ORIGINAL ARTICLE

Sales of over-the-counter remedies as an early warning system for winter bed crises

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Objectives To evaluate the pattern of emergency adult medical admissions during the winter period and the usefulness of sales of over-the-counter cough/cold remedies as a predictor of these.

Methods The databases of a single NHS trust acute unit and pharmacy outlets in its catchment area were analyzed retrospectively, comparing numbers of emergency admissions, ICD-10 discharge codes, local electronic point-of-sale (EPOS) and national sales data.

Results Over nine consecutive winter periods from 1992/3, peak admissions always occurred within a defined ten-day period from 29th December to 9th January. Emergency admissions increased significantly during this period ($P = 0.0002$). Pharmaceutical/retail data were available for three consecutive winters 1998/99, 1999/2000 and 2000/2001, none of which coincided with increased influenza activity nationally. Acute respiratory illness as defined by International Classification of Diseases, 10th edition (ICD-10) discharge coding did not appear to contribute to the increase in admissions at the peak. However, National and Local EPOS sales were positively correlated with admissions and the rate of EPOS sales exceeded an empiric threshold of 1000 units per week two weeks prior to the admissions peak in each year.

Conclusions Emergency admissions over the winter period are increasing and can be expected within a period of only ten days each year. No firm relationship between acute respiratory illness and admissions could be defined but local EPOS data may give up to two weeks warning of the peak in admissions and merits further prospective evaluation.

Keywords Influenza, pharmacy, acute admissions, health service

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Winter pressures on acute medical services in the UK National Health Service (NHS) are increasingly difficult to manage [1]. In order to promote the most effective use of services, robust models are needed to predict the demand [2]. Respiratory infections, particularly the activity of epidemic influenza, are thought to contribute significantly to the increased workload. National sentinel surveillance systems for influenza-like illnesses have been in place for some years [3,4,5], but few local initiatives exist [6]. The pharmaceutical industry has developed similar models to predict sales of over the counter (OTC) 'cough and cold' remedies during the winter period at a national level (e.g. Lemsip FluForecast; ReckittBenckiser, Hull, UK)

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while multiple retailers use 'real time' sales data (Electronic point of sale or EPOS) which is readily available at the local level. A single study more than 20 years ago identified by a systematic MEDLINE search, has specifically linked sales of OTC remedies to the activity of influenza B in Los Angeles [7], however this area has otherwise received little attention. We investigated whether currently operating pharmaceutical data collection systems could be useful predictors of respiratory illness and hence emergency admissions for our hospital during the winter period.

METHODS

Data series made available by Nottingham City Hospital NHS Trust, Boots the Chemists retail outlets in the City Hospital catchment area and Reckitt Benckiser were analyzed retrospectively for the winter periods of 1998/99, 1999/2000 and 2000/2001. Hospital admissions data captured by the MEASLES database, which records inpatient episodes Trust-wide based on clinical coding of discharge diagnoses, were available daily and retrospectively from the winter of 1992/93. Data on admissions for unselected adult admissions for all causes and for a subset coded as related to respiratory illness were collated. Respiratory illness was defined as a subset of discharge ICD codes comprising J06 (acute upper respiratory illness of multiple or undefined site), J10-18 (influenza, bacterial, viral and unspecified pneumonia), J20-22 (acute bronchitis, bronchiolitis or lower respiratory tract infection), J40-42 (unspecified bronchitis) and J44 (chronic obstructive airways disease with acute lower respiratory infection). National sales data for cold and flu remedies were derived from the cumulative reports of the Reckitt Benckiser's Lemsip FluForecast model which utilizes a composite of retailing, environmental and surveillance data and trend analysis to predict short-term sales (five weeks in advance by market subcategories). Electronic point of sales data were drawn from Boots the Chemists retailers in postal-code areas identified as contributing to acute admissions at the City Hospital (Boots market share of OTC medicines in Nottingham is approximately 30%). Both sales datasets were available on a weekly basis. The study dataset was compiled on an Excel spreadsheet (Microsoft Corporation, Redmond, Washington, USA). Graphical examination of the autocorrelation functions of the data series, calculation of the Box-Ljung Portmanteau Q statistics and pairwise product-moment correlation coefficients and Poisson regression analysis were all carried out with the statistical package STATA version 7.0. (Stata Corporation, TX, USA).

RESULTS

Pattern of admissions

According to data from nine winter periods commencing in 1992, peak admissions always occurred between the 29th December and 9th January though subsidiary peaks were recorded as early as the 22nd December and as late as the 10th January. The number of admissions at the peak, fitted by poisson regression, increased significantly by year over the period of study with an incidence rate ratio of 1.06 (95% confidence interval 1.03–1.09, $P = 0.0002$), see Table 1.

Table 1 Main and subsidiary peaks in emergency admissions

	Main peak		Subsidiary peak	
Year	No. admissions	date	No. admissions	date
1992/1993	46	4/1/93	45	6/1/93
1993/1994	48	30/12/93	47	10/1/94
1994/1995	53	9/1/95	52	29/12/94
1995/1996	64	8/1/96	61	8/12/95
1996/1997	88	6/1/97	76	23/12/96
1997/1998	66	29/12/97	63	22/12/97
1998/1999	80	29/12/98	61	31/12/98
1999/2000	71	30/12/99	65	29/12/99
2000/2001	71	02/01/01	59	27/12/00 & 05/01/01

Analysis of the pattern of admissions 1998/99, 1999/2000 and 2000/2001

None of the three periods studied in more detail coincided with epidemic influenza activity as defined by the Royal College of General Practitioners/Public Health Laboratory Service Surveillance Scheme [3]. Recorded national peak consultation rates over the winter period for influenza-like illnesses were 272, 231 and 81 consultations per 10^5 per week, respectively. These appeared to be in agreement with the mean proportion of emergency admissions with a primary diagnosis of respiratory illness in each year locally (33.0%, 30.66% and 16.53%, respectively). In the first two winters the series of admissions attributed to respiratory causes showed a significant nonrandom trend (see Table 2). This was not the case in 2000/2001 and seems consistent with the low level of influenza activity that year. By contrast, Q statistics for the total of the emergency admissions were consistent with a greater degree of randomness overall despite the prominent peaks in hospital activity and were only statistically significant in 1998/1999. The correlation between the absolute number of emergency admissions and the proportion attributed to respiratory illness was not statistically significant in any period (correlation coefficients of 0.162, 0.260, 0.104 with corresponding *P*-values of 0.410, 0.181, 0.600 for the winters 1998/9, 1999/2000 and 2000/1, respectively).

Analysis of hospital and pharmaceutical data

Both National and EPOS total sales were positively correlated with total emergency admissions over the first two winters (see Table 3). Again this was not true for the 2000/2001 period. No single market component (cold, cough, decongestant or throat preparations) differed significantly from the pattern of total sales in any year (data not shown). Sales peaks both preceded and lagged the peak in admissions in different years but in all three winters it was noted that the rate of change of sales abruptly exceeded an arbitrary and empiric threshold of 1000 units per week two weeks prior to the peak in emergency admissions. The rate of increase in sales two weeks prepeak varied from year to year (1770 μ/week, 4146 μ/week and 2681 μ/week), see Figure 2.

CONCLUSIONS

We have explored the use of a simple model for forecasting winter emergency admissions at a district level using readily available data from an NHS Trust and partners in the local pharmaceutical and retailing sectors. Hospital activity in the period studied showed an upward trend of 6% each year and the peak period of emergency admissions fell within a well-defined period of approximately ten days each year; a 'long-range forecast' robust over a nine-year period. ICD

Table 2 Box-Ljung Q statistics for the series of emergency and respiratory admissions over three winter periods

	All emergency admissions		Respiratory emergency admissions	
	Q	***P***	**Q**	***P***
1998/1999	30.044	0.003	57.269	<0.001
1999/2000	19.157	0.085	35.980	<0.001
2000/2001	16.293	0.178	12.970	0.37

Table 3 Product moment correlation coefficients for the series of all emergency admissions, EPOS and Reckitt-Benckiser national sales over three winter periods

	Reckitt-Benckiser National		EPOS	
	Coefficient	***P***	**Coefficient**	***P***
1998/1999	0.633	0.037	0.572	0.066
1999/2000	0.856	<0.001	0.850	<0.001
2000/2001	0.119	0.729	0.319	0.340

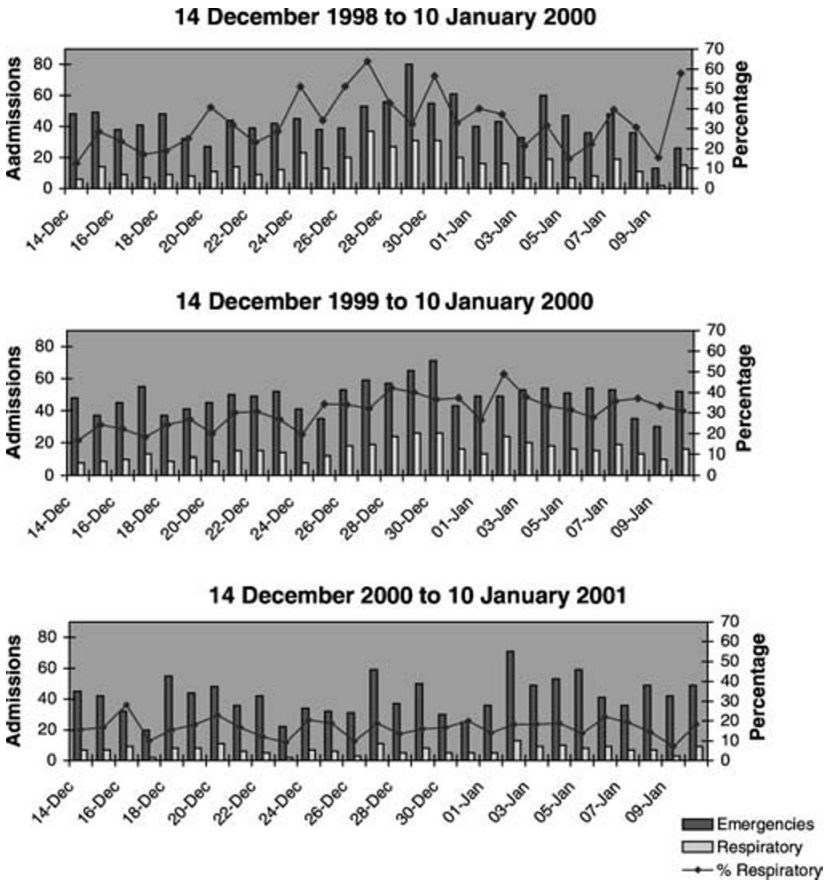

Figure 1 Total, respiratory and percentage of respiratory emergency admissions.

discharge codes for emergency admissions did not confirm a strong relationship between respiratory illness and admissions. However, rises in emergency admissions were preceded by a rise in local sales of OTC flu and cold remedies and EPOS data did seem capable of giving up to two weeks notice of peak hospital activity, though the reliability of this 'short-range forecast' remains to be proven.

The link between pharmaceutical sales, respiratory illness and emergency admissions is clearly complex. Influenza is often loosely invoked as a cause of winter pressures but there are inconsistencies between influenza surveillance data alone and hospital admissions for all cause morbidities. Other respiratory viruses may be contributing to the morbidity but useful surveillance data for these pathogens are sparse. In none of the winters we studied did national influenza activity, as measured by sentinel GP consultation, exceed expected levels. This may be one reason why we did not observe a strong relationship between respiratory illness and emergency admission in our study though there are undoubtedly many others, amongst which we would include the likely poor sensitivity of discharge coding to the spectrum of clinical effects of respiratory infection and the multiplicity of determinants of emergency admission, many of them socio-economic which are not accounted for in our simple model. The period studied was also relatively short and sales data were only available on a weekly basis. Neither did we include other variables used in addition to the sales data in the Lemsip FluForecast model (National Influenza Surveillance, meteorological data, seven years historical sales and national trends in EPOS sales). Use of all these variables would require sophisticated time-series techniques, more detailed local data than are presently available to us and would involve a sacrifice of the simplicity which can be such an advantage in operationalizing health systems research. As we hypothesized, local EPOS data did qualitatively appear to be more closely linked to local

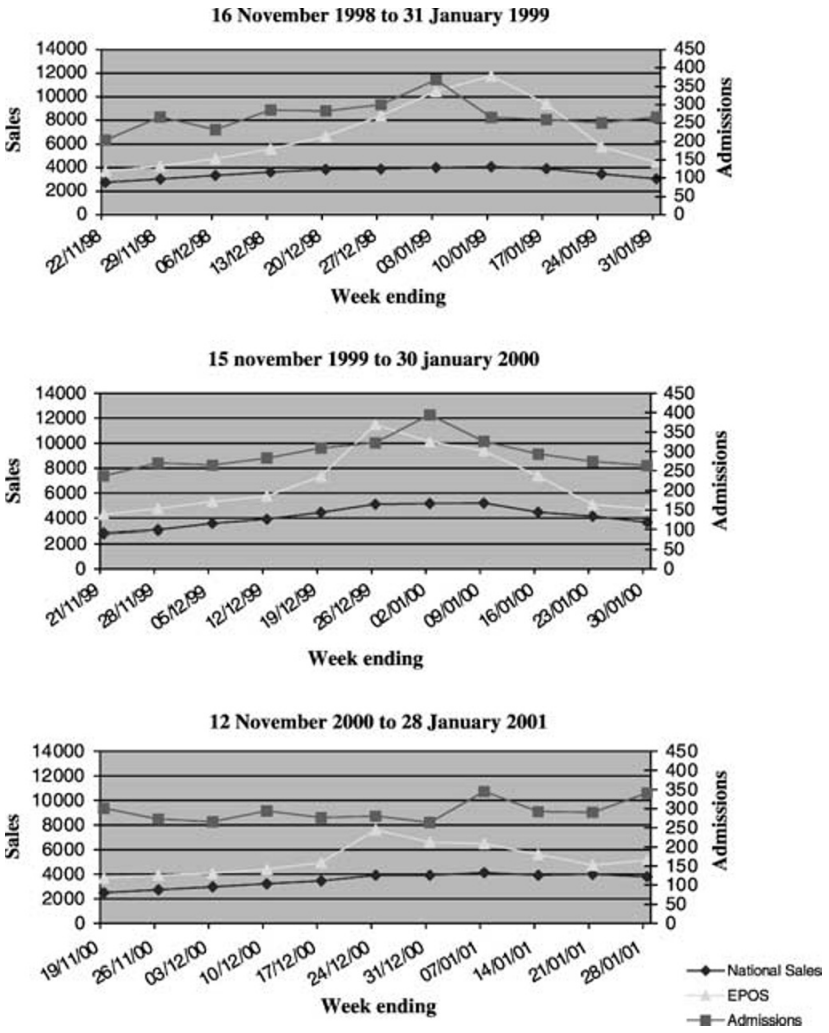

Figure 2 Emergency admissions, Boots' EPOS and Reckitt's National Sales (× 1000).

emergency admissions than national data, lending some support to our empirical approach. National forecasting systems might not be as useful as predictors of hospital activity, unless they can be adapted to local variations in their components.

This model has the great virtue of simplicity, low cost and the potential for direct local application and we will continue to evaluate and refine data collection in our district over the coming years. Collecting sales data on a daily basis as well as capturing a higher percentage of local retail sales might enhance the sensitivity of the model. If it proves reliable over a longer data series it could form the basis of a prospective project to help acute services to manage winter pressures more effectively by allocating staff and resources when and where they are needed most.

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