR=1.2, 95% CI=1.0-1.4, p=0.02), impaired physical function (OR=1.1, 95% CI=1.0-1.1, p<0.01), and active DNR order (OR=3.1, 95% CI=1.9-5.0, p<0.01) were associated with a higher likelihood of appropriate antibiotic therapy, and presence of a chronic wound (OR=0.6, 95% CI=0.5-0.7, p<0.01) and/or indwelling medical device (OR=0.5, 95% CI=0.2-1.0, p=0.05) associated with a lower likelihood of appropriate antibiotic therapy. Our study shows that "fixed" resident factors, those independent of the acute change-in-condition (e.g., fever), are associated with the appropriateness of antibiotic prescribing in nursing homes. We are unable to ascertain whether providers are aware of these influences on their prescribing decisions using these data. However, these data do support the notion that differences in resident case-mix may explain some of the observed variation in antibiotic prescribing across nursing homes and suggests that this may need to be accounted for if benchmarking of antibiotic utilization in NHs is pursued. An abstract based on this study has been submitted to the 2016 IDWeek meeting, an international scientific meeting jointly sponsored by the Infectious Disease Society of America and the Society for Healthcare Epidemiology of America.

As part of this project, we performed rapid field assessments homes to better understand the process involved in the initiation and subsequent modification of antibiotic prescriptions in several Wisconsin nursing. Primary data collection for this work involved observations and interviews with frontline staff and leadership in these fields. Archetypal process flow maps of the work system leading up to an initial antibiotic decision and after initiation of an antibiotic were generated. Interview transcripts were then analyzed using a hybrid inductive/deductive thematic approach based on the archetypal flow maps (Figures 2 & 3).

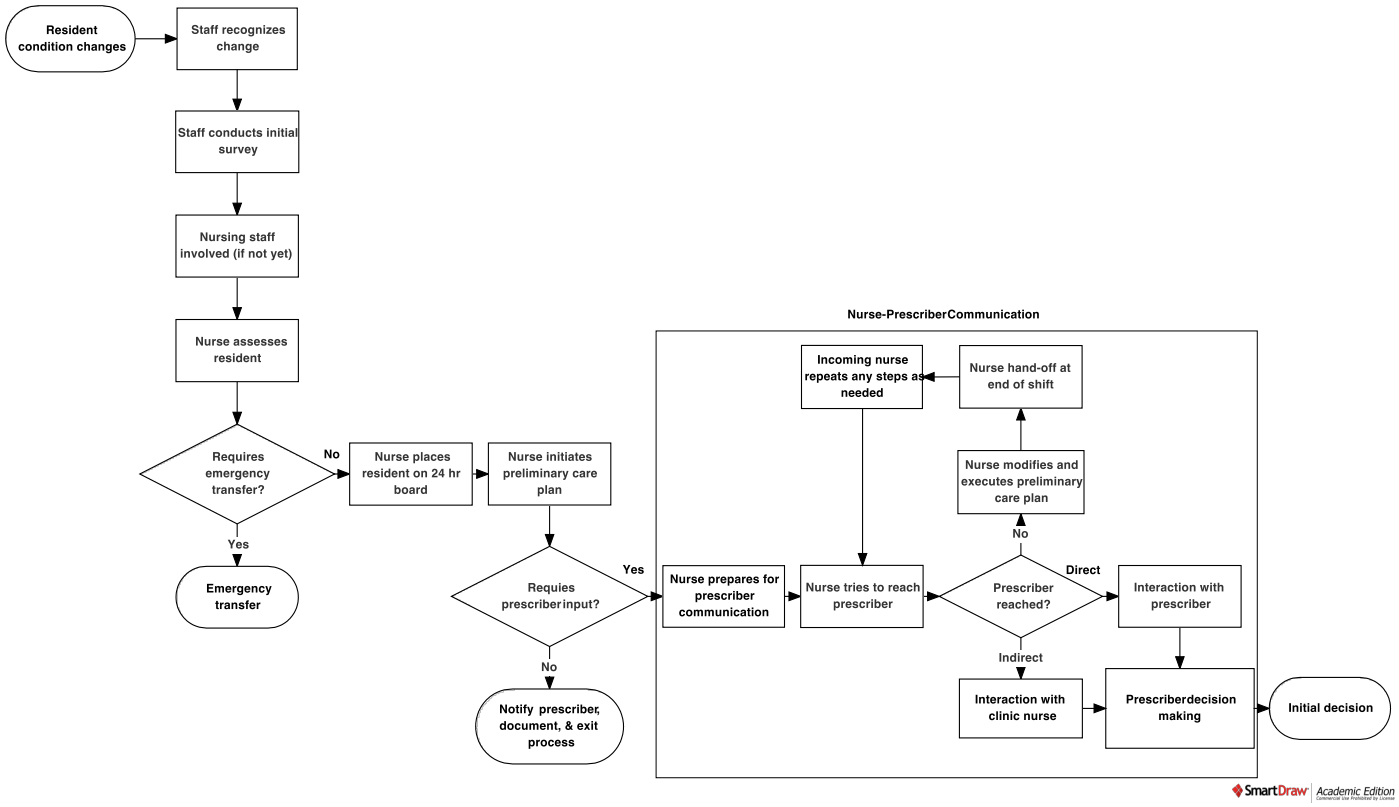

Figure 2. Archetypal flow-map of the process associated with initiation of antibiotics in nursing homes.

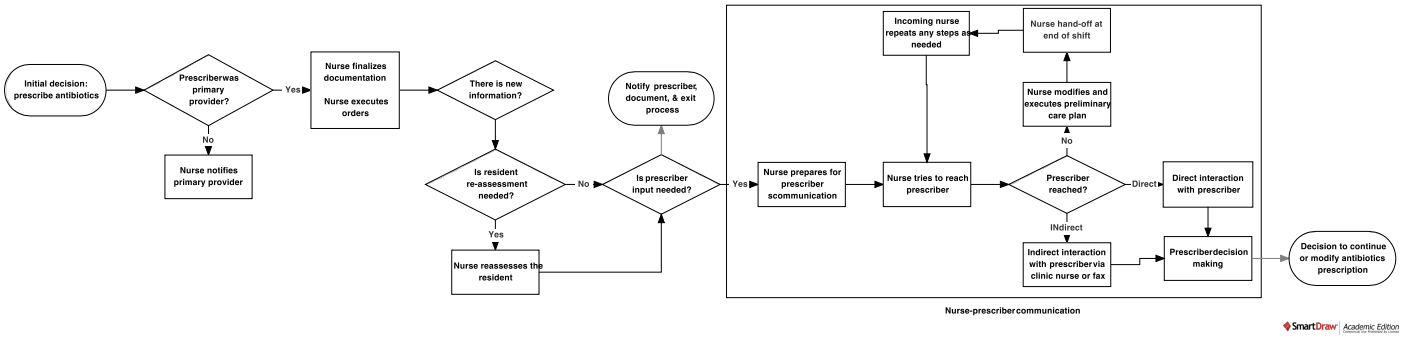

Figure 3. Archetypal flow-map of the process associated with modification of existing antibiotic orders in nursing homes.

Our analyses uncovered several key findings: 1) the initial resident assessment, which is officially the responsibility of the RN, is a task shared by many staff with varying scopes of practice (CNA, LPN, nurse supervisor); 2) communication of resident change-in-condition to the provider was subject to frequent delays and interruptions both within and between shifts; 3) provider communication was often performed by surrogates uninvolved in the original assessment; 4) primary care providers were not consistently notified when their residents were started on an antibiotic by another provider; and 5) post-prescribing changes to antibiotic therapy was inconsistent and changes to therapy only occurred when discordant culture results were identified. The initial antibiotic decision in NHs is highly susceptible to information decay as a result of the involvement of multiple agents and the asynchronous nature of communication in this setting. This likely contributes to increased diagnostic uncertainty which has been linked to antibiotic overuse. In addition, post-prescribing modification of antibiotics in NHs is a reactive process which promotes escalation rather than de-escalation of antibiotics. Interventions to counteract these prevailing system influences are a critical need in NHs. We are still in the process of analyzing transcript data in order to identify if there are major facility-level variations in both of these processes. We have submitted our preliminary findings as an abstract for the 2016 IDWeek meeting, an international scientific meeting jointly sponsored by the Infectious Disease Society of America and the Society for Healthcare Epidemiology of America.

Next Steps:

The funding provided by the Wisconsin Civil Monetary Penalty fund has been invaluable resource that has allowed our research group to better understand the antibiotic prescribing process in Wisconsin nursing homes and identify several targets for improvement. Our immediate plans are to complete the analyses described above and publish our findings in the peer-reviewed literature. Our group is currently in the process of finishing development of a novel antibiotic stewardship intervention that we believe targets a number of the factors that promote inappropriate antibiotic prescribing which were uncovered during our work supported by CMP funds. We plan to implement and evaluate this intervention in the coming year in a small number of Wisconsin nursing homes using funding from the Agency for Healthcare Research and Quality. If successful, we anticipate that there will be an opportunity to disseminate this intervention on a wider scale through continued collaboration with the State of Wisconsin.

SHEA Spring 2015 Conference

Orlando, FL – May 17, 2015

Abstract #6640:

Comparison of Explicit Criteria for Determining Appropriateness of Antibiotic Prescribing in Nursing Homes

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Disclosures

AHRQ Agency for Healthcare Research and Quality
Advancing Excellence in Health Care www.ahrq.gov

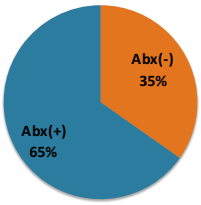
- R18HS022465-01A1
- HHSA290201000018I

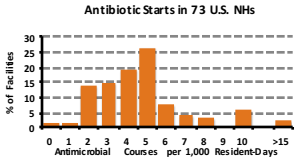
WISCONSIN DEPARTMENT OF HEALTH SERVICES

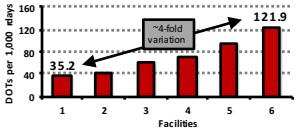
- FCC1043 – Civil Monetary Penalty Fund

Background: Antimicrobial Use in NHs

n = 449



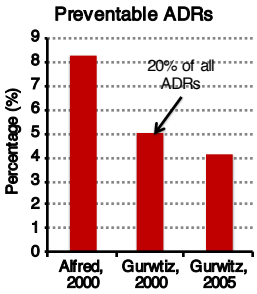


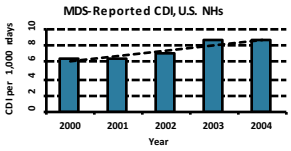


20% of subjects responsible for:
- 48% of antibiotic days
- 60% of antibiotic starts

Cmich et al. ID Week 2012, San Diego, CA
Benoit et al. *J Am Geriatr Soc* 2008; 56(11): 2039-44

Adverse Consequences of Abx Use





Risk Factors for Acquisition of MRSA

Risk Factor	RR	95% CI	*P*-value
Abx Use	7.8	2.1 – 28.6	0.002
Hospitalization	1.5	0.5 – 4.7	0.48
IV Line	3.44	0.9 – 13.6	0.08
Charlson	1.20	1.0 – 1.5	0.08

Gurwitz et al. *Am J Med* 2000; 109(2): 87-94
Gurwitz et al. *Am J Med* 2005; 118(3): 251-58
Cmich et al. *Infect Control Hosp Epidemiol* 2007; 28(8): 1006-8
Furuno et al. *Infect Control Hosp Epidemiol* 2011; 32(3): 244-9
Stone et al. *Infect Control Hosp Epidemiol* 2012; 33(6): 551-57

Tools to Assess Abx Appropriateness

- Implicit Review
  - Verbatim versus structured abstraction of nursing home records
  - External review by specialists with expertise in ID and/or geriatrics
  - Appropriateness across single (e.g., necessity) or multiple dimensions (e.g., necessity, spectrum, dose, etc.)
- Explicit Review (necessity)
  - Modified NNIS Criteria; 1986
  - McGeer Criteria; 1991
  - Loeb Criteria; 2001
  - Revised (Stone) McGeer; 2012

Zimmer et al. *J Am Geriatr Soc* 1986; 34(10); 703-10
Jones et al. *Am J Med* 1987; 83(3): 499-502
McGeer et al. *Am J Infect Control* 1991; 19(1): 1-7
Hanlon et al. *J Clin Epidemiol* 1992; 45(10): 1045-51
Pickering et al. *J Am Geriatr Soc* 1994; 42(1): 28-32
Loeb et al. *Infect Control Hosp Epidemiol* 2001; 22(2): 120-4
Stone et al. *Infect Control Hosp Epidemiol* 2012; 33(10): 965-77

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Loeb vs. McGeer (Stone)

- McGeer designed for surveillance purposes
  - Intended to be applied retrospectively
  - Some definitions require diagnostic test results
  - Frequently used for clinical decision-making in nursing homes
- Loeb designed for clinical decision-making
  - Intended to be applied prospectively
  - Designed for situations where diagnostic test results are not yet available
  - Nursing staff less familiar with these criteria

Non-Catheterized UTI

Revised McGeer (Stone)

(A) Clinical
(Must satisfy one of the following scenarios)

1. Either of the following:
   - ☐ Acute dysuria or
   - ☐ Acute pain, swelling or tenderness of testes, epididymis or prostate
2. If either FEVER* or LEUKOCYTOSIS present need to include ONE or more of the following:
   - ☐ Acute costovertebral angle pain or tenderness
   - ☐ Suprapubic pain
   - ☐ Gross hematuria
   - ☐ New or marked increase in incontinence
   - ☐ New or marked increase in urgency
   - ☐ New or marked increase frequency
3. If neither FEVER or LEUKOCYTOSIS present INCLUDE TWO or more of the ABOVE (Box #2).

+

(B) Lab (At least one of the following must be met)

1. VOIDED SPECIMEN: POSITIVE URINE CULTURE (≥ 10^5 CFU/ML) NO MORE THAN 2 ORGANISMS
2. STRAIGHT CATH SPECIMEN: POSITIVE URINE CULTURE (≥ 10^2 CFU/ML) ANY NUMBER OF ORGANISMS

Loeb Minimum Criteria

(A) Clinical
(Must satisfy one of the following scenarios)

1. Acute dysuria
2. FEVER** plus ONE or more of the following:
   - ☐ New or worsening urgency
   - ☐ New or worsening frequency
   - ☐ Suprapubic pain
   - ☐ Gross hematuria
   - ☐ Costovetebral angle tenderness
   - ☐ Urinary incontinence

* Fever (Revised McGeer): single temp ≥ 100°F or repeated temp ≥ 99°F or 2°F above baseline

** Fever (LMC)x: single temp ≥ 100°F or 2.4°F above baseline

Catheterized UTI

Revised McGeer (Stone)

(A) Clinical
(≥1 of the following without no alt. explanation)

- ☐ Fever*
- ☐ Rigors
- ☐ New onset hypotension
- ☐ Either acute change in mental status or acute functional decline, with no alternate diagnosis AND leukocytosis
- ☐ New onset costovertebral angle pain or tenderness
- ☐ New onset suprapubic pain
- ☐ Acute pain, swelling or tenderness of the testes, epididymis or prostate
- ☐ Purulent drainage from around the catheter

+

(B) Lab (Must be met)

- ☐ Positive urine culture (≥ 10^5 CFU/ML) OF ANY ORGANISM(S)

Loeb Minimum Criteria

(A) Clinical
(Must have one of the following)

- ☐ Fever**
- ☐ New onset costovertebral angle pain or tenderness
- ☐ Rigors
- ☐ New onset delirium

* Fever (Revised McGeer): single temp ≥ 100°F or repeated temp ≥ 99°F or 2°F above baseline

** Fever (LMC): single temp ≥ 100°F or 2.4°F above baseline

How Well Do They Work?

- Stevenson et al. *Am J Infect Control* 1999; 27(1): 20-26 & *J Am Geriatr Soc* 2004; 52(5): 707-11
  - McGeer (1991) criteria
  - Compared rates across 6 NHs and contrasted with MDS dataset UTI measure (Agreement = 14%)
- Juthani-Mehta et al. *J Am Geriatr Soc* 2007; 55(7): 1072-77
  - McGeer (1991) vs. Loeb Criteria
  - Assessed predictive accuracy for bacteriuria (not necessarily symptomatic)
- Olsho et al. *J Am Med Dir Assoc* 2013; 14(4): e1-7
  - Association of Loeb criteria with facility Abx utilization
  - Higher levels of adherence not associated with lower rates of antibiotic use

Methods - 1

- **Study Objectives:**
  - Primary: Determine level of agreement between Revised McGeer (Stone) and Loeb criteria
  - Secondary: Determine if level of agreement between the two criteria vary by facility
- **Study Design:** Prospective cohort
- **Study Location:** 5 Wisconsin NHs
- **Study Period:** March 2013 – June 2014

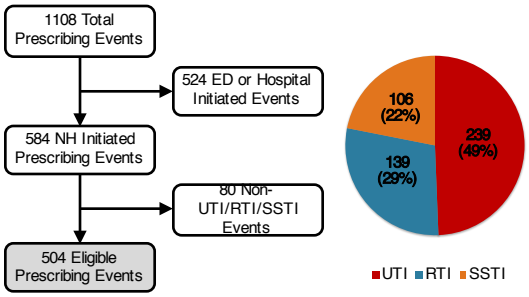
Methods - 2

- **Eligibility:** Any antibiotic course initiated in the nursing home for the one of the following indications
  1. UTI (catheter and non-catheterized)
  2. RTI (McGeer: pneumonia & LRTI; Loeb: febrile [n = 2] and afebrile [n = 2])
  3. SSTI
- **Data Collection:**
  - Antibiotic starts identified through review of physician orders and MAR
  - Resident signs and symptoms manually abstracted from resident health records
  - Data entered onto password protected electronic standardized case report forms (RedCap)

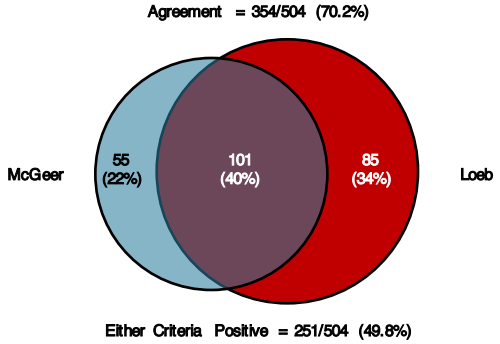
Analyses

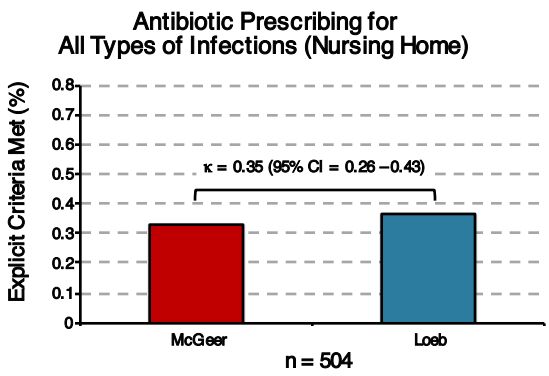
- Kappa statistics used to assess level of agreement
  - All indications combined
  - By infection type (UTI, RTI, SSTI)
  - By facility (all indications combined)

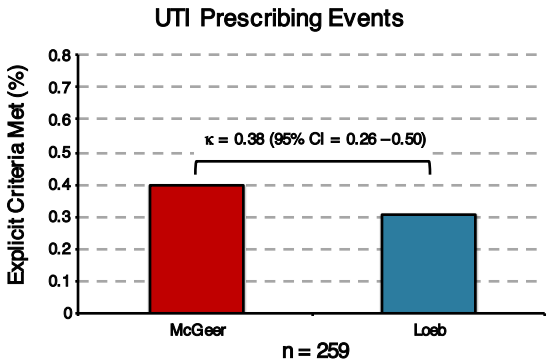
Results - 1

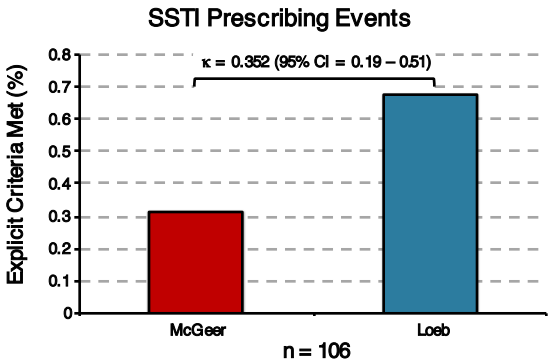


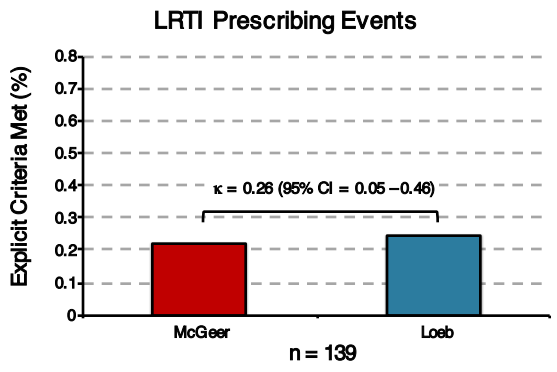
McGeer/Loeb Agreement

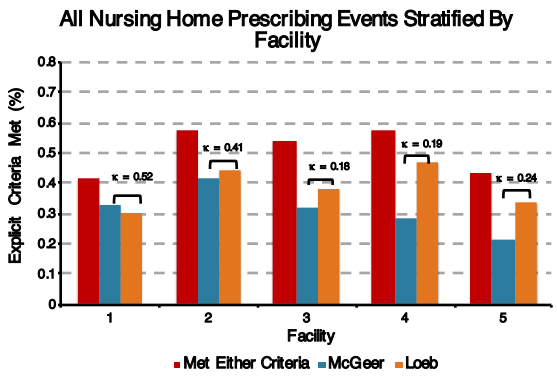












Limitations

- No gold standard reference
  - Cannot calculate sensitivity/specificity
  - Future research: contrast with implicit review?
- Collapsing the four Loeb RTI categories may explain the low kappa values for the sub-comparison with McGeer pneumonia/LRTI

Conclusions

- Individually, non-adherence to NH explicit criteria is high
  - 50% of prescribed antibiotic courses do not satisfy McGeer (Stone) or Loeb criteria
- The two criteria appear to be measuring different constructs (minimal levels of agreement [0.2 – 0.4]
- McGeer (Stone) criteria, on average, are more conservative than Loeb criteria
  - Loeb more conservative for UTI (fever req.)
  - McGeer substantially more conservative for SSTI
- There is cross-facility variation in absolute terms, but relative relationships appear stable across facilities

Questions?