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Impact of Infection Prevention and Control Initiatives on Acute Respiratory Infections in a Pediatric Long-Term Care Facility

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Abstract

We evaluated the collective impact of several infection prevention and control initiatives aimed at reducing acute respiratory infections (ARIs) in a pediatric long-term care facility. ARIs did not decrease overall, though the proportion of infections associated with outbreaks and average number of cases per outbreak decreased. Influenza rates decreased significantly.

Acute respiratory infections (ARIs) are burdensome in pediatric long-term care facilities (pLTCFs). Infection prevention and control (IP&C) interventions such as hand hygiene improvement, hiring IP&C personnel experienced in long-term care, prophylactic administration of oseltamivir, and staff and resident influenza vaccination have reduced outbreaks in adult long-term care.[1] However, pLTCFs present additional challenges due to the family-centered approach, on-site schools, age-related vulnerability to infections, high rate of device utilization, and behavioral factors that increase transmission (eg, uncontrolled secretions).[2]

Outbreaks in pLTCFs lead not only to morbidity and acute care hospitalizations for infected children but also to school closures and service reductions that affect quality of life for all residents.[3] Thus, preventing ARIs and limiting outbreaks are uniquely important in these settings. In this study, we implemented several IP&C interventions aimed at reducing ARIs in a pLTCF, and we compared the incidence of ARIs and related outcomes before and after implementation.

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METHODS

Study Population

This study was conducted from January 2009 through May 2015 at a 137-bed pLTCF in New York that provides subacute, long-term, and rehabilitative services (bed occupancy, 97%–100%). The mean age of residents was 9.7 years (range, 2 months–21 years), and the average length of stay was 477 days (range, 1–7,315 days). Residents were being treated with mechanical ventilation (6%), tracheostomies (36%), and gastrostomy tubes (80%). Most residents had neurological deficits (>90%) including cerebral palsy, brain anomalies, and/or hypoxic ischemic encephalopathy. Most residents (83%) attended an on-site Department of Education school, and a few residents (4%) attended schools in the community. The staff-to-resident ratio was 4:1 and included 7 onsite clinicians. This study was approved by the appropriate institutional review boards.

Infection Prevention and Control Policies

A single IP&C coordinator worked with medicine, nursing, and environmental services to conduct active surveillance and to develop IP&C policies. Resident influenza vaccination and ARI isolation policies remained consistent throughout the study. All residents without a contraindication (>95%) were vaccinated for influenza. Residents with ARIs (index cases) were placed on contact/droplet precautions until 48 hours after symptoms improved or the pathogen's shedding period passed, if the pathogen had been identified. The IP&C coordinator traced each case's contacts by reviewing bed locations, school rooms, and group activities. Asymptomatic contacts were placed on contact/droplet precautions until precautions were discontinued for the index case. Beginning in 2009, the facility implemented a series of initiatives aimed at reducing ARIs (Table 1).

Data Collection

The IP&C coordinator and a trained researcher collected data regarding the incidence of ARI outbreaks and cases associated with each, incidence of total ARIs and of ARIs unassociated with outbreaks, and number of ARI-related transfers to a separate acute care facility (eg, for respiratory distress). Date of onset, symptoms, and diagnostic testing results were recorded. The proportion of staff who received inactivated influenza vaccination was obtained from the facility's employee health service.

ARIs were identified using the IP&C coordinator's line list, medical records, in-house pharmacy database, and outside referral laboratory database. Case definitions were modified from the Society for Healthcare Epidemiology of America 2008 guidelines for adult long-term care.[4] ARIs were defined as (1) documented clinical diagnosis of upper or lower respiratory tract infection including pneumonia, tracheitis, and respiratory viral infections; (2) ≥2 documented symptoms (eg, abnormal temperature, cough, increased secretions, wheezing, vomiting/diarrhea, increased oxygen need, congestion, desaturation); and/or (3) positive laboratory test for a respiratory tract pathogen.

ARI outbreaks were defined as ≥2 cases of the same laboratory-confirmed pathogen or ≥2 cases on the same unit with the same symptoms.[3] Cases were considered part of an outbreak

if they occurred within the maximum incubation period of the pathogen defined by *Red Book*.[5]

Analysis

To analyze the collective impact of the interventions, we used Poisson regression to compare rates (incidence per 1,000 resident days) of total ARIs, ARIs unassociated with outbreaks, ARI-related transfers to acute care, use of viral diagnostic testing, and influenza before (January 2009–March 2012) and after (April 2012–May 2015) full implementation of the IP&C changes. Cases per outbreak were compared using the Student's *t* test. Analyses were conducted using SAS 9.1 (SAS Institute, Cary, NC).

RESULTS

From January 2009 through May 2015, 946 ARIs occurred in 251 residents (3.0 per 1,000 resident days). There were 107 outbreaks, with an average of 3.7 infections per outbreak. Of 549 ARIs, 58% were single infections unassociated with outbreaks. ARI-related transfers to acute care occurred 219 times; 39 of these resulted in hospitalizations. Laboratory testing was performed for 475 ARIs (50%). Tests included direct fluorescent antibody (n = 176), viral culture (n = 159), and/or reverse transcriptase polymerase chain reaction (n = 111). Test type was unknown for 201 samples (42%). Viral pathogens were identified for 267 ARIs (56%) and included parainfluenza (n = 75; 28%), rhinovirus/enterovirus (n = 56; 21%), influenza (n = 47; 16%), human metapneumovirus (n = 40; 15%), respiratory syncytial virus (n = 34; 13%), coronavirus (n = 7; 3%), and 2 cases (1%) had ≥1 virus. One resident died due to adenovirus.

Table 2 describes differences in ARI outcomes before and after implementation of the new policies. While the rates of total ARI and outbreaks increased ($P < .01$ and $P = .20$, respectively), the proportion of infections associated with outbreaks and the average number of cases per outbreak decreased ($P < .01$ and $P = .17$, respectively). Staff vaccination increased from an average of 65% during 2009–2013 (range, 44%–77%) to an average of 97% during 2013–2015 (range, 96%–98%), and incidence of influenza in residents decreased significantly.

DISCUSSION

We detected increases in ARIs and outbreaks after implementing IP&C initiatives, including a respiratory illness algorithm, enhanced screening for visitors and staff, mandatory staff influenza vaccination, and an 83% increase in facility size, which increased space between residents. We suspect that the observed increase may be due to greater case detection from improved surveillance and testing. Another contributing factor may be the doubling of mechanical ventilation beds after facility expansion, which elevated the average severity of illness among residents. We detected higher rates of ARI versus adult long-term care, 3.0 versus 1.2 ARIs per 1,000 resident days, respectively.[7] This result is not surprising considering the immunologic immaturity and behavioral characteristics of pediatric patients. Pathogens identified in our facility are similar to those reported by other pLTCFs, including influenza and adenovirus.[8,9]

Although ARIs increased overall, the rate of single infections unassociated with outbreaks increased and outbreak size decreased, suggesting that IP&C initiatives successfully curtailed the spread of ARIs. Because complete ARI prevention is likely infeasible, focusing on limiting transmission may have a strong impact on reducing resident morbidity, mortality, and facility-wide disruption of services due to isolation. Influenza rates also decreased significantly, likely due to high compliance with the staff vaccination policy. The respiratory illness algorithm was intended to reduce acute care transfers by providing information to help manage residents within the facility. However, no change was observed, possibly because 44% of the assays performed did not detect viral pathogens.

Because IP&C changes were implemented sequentially during a short period, it was impossible to isolate the effects of any single initiative. Detection bias likely resulted from enhanced surveillance and greater use of more sensitive and specific tests. Furthermore, consistent ARI documentation in this population is challenging due to the lack of pLTCF-specific case definitions.[10] High nursing turnover during facility expansion and turnover in the IP&C coordinator role may also have confounded our results. Nevertheless, our findings support the use of mandatory staff influenza vaccination and suggest that factors such as increased space between residents and heightened ARI symptom monitoring among staff may limit transmission within the facility once a case occurs.

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TABLE 1

Implementation of Infection Prevention and Control Policies and Procedures at a Pediatric Long-Term Care Facility

Date	Policy	Description
January 2009	Visitor ARI screening prior to facility entry	• Visitors with ARI symptoms are restricted from entering. Security guard administers symptom-based screening questionnaire to all visitors and informs IP&C coordinator or nurse manager if symptoms are reported or observed. • Visitors <13 years are restricted from facility's units October through May.
October 2010	Enhanced staff ARI screening	• Nurse managers monitor staff and refer to facility's employee health service if ARI symptoms are present. • Nursing office monitors daily staff absenteeism logs and refers reported ARI symptoms to IP&C coordinator for follow-up.
October 2010	Viral respiratory illness algorithm	• Symptom-based surveillance identifies residents with ARIs, and prompt testing for respiratory viral pathogens is performed. IP&C coordinator reviews daily reports of resident ARI symptoms (fever/change from baseline temperature, vomiting, new/increased secretions, increased oxygen requirement, cough) and performs daily rounds to review possible ARI cases with nurse managers. • Diagnostic testing is performed by referral laboratory if symptoms persist >48 h.[a] DFA is performed. If DFA is negative, viral culture is performed. If both tests are negative, RT-PCR is performed. DFA and PCR results are available within 48 h and culture results are available within 7 d.
March 2012	Facility relocation	• Increase in facility size from 90,000 to 165,000 square feet. Only 1 bed added (136 to 137 beds). No. of 4-bed rooms decreased from 34 to 12, allowing more space between residents.
March 2013	Mandatory staff influenza vaccination	• All staff are required to receive annual influenza vaccination. Staff with contraindications or documented religious exemptions are required to wear masks for the duration of the influenza season, defined annually by the New York State Department of Health. Unvaccinated staff without exemptions are suspended until vaccine is received.

NOTE. ARI, acute respiratory infections; IP&C, infection prevention and control; DFA, direct fluorescent antibody; RT-PCR, reverse transcriptase polymerase chain reaction.

[a]DFA tests for adenovirus; RSV; parainfluenza 1, 2, 3; influenza A and B; and metapneumovirus. Viral culture tests for adenovirus; RSV; parainfluenza 1, 2, 3; and influenza A and B. RT-PCR tests for adenovirus; coronavirus HKU1, NL63, 229E, OC43; human metapneumovirus; human enterovirus/rhinovirus; influenza A; influenza A/H1; influenza A/H3; influenza A/H1 − 2009; influenza B; parainfluenza viruses 1, 2, 3, 4; respiratory syncytial virus; Bordetella pertussis; *Mycoplasma pneumoniae*; and *Chlamydophila pneumonia*.

TABLE 2

Acute Respiratory Infections, Outbreaks, and Use of Viral Diagnostic Testing Before and After Implementation of New Infection Prevention and Control Policies

Monitored Item[a]	Before Implementation, Jan 2009–Feb 2013	Post Implementation, Mar 2013–May 2015	*P* Value
Total ARI[b]	2.5	3.9	<.01
ARI not associated with an outbreak[b]	1.3	2.4	<.01
ARI outbreaks[b]	0.3	0.4	.20
Cases per outbreak[c]	3.8	3.6	.17
Transfers to acute care[b]	0.7	0.7	.15
Viral diagnostic testing[b]	1.3	1.9	<.01
Influenza cases[a]	2.0	0.1	<.01

NOTE. ARI, acute respiratory infection.

[a]Includes data previously reported during an outbreak of human metapneumovirus in 2010.[6]

[b]Incidence per 1,000 resident days. Differences assessed using Poisson regression.

[c]Mean. Differences assessed using the Student *t* test.