The reducing incidence of respiratory tract infection and its relation to antibiotic prescribing

Douglas M Fleming, Andrew M Ross, Kenneth W Cross and Helen Kendall

SUMMARY

Background: *There is good evidence of reduced prescribing of antibiotics in recent years, but the reason for this has not been established.*

Aim: *To study the incidence of respiratory tract infections presenting to general practitioners (GPs) in England and Wales in relation to the incidence of other infections and to the prescription of antibiotics.*

Setting: *Sentinel practices in England and Wales who contribute to the Weekly Returns Service (WRS) of the Royal College of General Practitioners.*

Design: *Time-series analysis of disease incidence data reported by the practices and of antibiotic prescription data from the Prescription Pricing Authority (PPA) during the years 1994–2000.*

Method: *Incidence data reported weekly from 73 practices in England and Wales, serving a population of 600 000, for acute respiratory tract infections, otitis media, infectious mononucleosis, shingles, urinary tract infections, and skin infections, were consolidated into quarterly datasets and examined graphically for evidence of secular and seasonal trends. Trends in antibiotic prescription items (data for England only were supplied by the PPA) were examined for association after adjustment for seasonal variation.*

Results: *The incidence of respiratory tract infections and antibiotic prescribing showed virtually identical seasonal variation, with both declining from 1995: respiratory tract infections by 48% in winter and 38% in summer, and antibiotic prescriptions by 34% and 21%, respectively. Trends in both were very highly correlated. The incidence of shingles and skin infections was constant. The incidence of urinary tract infections declined by 10%. The incidence of otitis media in children and acute bronchitis in the elderly followed the all-age trend in the reduction of respiratory tract infections.*

Conclusion: *The considerable reduction in the incidence of respiratory tract infections between 1995 and 2000 is the main reason for the decline in antibiotic prescribing rather than changing prescribing thresholds for antibiotics.*

Keywords: *antibiotic; prescriptions; respiratory tract infections; time factor; analysis; prevalence; data collection.*

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Introduction

WE have previously reported a peaking of the incidence of asthma episodes and acute bronchitis in the years 1993–1994 using data from the Weekly Returns Service (WRS) of the Royal College of General Practitioners, with a continuing decrease in incidence onwards to 1997.[1] In this paper we examine trends in the incidence of respiratory tract infection since 1994 in relation to recent trends in antibiotic prescribing. The injudicious prescribing of antibiotics is a matter of concern because of fears over the emergence of antimicrobial resistance; to this end, the SMAC (Standing Medical Advisory Committee) report in 1998[2] contained strategies to reduce antibiotic prescribing in primary care.

Based on data collected in the Fourth General Practice Morbidity Survey (carried out between 1991 and 1992), it was estimated that 41% of the population consult each year because of infection and that 40% of all episodes of illness are caused by infections as defined by Wilson and Bhopal.[3,4] Respiratory tract infections accounted for half of the infection episodes.

Using total prescription data for England, as reported by the Prescription Pricing Authority (PPA), Davy *et al* drew attention to the rising numbers of antibiotic prescriptions between the years 1980 and 1991 — an increase of 45%.[5] Wrigley *et al* have reported decreased antibiotic prescribing between 1994 and 1998, as recorded on practice computerised records for the General Practice Research Database in England.[6] McCaig *et al* reported a 48% increase in the prescribing of antibiotics for children by office-based physicians in the USA between 1980 and 1992. In a further study, she and her colleagues used national ambulatory medical care survey data to study antibiotic prescribing in persons under 15 years of age.[7] In a complex sampling procedure involving between 2500 and 3500 physicians, they studied a sample averaging three paediatric patients per physician in each of six 2–year periods between 1989 and 2000. They reported highly significant prescribing reductions over the period in both population- and office-based visit (consultation) rates. For five respiratory tract infections considered in combination, the population-based prescribing rate decreased by 44%, and considerably exceeded the 14% reduction in office-based visit rates. In discussing the results, they commented that, without incidence data for the respiratory tract infections, they could not determine to what extent changes in disease incidence may have affected the office visit- and population-based rates.

Method

Weekly data on new episodes of illness collected in the WRS during the years 1994 to 2000 (inclusive), were considered.[8]

HOW THIS FITS IN

What do we know?

Respiratory tract infections are a major determinant for prescribing antibiotics in primary care. Prescriptions for antibiotics have been declining in recent years.

What does this paper add?

A reduced incidence of respiratory tract infections is the main reason for the reduction in antibiotic prescribing.

On average, the surveillance network covered 73 practices, with a population of 600 000. The disease groups examined included respiratory tract and other infections. Respiratory tract infections included: acute respiratory tract infections (ICD [International Classification of Diseases. 9th Revision] 460–466), pneumonia and influenza (ICD 480–487), and chronic obstructive pulmonary disease (COPD [ICD 490–496]). Data for COPD included asthma attacks in which there were episodes of illness where asthma was out of control, usually secondary to respiratory tract infection,[9] but ongoing consultations for repeat prescribing or continued management were not included. Other infections examined were: shingles (ICD 053), infectious mononucleosis (ICD 075), acute otitis media (ICD 381.0, 382.0, and 382.9), urinary tract infection (ICD 595 and 599), and infections of the skin and subcutaneous tissue (ICD 680–686).

The numbers of illness episodes reported each week were consolidated into quarterly periods (weeks 1–13, 14–26, 27–39, and 40–52) and the mean weekly incidence per 100 000 population in each quarter was calculated. In 1998, which included a week 53, data for weeks 52 and 53 were averaged. Trends in incidence of the above diagnostic groups were examined graphically. The PPA supplied comparable quarterly data on antibiotic prescribing in England.[10] These data are based on total prescription items dispensed by pharmacies and dispensing doctors. A time-series analysis was made of the quarterly data for the incidence of acute respiratory tract infections and for the antibiotic prescriptions dispensed. The seasonal component was removed using the well-known method described by Kendall,[11] and the resultant trends examined.

Results

The mean weekly incidence of acute respiratory tract infections and COPD (all ages, males and females per 100 000) in each quarter is summarised graphically for the 7–year period 1994–2000 (Figure 1). More than 90% of all respiratory tract infections are included in these two categories. In each quarter and for each category there was a sharp decrease from 1995: for the two winter quarters the decreases were roughly equivalent to a 50% reduction in incidence by the end of year 2000, and 40% for the two summer quarters. Examination of comparable data for pneumonia and influenza (not presented) did not show any consistent pattern, largely because of the impact of influenza epidemics in quarters 1 and 4 in 1995 and quarter 1 in 1997 when rates were particularly high. However, there was a suggestion of a downward trend in quarters 2 and 3, which was attributable to a reduction in the incidence of pneumonia (ICD 480-486).

The incidence of skin infections and shingles has remained seasonally and annually constant over the 7–year period. The incidence of urinary tract infection, although seasonally constant, has fallen by about 10% over the 7 years (Figure 2).

Incidence data for infectious mononucleosis (all ages), otitis media (children aged between 0 and 4 years), and acute bronchitis (in people aged 75 years and over) are given in Figure 3. Decreasing trends are evident for all of these examples.

The quarterly series of mean weekly incidence of acute respiratory tract infections and the number of antibiotic prescriptions dispensed over the 7 years are shown in Figure 4. The patterns of declining values, from peaks in 1995, and of quarterly variation, were very similar in the two series. The reductions in the incidence of infections were: 48% in the winter and 38% in the summer quarters, compared with reductions in antibiotics of 34% in winter and 21% in summer. There was a very close association between the two sets of data (Pearson correlation coefficient = 0.98).

The trend in the continuous series of quarterly incidence rates (per 1000) is contrasted with that of the quarterly number of prescriptions (per 100 000) after adjusting for seasonality in both series. Logarithms of the resulting trend values are plotted in Figure 5. After seasonal adjustment, the decline in incidence rates remained more pronounced than the decline in prescriptions. Values for the last quarter of 2000 were, respectively, 49% and 36% of the peak values in the fourth quarter of 1995.

Although not presented here, it was found that when these two trends were modelled by regression analysis they were both best fitted by cubic curves — implying that the reductions are petering. However, the effect of individual epidemic diseases, such as influenza, limit the use of these data for predictive purposes and therefore this theme was not developed.

Discussion

Findings

This analysis demonstrates a reduction in the incidence of respiratory tract infections presenting to doctors during the years 1994–2000, and a smaller but similar reduction in the trend of antibiotic prescriptions. Reduced incidence was seen consistently in all quarters, in all types of respiratory tract infection, and in all age groups (data not presented). There were no reductions in the incidence of skin infections and of herpes zoster, and only minimal reductions in the incidence of urinary tract infections over the same time period.

Methodological issues

Recording doctors are required to summarise the morbidity content of each consultation together with its episode type. The data are consolidated from weekly reports from sentinel practices covering all consultations. The practices are widely distributed across the country and the population is representative by age and sex of the national population.[8] Reporting within the practices has been validated by com-

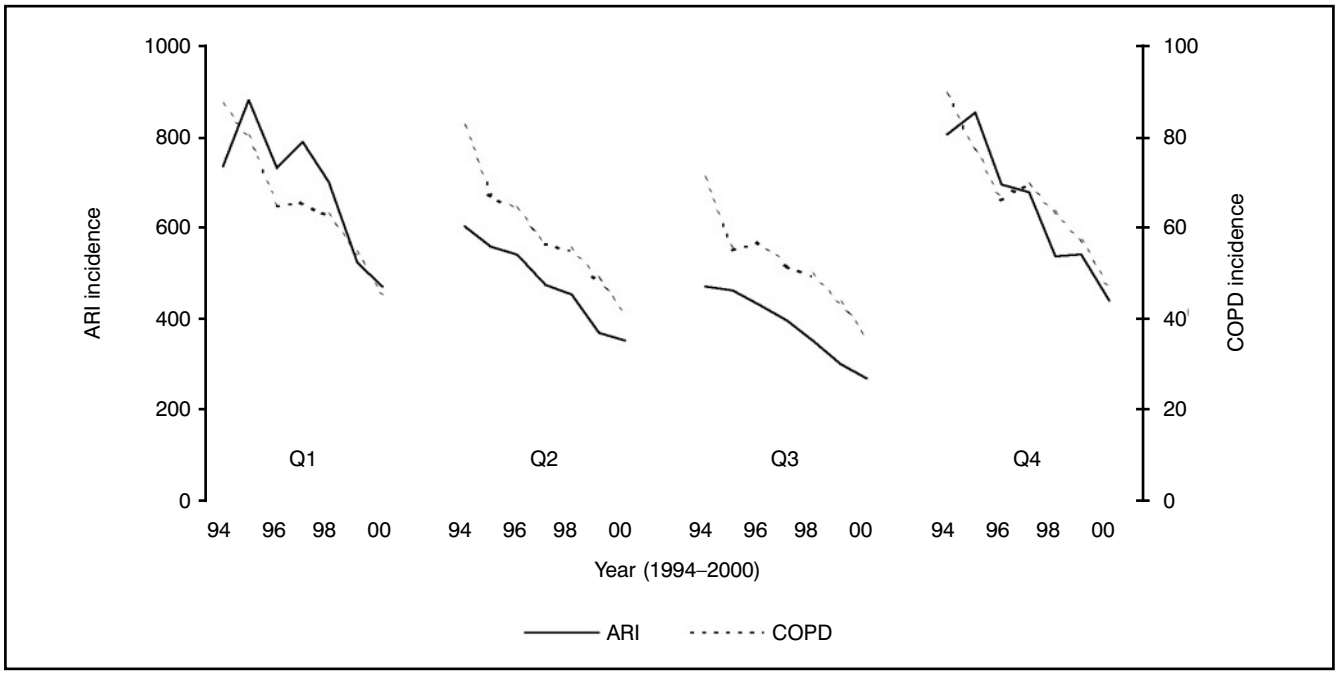

Figure 1. Mean weekly incidence per 100 000 of acute respiratory infections (ARI) and chronic obstructive pulmonary disease (COPD) by quarter and year.

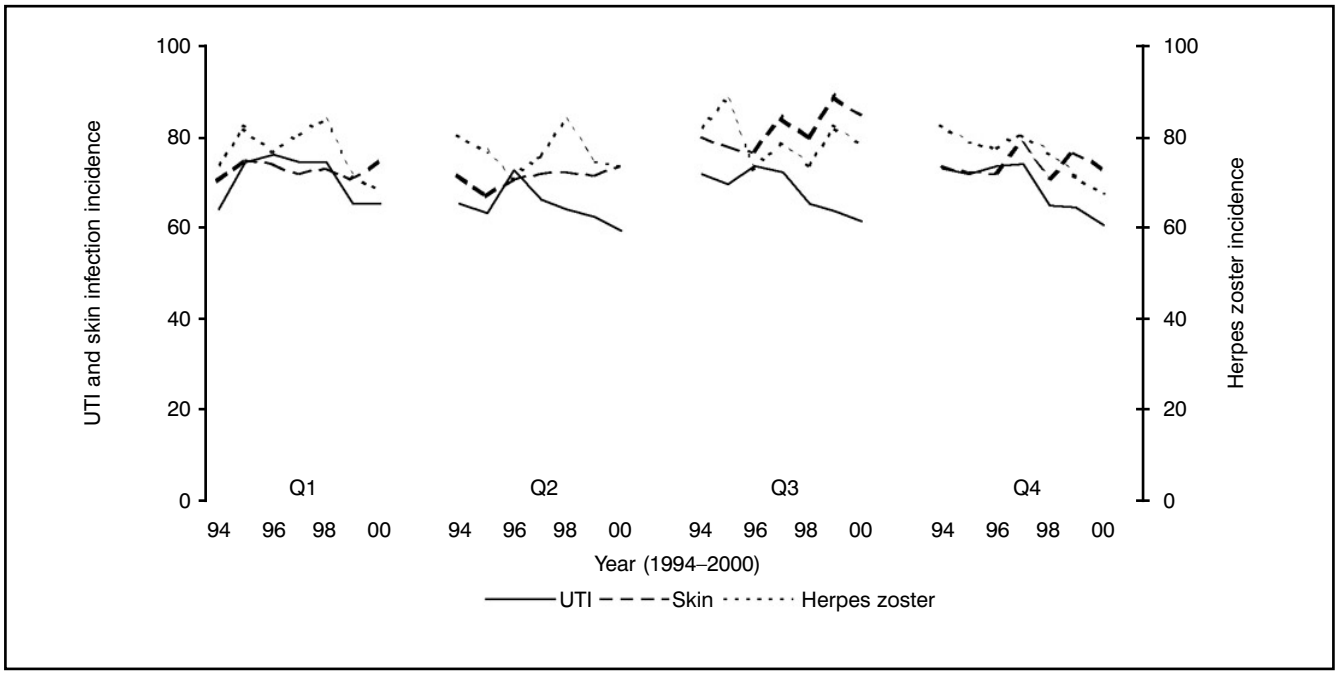

Figure 2. Mean weekly incidence per 100 000 of urinary tract infections (UTIs), skin and subcutaneous tissue infections, and herpes zoster by quarter and year.

parison with hospital admission data for asthma,[12] and by comparison with virological data for influenza.[13]

In a previous report comparing trends in the incidence of asthma and acute bronchitis, we have demonstrated that there is no evidence of a shift in diagnostic preference between these conditions. Likewise, in this study there are reductions across upper and lower respiratory tract infections, indicating no change between the two in preferred diagnostic usage. The concept that doctors could have labelled illnesses in ways that rationalised their prescribing[14] would have produced a swing away from lower and towards upper respiratory tract infections if they wished to avoid prescribing antibiotics, but there has been a reduction in the incidence of upper respiratory tract infection that is even greater than that of lower respiratory tract infection. For persons presenting with upper respiratory tract infection, the only other place to record the consultation would be in the symptom diagnostic category 'respiratory and chest symp-

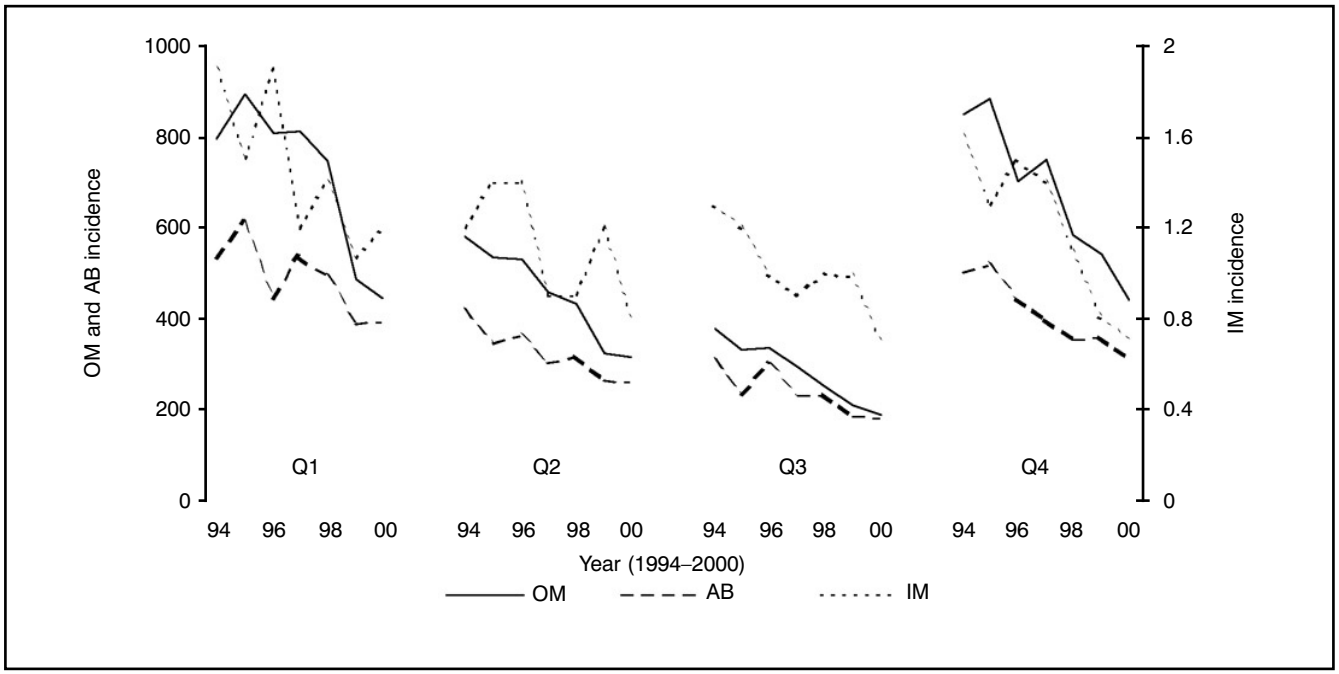

Figure 3. Mean weekly incidence per 100 000 of acute otitis media (OM [in children aged 0–4 years]), acute bronchitis (AB [in patients aged 75 years and over]), and infectious mononucleosis (IM [all ages]) by quarter and year.

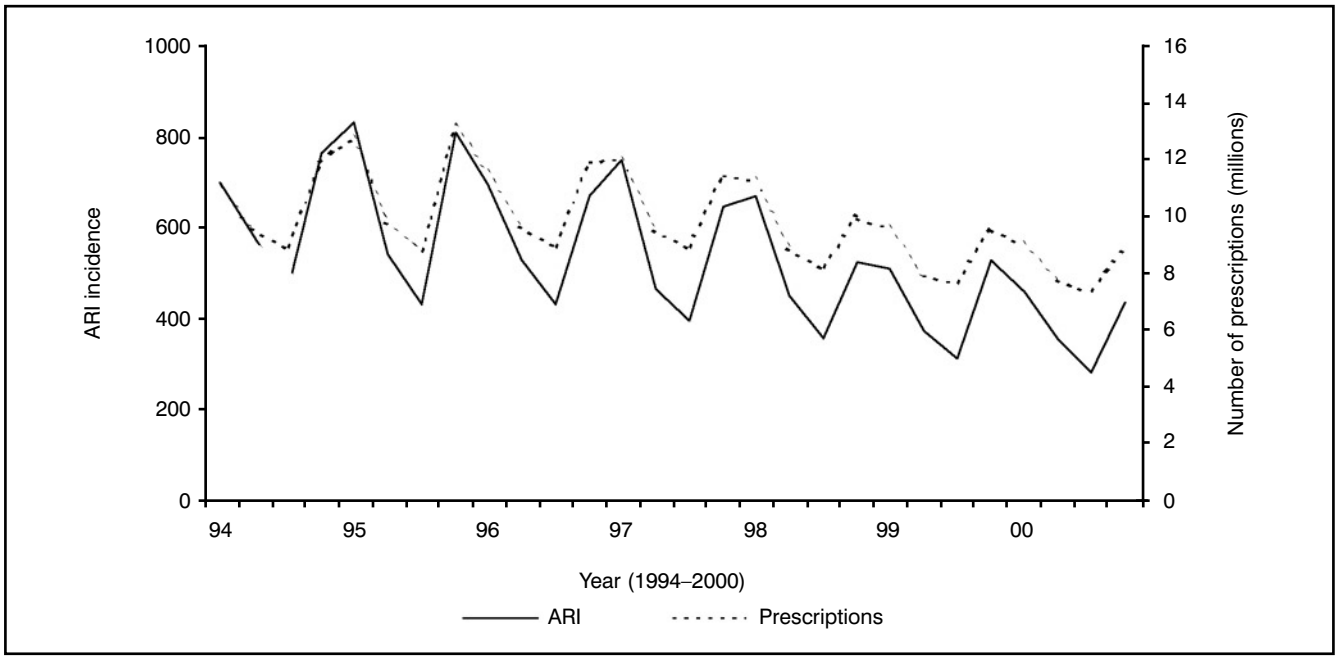

Figure 4. Mean weekly incidence of acute respiratory infections (ARI) versus number of prescriptions for antibiotics.

toms' (ICD9 786), incidence rates of which are about a tenth of those for respiratory tract infections, and which have been constant in recent years, indicating no change in recording practice.

There have been changes in out-of-hours cover over the study period, but doctors reporting in the network are required to collect deputising service data. The introduction of NHS Direct is too recent to have any bearing on the findings, save in the final year reported. We have, however, established that the introduction of NHS Direct did not impact on the practice recording rates for respiratory tract infections over the millennium period.[15]

There are both viral and bacterial causes of respiratory tract infection, but many bacterial infections are complications of viral illness. It is impossible to distinguish the two clinically, and diagnostic labels routinely used in primary care offer no possibility of separating them.

From the epidemiological perspective, the level of respiratory tract infection in the entire community (whether consulting or not), is the theoretical background in which to

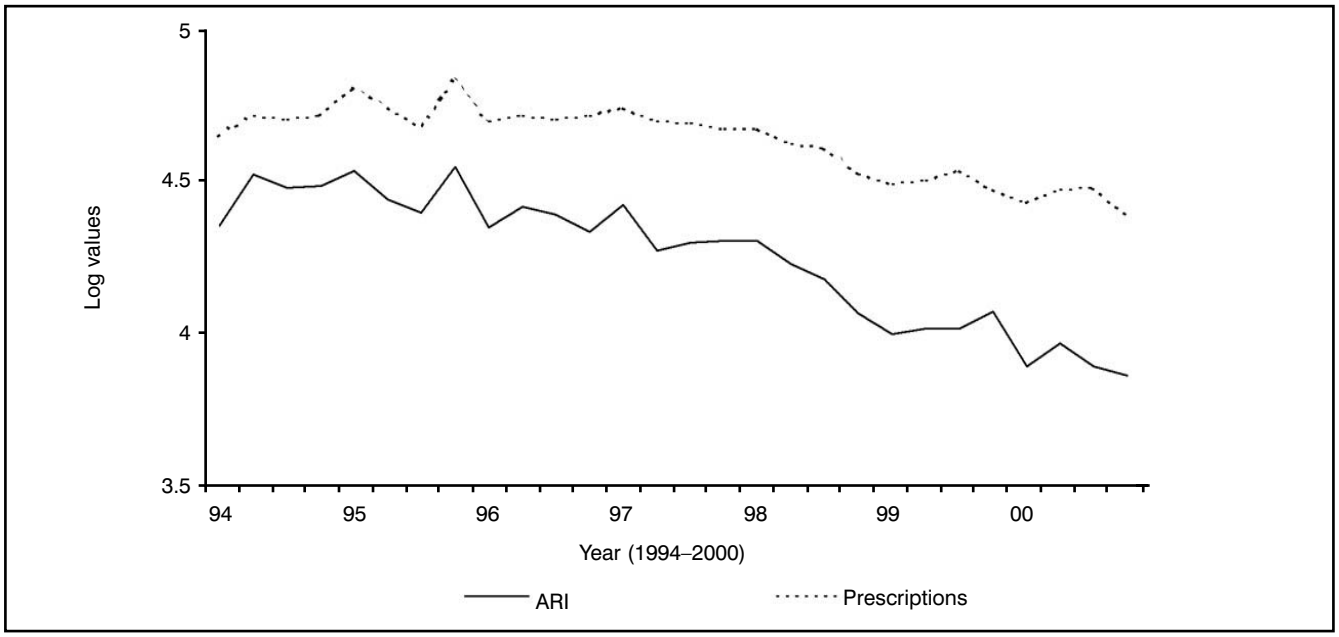

Figure 5. Seasonally adjusted trends in incidence of acute respiratory tract infections (ARI [per 1000]) and antibiotic prescriptions (per 100 000): quarterly data logged.

examine these data. This is not a realistic measure, since respiratory tract infections are so common and often asymptomatic. Consistent reporting from all consultations, with identification of new episodes, provides as close a measure as is practicable of the incidence of respiratory tract infection in the community. Possible variations in consulting threshold can be explored in other conditions and differentially by age group, as presented in this report.

Interpretation

A changing consultation threshold provides a possible explanation for the reduction. In recent years, patients with influenza-like symptoms have been discouraged from consulting and, following the publication of the SMAC report in 1998,[2] were discouraged from expecting an antibiotic. The role and number of prescribing advisors increased substantially after this report was published. However, the reductions presented here precede these initiatives. The reductions in respiratory tract infections are evident in cases such as in otitis media in young children, acute bronchitis in the elderly, and infectious mononucleosis, and it seems very unlikely that the threshold for consultation could have fallen for these. Furthermore, the data presented on skin infections, shingles, and urinary tract infections are not indicative of a reduced consultation threshold. There is evidence in the WRS of increasing, rather than declining, total consultation rates (1999 Annual Report).[16]

The incidence of infections varies over time. Streptococcal infections are much less virulent than they used to be.[17] An unexplained shift from Gram-positive to Gram-negative infections in low birth weight infants has recently been reported, demonstrating that change can occur, seemingly involving a wide range of pathogens.[18] It is almost inconceivable that change could affect the wide range of respiratory pathogens, with their varying seasonal patterns, but it is possible that one or two respiratory pathogens have such a dominating effect on the subsequent incidence of infection that change in those might have much wider effects than might otherwise be anticipated. Such a role is implied for influenza from the changing patterns of morbidity observed after discontinuing influenza vaccination in Japan.[19] Respiratory illnesses are predominantly caused by viruses, and therefore factors having an effect on viruses (as opposed to bacteria) might be particularly relevant and worthy of further exploration.

Factors influencing disease transmission have a bearing on incidence. A changing pattern of incidence in chickenpox reported from the WRS database is probably related to changes in socialisation in young children.[20] Overcrowding, poor hygiene, air pollution, including that caused by tobacco smoke, and particularly by adverse weather conditions involving fog, favour the spread of respiratory illness. Gradual improvements in all these factors may have contributed to the reductions reported here. However, this seems to be an insufficient argument to explain the reductions seen in the summer quarters.

Increased host resistance to infection might also explain the decreased incidence. Reductions affecting all age groups simultaneously cannot be genetically determined, and it is also difficult to imagine dietary improvements impacting on all age groups simultaneously.

The reductions in respiratory tract infection show an extremely close relationship with those in antibiotic prescribing. Data on specific antibiotics are not presented, but it is worth noting that prescriptions for flucloxacillin (the antibiotic chiefly used to treat skin infections), actually increased over the period, which is consistent with the incidence data reported for skin infections. The evidence we present suggests that the reduction in antibiotic prescribing follows the reduction in the incidence of respiratory tract infections, rather than preceding it, although there may have been a degree of synergism since 1998. Pressures to

reduce the prescribing of antibiotics are not likely to stop parents bringing young children with otitis media to the doctor, nor elderly people consulting with bronchitis. They might be expected to influence consulting behaviour for minor skin infections, but have not done so.

Relationship to relevant literature

Our findings, which are based on infections in all age groups, are consistent with those of McCaig *et al*, which are based solely on children, both in the timing and the magnitude of the prescribing reductions and, interestingly, in the findings in relation to otitis media (reduction) and urinary tract infections (no change in the USA, minimal reduction in England).[7] These researchers reported an average 44% reduction in population-based rates of respiratory tract infection, but only a 14% reduction in antibiotic prescribing rates for patients seen by the primary care physicians. Thus, the main contribution in the reduced antibiotic prescribing came from reduced attendance because of respiratory tract infection. They did not identify a reduction in other illness groups that were examined. In interpreting their results, they reserve their position because 'without incidence data for the respiratory tract infections examined in this study [they] could not determine the extent to which changes in disease incidence may have affected physician office visit rates and population-based prescribing rates for these conditions'.[7] This report presents incidence data from the total consulting population.

Conclusion

This study documents a decreasing incidence of respiratory tract infections since 1995. It offers probable explanations for the declining incidence of asthma attacks already reported,[1] and the reduction in antibiotic prescribing seen over recent years. Reduced antibiotic prescribing is to be welcomed, but reduced rates of infection even more so. Routine surveillance in the community is essential to identifying trends in the incidence of disease that varies for many and often unexplained reasons; and for the interpretation of healthcare interventions. Comparable analyses in other available national data would be particularly interesting.

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