

Impact of Nonpharmaceutical Interventions During the COVID-19 Pandemic on Medically Attended Acute Respiratory Infection: The U.S. Naval Academy Experience

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ABSTRACT

Introduction:

Medically attended acute respiratory infections (MAARI) at the U.S. Naval Academy increase during Plebe Summer, a training program for incoming freshmen. Because of COVID-19, extensive nonpharmaceutical interventions (NPI) were implemented during 2020 Plebe Summer.

Methods:

We reviewed MAARI counts in weeks 22–45 from 2012 to 2020 and compared counts in pandemic (2020) vs. pre-pandemic (2012–2019) periods.

Results:

From 2012 to 2019, an average of 1,642 MAARI cases occurred annually. In 2020, 443 MAARI cases occurred. NPI use was associated with a 77% reduction in MAARI.

Conclusions:

During a high-risk military training period, routine NPI use was associated with a major reduction in MAARI.

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INTRODUCTION

As a result of the COVID-19 pandemic, non-pharmaceutical interventions (NPI) became a common public health control measure for the prevention of disease. These include wearing of face masks, increased hand hygiene, social distancing practices, school and work closures, and travel restrictions.¹ In numerous settings, widespread adoption of NPI has led to significant reductions in rates not only of COVID-19 but of other acute respiratory infections (ARI) as well.^{2–5}

ARI prevention is particularly important for colleges and universities, where the congregation of large numbers of students in shared educational, living, and social settings increases the risk of disease outbreaks.⁶ At the U.S. Naval Academy (USNA), rates of medically attended ARI (MAARI) typically increase in the months of July and August, when incoming freshmen embark on a rigorous physical conditioning and military training program known as Plebe Summer. A preponderance of ARI risk factors during this period (e.g., close proximity areas [dormitory housing, shared dining facilities, and large gathering events] and physiologic/psychologic stress) likely accelerates the transmission of respiratory pathogens, leading to outbreaks of ARI.⁷

Plebe Summer in 2020 commenced on June 28th. A total of 1,200 Plebes and 500 “Detailers” (upperclassmen who lead training activities) arrived from 50 states and 13 countries. COVID-19 risk mitigation strategies were extensive, including: the staggered arrival of Midshipmen over a 5-day period; universal SARS-CoV-2 testing upon arrival; a 14-day quarantine period; repeat SARS-CoV-2 testing at the end of

quarantine; physical isolation and symptom monitoring of individuals who tested positive for SARS-CoV-2; physical isolation and symptom monitoring of those individuals' close contacts; daily temperature checks and monitoring for respiratory symptoms for all Midshipmen; the assignment of Plebes to 50-member companies and prohibited interactions with Plebes from other companies; and the use of socially distanced and/or online training modules when feasible. We evaluated the effectiveness of these strategies for the prevention of MAARI at USNA using historical data as a comparison.

METHODS

In collaboration with the Navy Marine Corps Public Health Center EpiData Center (Portsmouth, VA), we conducted a retrospective review of USNA MAARI data from 2012 to 2020. Nonemergency medical care for all Midshipmen is provided through the Brigade Medical Unit (BMU), located in the single dormitory in which all Midshipmen reside. ARI-associated medical encounters at the BMU were identified through a search of the Military Health System Data Repository (MDR) using ARI-specific ICD-9 and ICD-10 diagnostic codes. Because we were specifically focused on the risk period spanning the start of Plebe Summer (late June/early July) and the start of the academic year (late August/early September, when second- to fourth-year Midshipmen return to campus), we restricted the MDR data query to calendar weeks 22–45 of each year.

We conducted an interrupted time series (ITS) analysis to evaluate the impact of NPI on MAARI counts in

2020. ITS analysis has particular utility in the evaluation of health outcomes when disease interventions are employed at a population level.⁸ Weekly MAARI counts in pre-COVID-19 pandemic years (2012–2018) were fitted to a Seasonal Autoregressive Integrated Moving Average (SARIMA) model.⁹ Model estimates were then used to predict the weekly number of MAARI counts at USNA that would have occurred in 2020 had no ARI prevention strategies been implemented. Because routine vaccination of Plebes for adenovirus was initiated in 2019 and continued in 2020, model forecasts were based on MAARI counts from 2012 to 2018.

Following diagnoses of model fit, an ARIMA(1,0,1)(2,1,0)₂₄ model was selected for the forecast of MAARI counts. Assuming that universal use of NPI in 2020 would have an immediate impact on MAARI counts at USNA, the magnitude of the impact was calculated as the mathematical difference between estimated and observed weekly counts. Analyses were conducted in R Studio (RStudio: Integrated Development for R. RStudio, PBC, Boston, MA).

RESULTS

From 2012 to 2020, there were a total of 13,579 cases of MAARI between calendar weeks 22 and 45. MAARI case counts in pre-COVID-19 pandemic years averaged 1,642 per year, ranging from 1,040 (2014) to 2,230 (2018; Fig. 1). By contrast, there were 443 cases of MAARI in 2020. Every year, case numbers were highest between weeks 28 and 33, roughly spanning the start of Plebe Summer in mid-July through the start of the academic year. Notable peaks of

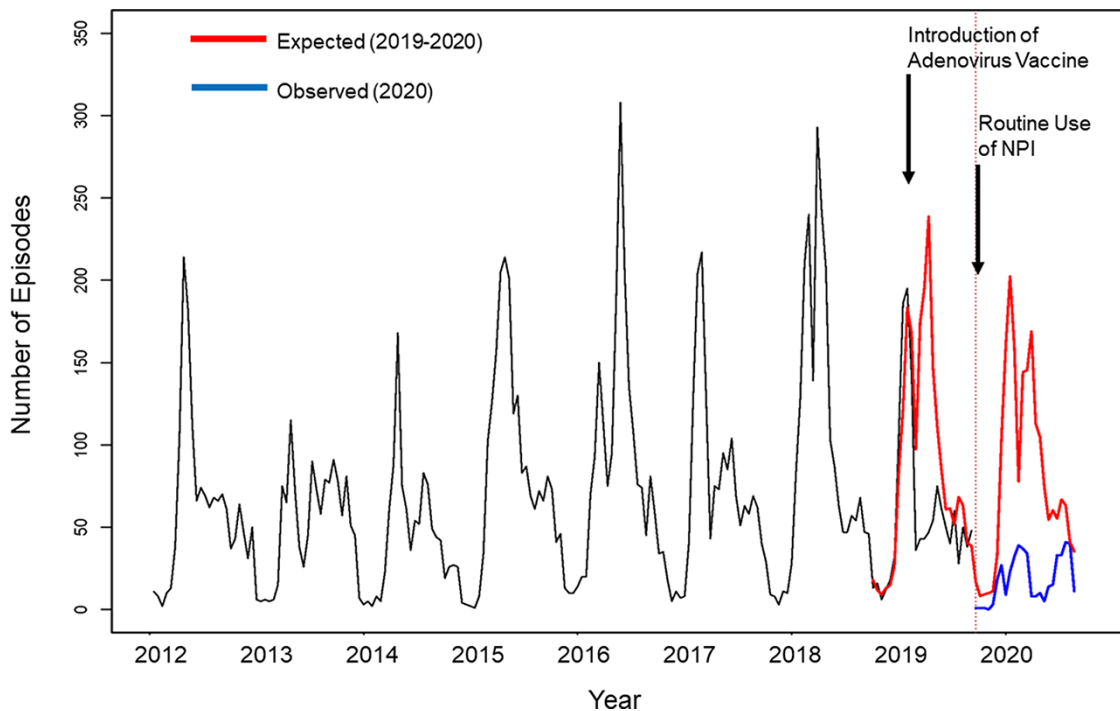


FIGURE 1. Time series analysis of MAARI data at USNA using a seasonal autoregressive integrated moving average (SARIMA) model. The red (upper) lines in 2019–2020 represent model forecasts (i.e., expected counts). The blue (lower) line in 2020 represents observed counts.

MAARI in 2016 and 2018 were attributed to outbreaks of adenovirus-associated respiratory illness that started during the summer training program and extended several weeks into the academic year (Modi J, IDWeek 2020).⁷

The model forecasted a total of 1,920 MAARI cases in 2020, whereas 443 MAARI cases were observed. Taken together, the widespread use of NPI in 2020 was associated with a 76.9% (95% CI: 75%–78.8%) reduction in the weekly number of MAARI cases. The comparison of estimated versus observed MAARI case counts for 2019, when routine adenovirus vaccination was implemented, demonstrated a 32.8% (95% CI: 30.8%–34.8%) reduction in the weekly number of MAARI cases.

DISCUSSION

The COVID-19 pandemic has highlighted how persons in communal settings, including colleges and universities, are at increased risk for SARS-CoV-2 infection.^{10,11} The findings of our study—conducted at a 4-year military service academy where students continued to live in dormitory-style housing at capacity, use shared bathroom facilities, participate in mission-essential training, and attend in-person classes—demonstrated that the adoption of the aforementioned NPI contributed to a 77% reduction in clinic visits for ARI during a period of the year when the peak incidence of respiratory disease is historically observed.

The impact of NPI on rates of COVID-19 and other ARI has been reported in other settings.^{2–4} An analysis of nationwide data from China revealed that the mean incidence of influenza in the 2019–2020 season was 64% lower than that of the prior two seasons; disease trends were strongly correlated with the implementation of strict measures to control COVID-19 (e.g., travel bans, suspension of public transportation, and banning of mass gatherings).⁴ In the Republic of Korea, nationwide implementation of NPI due to COVID-19 was associated with significant reductions in rates of chickenpox and mumps.³ Similar declines in rates of influenza A, influenza B, and respiratory syncytial virus were reported from two cities in the United States in the early months of the pandemic.⁵

ARI have posed a long-standing burden of illness on Midshipmen at USNA since the establishment of the institution in 1845.¹² Both viral and bacterial pathogens have been associated with large outbreaks of disease.^{7,13} A longitudinal study of ARI revealed that 80% of Plebes had experienced respiratory symptoms over the course of an academic year, with 15% reporting that respiratory illness had moderately or greatly affected their performance.¹³ In 2019, following outbreaks of adenovirus-associated respiratory illness in prior years, USNA adopted routine adenovirus vaccination for all incoming Plebes.

There are several strengths to this study. First, the data represent 9 years of clinical encounters at the sole, on-campus health care facility that serves the entire USNA student body. Consequently, the data represent nearly 100% of medical

encounters for our population and account for secular trends and year-to-year variability in medical encounters for ARI. Second, whereas many U.S. colleges and universities drastically reduced the on-campus student population due to the COVID-19 pandemic, the USNA population of ~4,500 Midshipmen continued with in-person experiences in the classrooms, in training, and in the dormitory. Third, because USNA is a military service academy where students follow a chain of command, universal adherence to COVID-19 prevention strategies was strictly enforced. There are limitations to our study. First, this is an ecological analysis. The decrease in MAARI rates was temporally associated with the adoption of NPI at USNA, but more robust study designs (e.g., cohort studies and randomized trials) are needed to determine causal association. Second, the use of ICD-9/ICD-10 codes is subject to misclassification error. Some patients presenting with ARI may have been assigned a diagnostic code that was not included in our search. Third, because viral PCR and/or culture panels are not routinely collected from Midshipmen who sought care for ARI, we were not able to determine the etiology of illness. Altogether, this study demonstrates that disease forecasting tools have utility for operational planning and hypothesis generation but that the output of statistical models are inherently imprecise and, therefore, warrant careful interpretation.

The sudden emergence of SARS-CoV-2 and the rapidity with which COVID-19 became a pandemic highlights the magnitude of the risk that novel respiratory pathogens can impose upon the health of military personnel in congregate settings.^{14,15} The absence of vaccines, immunoprophylaxis, and therapeutic options required full reliance on NPI to prevent outbreaks of COVID-19 at USNA. Our data demonstrate that widespread adherence to NPI dramatically reduced rates of all-cause MAARI in a congregate military population during a particularly high-risk period. Routine use of NPI, whether in pandemic or nonpandemic settings, is an important strategy to prevent ARI among military personnel in congregate living situations.

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CONFLICT OF INTEREST STATEMENT

J.M. has received personal fees from GSK, outside of the area of work commented on here.

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