

Hospital Outcomes Associated with Evidence-Based Recommendations for the Management of Pneumonia in Children with High-Intensity Neurologic Impairment

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Background: Pneumonia is one of the most frequent causes of hospitalization, intensive care unit (ICU) admission, and death among children with neurologic impairment (NI). The development of standardized, evidence-based treatment recommendations for otherwise healthy children with pneumonia has reduced the use of unnecessary therapies and improved patient outcomes. Recently, expert panel-endorsed recommendations for antibiotic and airway clearance therapies for children with NI hospitalized with pneumonia were implemented at Cincinnati Children's Hospital Medical Center. The clinical outcomes associated with these recommendations have not yet been studied.

Methods: This retrospective cohort study of 167 patients included patients of any age with high-intensity NI who were hospitalized with pneumonia from August 1st, 2021 through May 31st, 2023 on the Hospital Medicine and Pulmonary Medicine services. Patients were excluded if they were admitted directly to the ICU, had a length of stay (LOS) less than 24 hours, or were transferred from an outside hospital. Chart review was used to determine eligibility in the cohort and define exposures and outcomes. The primary exposures were therapies compliant with recommendations. Antibiotic therapy and airway clearance therapy were examined separately and in combination. Primary outcomes included hospital LOS and transfers to the ICU. The Wilcoxon rank sum test was used to compare medians and interquartile ranges for LOS, and the Fisher's exact test was used to compare number of transfers to the ICU.

Results: Recommended antibiotic therapy was prescribed to 105 (95.45%) of 110 patients. Recommended airway clearance therapy was provided to 119 (71.26%) of 167 patients. Recommended combined antibiotic and airway clearance therapies were provided to 113 (67.67%) of 167 patients. Median hospital LOS was 3.92 days (IQR 2.56-7.91 days). 19 (11.38%) of 167 patients were transferred to the ICU at least once. There were no statistically significant differences between those who received recommended therapies and those who did not in LOS ($P = 0.71$ for antibiotics, $P = 0.12$ for airway clearance, $P = 0.14$ for combined) or transfers to the ICU ($P = 0.79$ for antibiotics, $P = 1$ for airway clearance, $P = 0.62$ for combined).

Conclusion: There were no negative outcomes associated with the implementation of panel-endorsed recommendations for the management of children with NI hospitalized with pneumonia. Investigation of these outcomes is a first step toward developing widespread, evidence-based guidelines for the treatment of pneumonia in this vulnerable population.

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Key Words: pneumonia, neurologic impairment, inpatient, antibiotics, airway clearance

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Background

- High intensity **neurologic impairment (NI)** includes a heterogeneous group of disorders that affect the central and/or peripheral nervous systems, are expected to last more than 12 months, and result in significant functional impairments requiring subspecialty medical care.
- Pneumonia** is one of the most frequent causes of hospitalization, intensive care unit (ICU) admission, and death among children in this population.
- The development of standardized, evidence-based treatment recommendations for otherwise healthy children with pneumonia has reduced the use of unnecessary therapies and improved patient outcomes.
- Yet, children with NI are often excluded from quality improvement studies and evidence-based guidelines.
- Recently, expert panel-endorsed guidelines for antibiotic and airway clearance therapies for children with NI hospitalized with pneumonia has been implemented on the inpatient Hospital Medicine and Pulmonary services at Cincinnati Children's Hospital Medical Center (CCHMC) using quality improvement methodology (**Figures 1-2**).
- The clinical outcomes associated with these recommendations have not yet been studied.

Figure 1. Project Timeline.

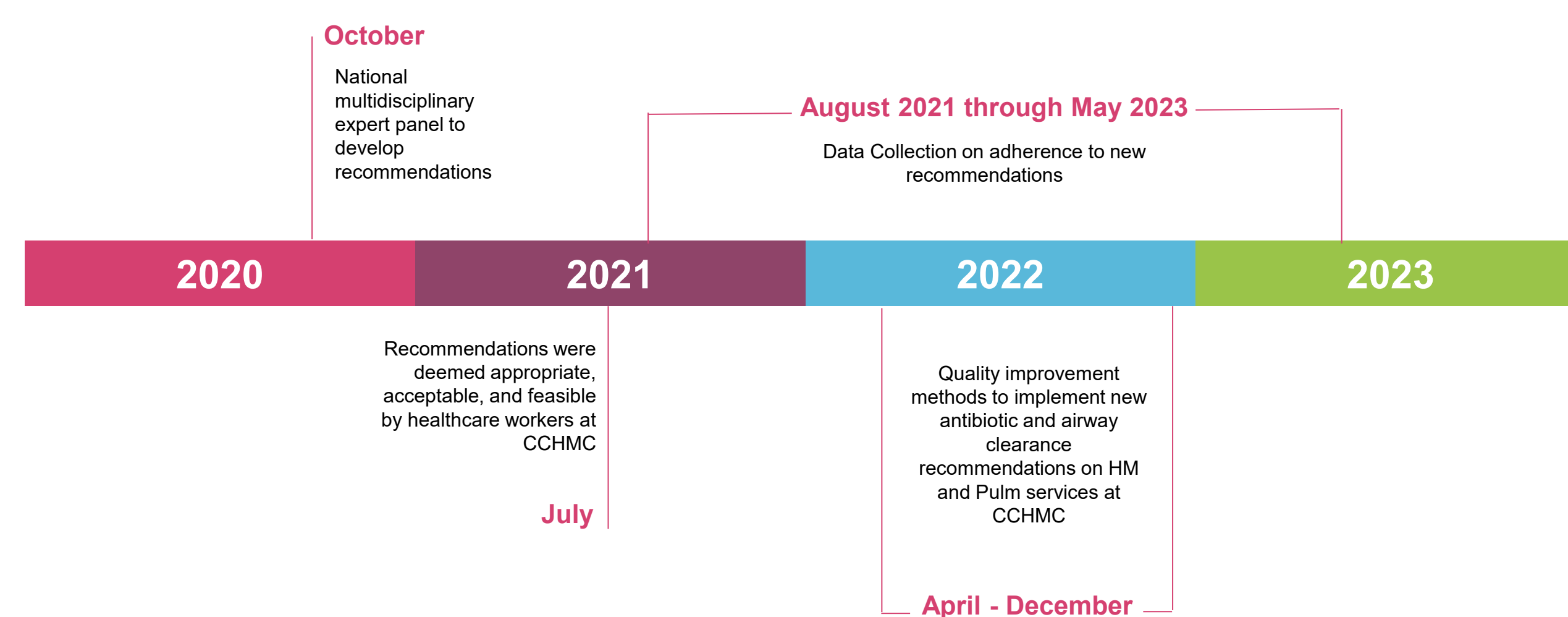
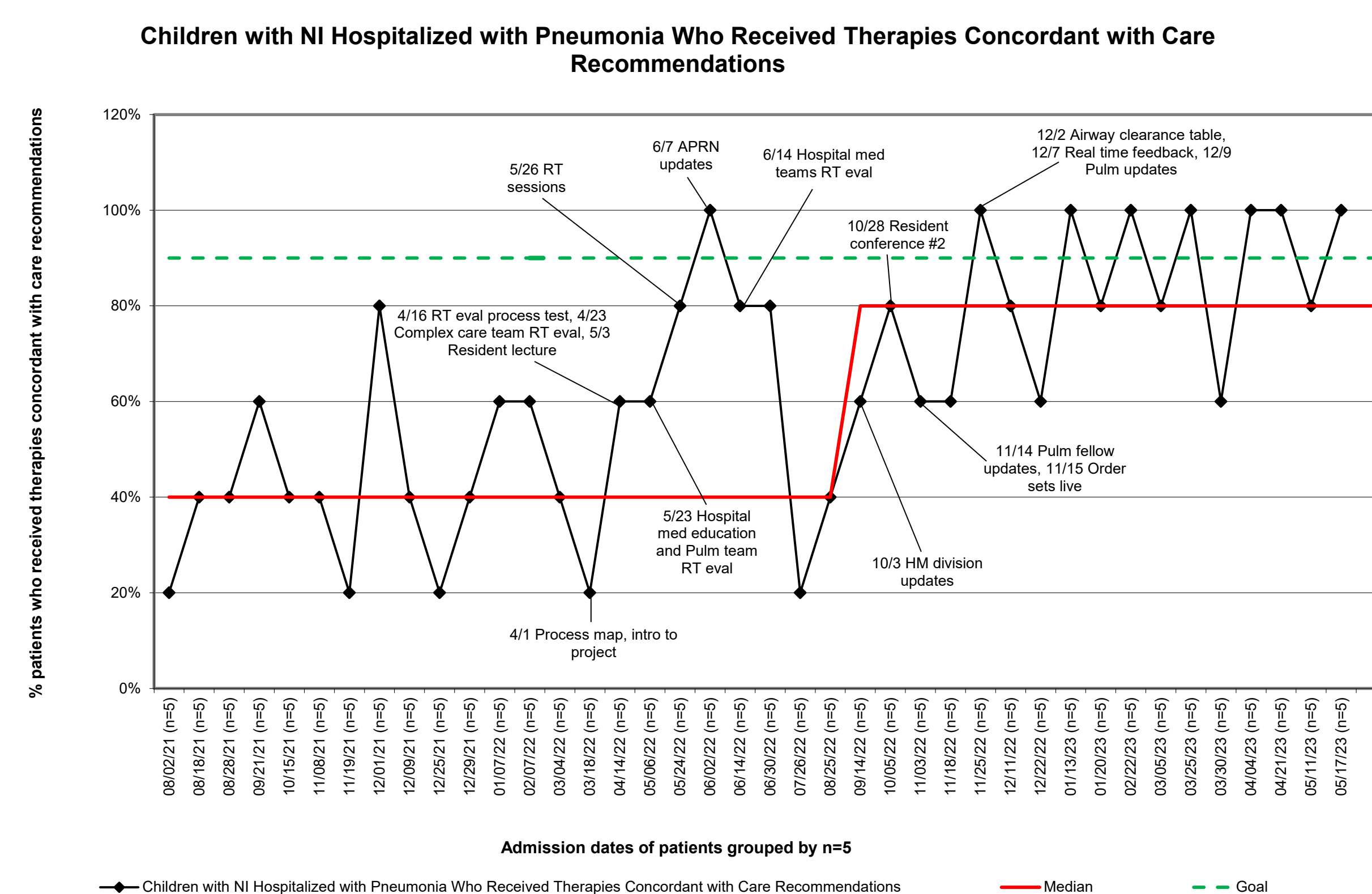


Figure 2. Quality Improvement Run Chart. This chart details the quality improvement methods utilized by the study team and the improvement from median concordance to recommendations of 40% to 80%.



Aims & Hypothesis

Aim

- To investigate how the adoption of the implemented antibiotic and airway clearance recommendations impacted patient hospitalization outcomes of **hospital length of stay** and **transfers to the ICU**.

Hypothesis

- Children who received the recommended antibiotic and/or airway clearance therapies on admission will have had **shorter hospitalizations** and **fewer transfers to the ICU**.

Methods

Study Design

- Single-center retrospective cohort study
- Data from CCHMC Epic electronic medical record
- Patient eligibility determined by diagnostic codes and confirmed by chart review
- Exposure determined from chart review; outcomes from EMR data pull

Inclusion Criteria

- Patients of any age with a pre-existing diagnosis of high-intensity NI who were hospitalized between 08/1/2021 to 5/31/2023 on either the general hospital medicine or pulmonary services with a primary diagnosis of pneumonia (viral, bacterial, or aspiration).

Exclusion Criteria

- Patients were excluded if they were admitted directly to the ICU, had a LOS < 24 hours, or if they were transferred from an outside hospital.

Exposures

- Received both recommended antibiotics and airway clearance (Y/N): **Combined**
- Received recommended airway clearance (Y/N): **Airway Clearance**
- Received recommended antibiotics (Y/N): **Antibiotics**

Statistical Analysis

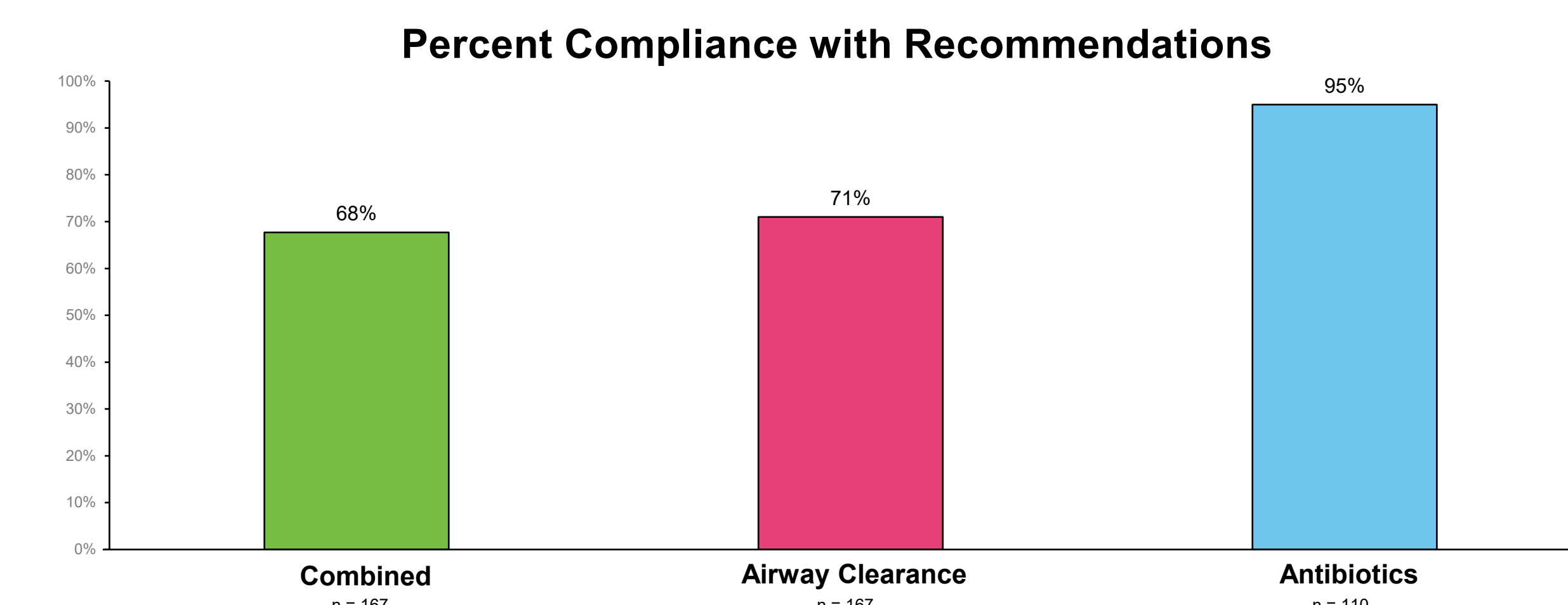
- Median and IQR length of stay (in days) compared between groups using Wilcoxon rank sum test
- Number of transfers to the ICU at least once compared between groups using Fisher's exact test

Overall Results

Table 1. Characteristics of cohort.

Characteristic (n, (%) unless otherwise indicated)	Overall Cohort (n = 167)
Age (Median, (IQR))	8.84 (4.27-14.71)
Male	105 (62.87%)
Publicly Insured	101 (60.48%)
Admitted Service	
Hospital Medicine	92 (55.09%)
Pulmonary (Including TCC)	75 (44.91%)
Diagnoses	
Bacterial Pna/CAP/Pleural Effusion	81 (48.50%)
Viral Pna/Influenza/COVID	48 (28.74%)
Unspecified (LRTI/Fever/Hypoxia/Respiratory Distress)	22 (13.17%)
Aspiration Pna	16 (9.58%)

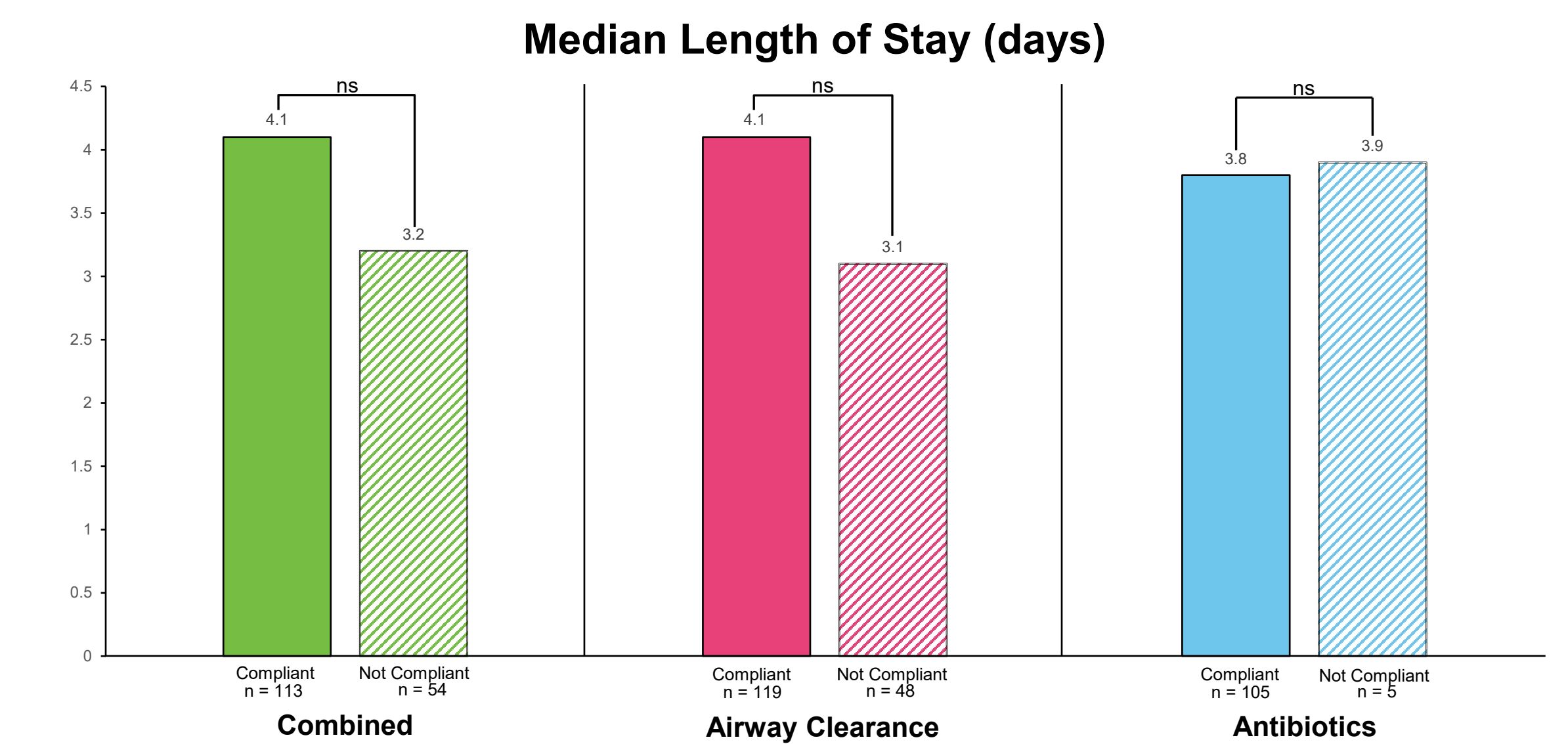
Figure 3. Percentage of patients in each group who received recommended therapy.



Specific Outcome Data

3.92 days (IQR 2.56-7.91 days) was the overall median LOS for the cohort.

Figure 4. LOS outcome data for each treatment group. For the combined group, median LOS was 4.1 days (IQR 2.6-8.1) for compliant; 3.2 days (2.2-6.1) for not compliant; $P = 0.14$. For the airway clearance group, median LOS was 4.1 days (2.7-8.1) for compliant; 3.1 days (2.1-6.5) for not compliant; $P = 0.12$. For the antibiotics group, median LOS was 3.8 days (2.2-6.8) for compliant; 3.9 days (3.2-3.9) for not compliant; $P = 0.71$.



11.4% or 19 of 167 patients in the cohort were transferred to the ICU at least once.

Table 2. Transfer to the ICU outcome data for each treatment group. There were no significant differences in transfers to the ICU in any of the exposure groups between those who received recommended care and those who did not.

ICU Transfers (number in group/total, (%))	Compliant	Not Compliant	Fisher's exact test p-value
Combined	13/113 (11.50%)	6/54 (11.11%)	0.62
Airway Clearance	13/119 (10.92%)	6/48 (12.5%)	1
Antibiotics	10/105 (9.52%)	0/5 (0%)	0.79

Discussion

Conclusions

- No statistical differences in hospital outcomes between patients who received care concordant and non-concordant with recommendations
- No evidence of negative consequences
- Limited by small sample size

Future Directions

- Multicenter implementation and study of outcomes
- Investigation of other outcomes and inclusion of likely confounding variables

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