Seasonality in testing and positive respiratory bacterial infections in the Australian Capital Territory, 1997-2007

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Introduction

- *Chlamydia pneumoniae* (Cp) and *Mycoplasma pneumonia* (Myco) bacteria are atypical pathogens that can cause pneumonia and exacerbate asthma and chronic obstructive pulmonary disease (COPD).
- Commonly-used serological detections are complicated by false negative results in the early acute phase of infection) and the epidemic peak is short.
- Identifying seasonal patterns of Cp and Myco infections is necessary to efficiently allocate public health resources, to guide early prevention, and to establish vaccine priorities.

Method

- This study is based on de-identified data collected from August 1998 to March 2007 and extracted from ACT Pathology Laboratory databases located in the Canberra Hospital.
- Pathology data were collected from patients with respiratory diseases who underwent testing for Cp and/or Myco infections. For Myco, a result of < 40 is recorded as negative and ≥ 40 as positive for the infection. For Cp, a result of < 0.9 is recorded as negative, and ≥ 0.9 as positive.
- Additive time series decomposition was performed to identify long-term trend, seasonal and random components in the observed counts and proportions
- Time series regression models were fitted using generalised least squares (GLS)
- The model comprised an overall mean, long-term linear and quadratic trends; seasonal components for the 12 months; and a random error assumed to be normally distributed with an ARMA error structure estimated from the data.

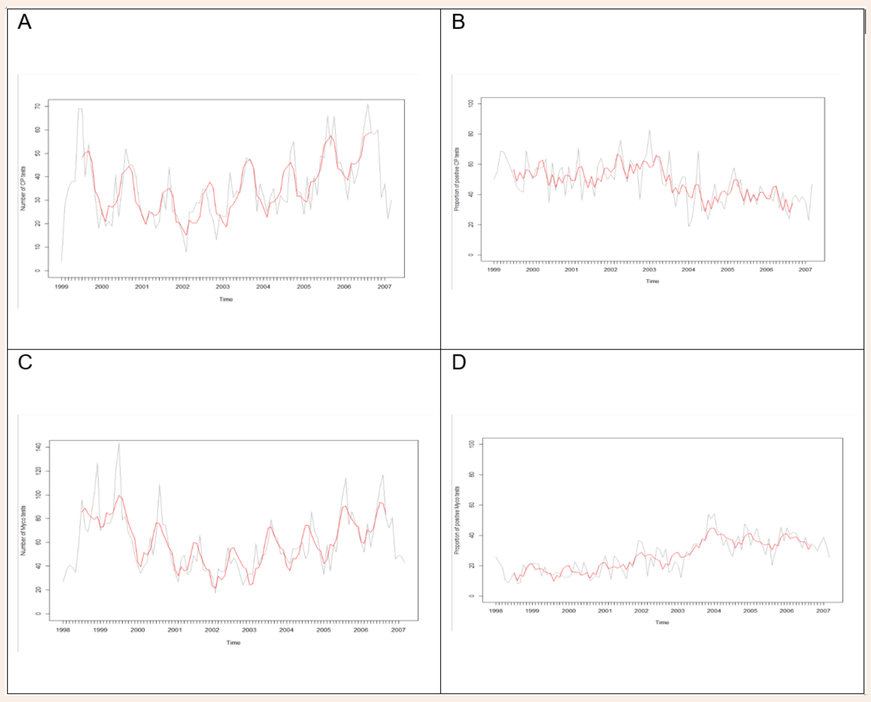

Fig. 1. Time series plot and additive decomposition observed time series line (gray) with trend and seasonal line (red). **A. Monthly number of Cp tests. B. Monthly proportion of positive Cp tests. C. Monthly number of Myco tests D. Monthly proportion of positive Myco tests.**

Table 1. Regression models for Cp

Model	Number of tests			Proportion of positive tests		
Coefficient	Value	SE[a]	p	Value	SE[a]	p
AR(1)	0.44	–[b]	–[b]	–	–	–
AR(2)	0.32	–[b]	–[b]	–	–	–
MA(1)	-0.03	–[b]	–[b]	0.17	0.10	0.0891
MA(2)	–	–	–	–	–	–
Intercept	-11.78	19.04	0.5376	81.41	7.23	**< 0.0001**
Year[c]	2.76	1.42	0.0549	-2.72	0.56	**< 0.0001**
February	-0.96	3.69	0.7961	-0.2	4.66	0.9657
March	5.94	3.79	0.1199	10.37	5.13	0.0462
April	6.22	4.46	0.1663	10.23	5.38	0.0606
May	7.21	4.65	0.1253	1.86	5.41	0.7300
June	13.50	4.84	**0.0065**	-4.75	5.42	0.3827
July	18.77	4.89	**0.0002**	1.55	5.42	0.7756
August	20.17	4.87	**0.0001**	-6.57	5.42	0.2285
September	21.65	4.74	**< 0.0001**	-0.69	5.41	0.8991
October	17.72	4.51	**0.0002**	-3.77	5.39	0.4862
November	8.83	4.01	**0.0304**	-1.36	5.16	0.7931
December	5.14	3.95	0.1961	3.00	4.70	0.5253

a SE: standard error.
b Not able to be calculated due to non-positive definite covariance matrix.
c Year: years since 1990.

Table 2. Regression models for Myco

Model	Number of tests			Proportion of positive tests		
Coefficient	Value	SE[a]	p	Value	SE[a]	p
AR(1)	0.65	0.09	**0.0228**	0.81	0.17	**<0.0001**
AR(2)	–	–	–	–	–	–
MA(1)	–	–	–	-0.36	0.13	0.0056
MA(2)	–	–	–	–	–	–
Intercept	169.61	63.63	**0.0089**	-2.78	8.27	0.7377
Year[b]	-23.00	11.02	**0.0394**	2.72	0.63	**<0.0001**
Yearsq[c]	0.97	0.46	**0.0368**	–	–	–
February	-0.31	5.38	0.9540	-3.88	2.22	0.0840
March	8.56	6.90	0.2177	-4.69	2.48	0.0614
April	7.73	7.88	0.3289	-4.79	2.73	0.0827
May	11.17	8.37	0.1851	-6.19	2.86	**0.0326**
June	25.00	8.59	**0.0044**	-5.70	2.92	0.0541
July	37.49	8.56	**<0.0001**	-4.96	2.91	0.0910
August	37.95	8.49	**<0.0001**	-8.56	2.89	**0.0037**
September	27.85	8.26	**0.0011**	-3.89	2.83	0.1714
October	22.81	7.82	**0.0043**	-5.70	2.71	**0.0384**
November	18.15	7.03	**0.0113**	-0.51	2.55	0.8412
December	11.47	5.56	**0.0417**	0.52	2.30	0.8202

a SE: standard error
b Year: years since 1990.
c Yearsq: years since 1990 squared.

Results

- The data set comprised tests from 7275 patients from August 1997 to March 2007. There were 1633 individuals who tested positive only for Cp infection; 1880 tested negative, with 3513 total tests.
- There were 1787 individuals who tested positive only for Myco infection; 5182 tested negative, with 6969 total tests. Finally, there were 356 individuals who tested positive for both Cp and Myco. These infections were included in both datasets.
- The highest total numbers of patients tested for Cp infection and Myco infection were noted in the spring and winter periods, respectively (Figures 1 – 2)
- Pneumonia caused by Cp was most often observed in autumn (March and April), while pneumonia caused by Myco was most commonly observed in summer (December and January).
- The lowest proportion of pneumonia cases caused by these two microorganisms was noted in winter (June and August).
- Regression model parameter estimates (Tables 1 – 2) also show that the error structure varied across models.
- Best fitting autocorrelation models were for Cp, ARMA(2,1) for number of tests and MA(1) for proportion of positive tests; and for Myco, AR(1) for number of tests and ARMA(1,1) for proportion of positive tests.

Discussion

- The current research concentrates on testing rather than on the diagnosis of infection, thus our focus is on workforce planning at the testing end of the disease cycle.
- By analysing the positive cases in proportion to testing we get less clear but different seasonal patterns, with a peak for Myco in December and January and a peak for Cp in March.
- This can help target resource allocation and identify the underlying mechanisms of seasonality, which are less likely to be an artefact of increased testing. The high proportion of positive Myco infections in summer may be due to behavioural factors or climatic factors such as temperature.
- In this study, for both Cp and Myco infections, we show seasonal patterns of testing and of the proportion of positive tests, findings which have important implications for public health control of these infections. High testing in certain seasons may dilute the positive rate, since the numerator (actual positive infection patients) is unchanged but the denominator (patients tested for infection) increases. This could cause an incorrect estimation of the actual peak of infection because the total number of tests will dilute the positive proportion. Often, testing data for infections is not available, with recording only of the number of confirmed positive cases. Consequently, the public health response to the actual peak of infection may be misdirected due to a testing artefact rather than an actual increase in infection. This could potentially lead to misallocation of health responses to controlling the peak of infection, as well as a focus on the wrong potential drivers of the infection.
- The proportion of positive Cp and Myco infections may be affected by many other factors not accounted for in this study, for example age and gender. In addition, the analysis was conducted only for patients who were tested; accordingly, not all cases in the community were represented, so there are no estimates of actual community burden. As individuals with Myco infections typically experience mild disease symptoms or no symptoms at all, many may not seek health care, leading to under-ascertainment.
- We provide a population-level view of how testing for respiratory bacterial pathogens has changed across seasons and over time in the ACT. Future research should examine the role of weather-related factors (e.g., rainfall, temperature, humidity) and should examine more diverse populations to improve the generalisability of the findings. Combining findings from this and other research will help to develop more accurate estimates of seasonality in bacterial respiratory infections from routinely collected data.