Additional studies on the three to six year pattern in medical emergency admissions

Rodney P Jones Ph.D.
Statistical Advisor
Healthcare Analysis & Forecasting
Camberley, Surrey
hcaf_rod@yahoo.co.uk

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Key Words: Infectious outbreak, new disease, medical admissions, emergency admissions, step-change, unexpected increase, admission rate, inpatient care, zero day stay admissions, epidemiology, public health, trends in hospital admissions

Abstract

For many years medical admissions to acute hospitals have been increasing at a rate far higher than expected from demographic change. Factors such as emergency re-admission, GP thresholds, breakdown of the family unit and deficiencies in primary, community and social care have been suggested to explain this widening gap. Analysis of daily admissions in Scotland, England and at individual hospitals over the past 25 years shows that admissions tend to increase in a step-like manner at an interval of three to six years. This causes a typical 10% step-increase in physician workload and inpatient medical costs and across England adds over 1,200,000 occupied bed days of additional bed demand into the health service within the space of around three months. The step increase is characterised by admissions specifically in general medicine and aspects of mental health described by a cluster of diagnoses, has a greater magnitude with age, is associated with a transient increase in excess deaths and triggers longer-term changes in the proportion of female to male admissions. Such behaviour could be the result of a previously unrecognised form of infectious outbreak.

The material in this paper was originally submitted to 'Medical Hypotheses' on 22nd December, 2009 as part of a longer document which was eventually split into two parts. The main document became: ***Jones R (2010) Unexpected, periodic and permanent increase in medical inpatient care: Man-made or new disease? Medical Hypotheses 74(6): 978-983,*** while the remaining material has been incorporated into this supporting paper.

Introduction

Around the world there has been an enduring trend to increasing numbers of inpatient medical admissions that is far above that explained by demography. Factors such as increasing re-admission, GP thresholds, breakdown of the family unit, deficiencies in primary, community and social care have been proposed as contributing to the gap [1,2]. It has been assumed that the observed trends are the result of a series of emerging trends overlaid on basic demographic trends and this assumption has been shown to be true for many but not all diagnoses [1].

The first suggestion that the increase may be something different to an emerging trend arose from analysis of the unusual, unexpected, rapid and permanent rise in medical emergency admissions which occurred across the UK in early 1993. The exact nature of the local change seen at the Royal Berkshire Hospital in Reading was demonstrated to arise from a step-increase in admissions rather than the usual emerging upward trend [3]. A step-increase is one where the admission rate steps up to a new and higher level over a very short space of time. The higher admission rate then continues until the next step increase. A further study revealed that a step increase in bed occupancy had also occurred [4]. Ambulance journeys in Wiltshire over the period 1988 to 1996 also showed a distinct step increase in medical-related journeys around 1993 [5].

By late 2008 an unexpected increase in medical bed demand similar to that seen in 1993 was causing operational problems in many hospitals. This led to a re-examination of the trends in emergency admissions and bed occupancy in England, Scotland and at specific hospitals over the past 28 years and confirmed that such step increases had occurred at a point in the 1983/4, 1990, 1993, 1996, 2002 and 2007 calendar years, i.e. between three to six years apart [1,6-8]. Previous studies had failed to identify these step changes because they had only looked at broad trends using financial year data, had looked over relatively short time scales, i.e. three to five years, and had not excluded the confounding effect of zero day stay admissions [1,6]. In addition many of the studies were conducted using data covering the period 1990 to 1996 when a series of three steps occurred in relatively short succession and this led to the appearance of an ongoing trend. The 1990 step appears to have been confined mainly to Scotland and perhaps to the northern parts of England.

In England the step behaviour is most clearly seen when zero day stay 'admissions', i.e. admitted and discharged on the same day, are excluded from the analysis [1]. Such zero day stay 'admissions' are probably more correctly regarded as Accident & Emergency (Emergency Department) attendances for assessment or observation [9-12].

This study presents the results of additional analysis designed to validate the previous findings and to further investigate the exact nature of the step change with respect to shifts in diagnosis, age, sex and potential regional variation. These findings could then lend support to the possibility that this could be the outcome of some form of previously unrecognised infectious outbreak.

Methods

A daily count of emergency admissions both with and excluding zero day stay admissions to the medical specialties were obtained for the whole of Scotland. Data was provided by the Information Services Division (ISD) of NHS Scotland and covered the period 1st April 1986 to 31st March, 2008. A daily count of emergency admissions (with and excluding zero day stay) and occupied beds in each specialty over the period 1st April 1994 to 14th January 2009 were obtained from the Royal Berkshire Hospital (Berkshire, England).

Detection of step changes in admission rate was conducted using a statistical method called the cumulative sum of differences (cusum) [13]. The daily average rate of admissions at the start of a long time period is first determined. This initial average is then subtracted from all daily admissions. For example, the initial average admission rate is 12.5 per day and this is subtracted from the count of admissions on each day of the time series to give a time series of differences. Each daily difference is then added consecutively over the entire time span to give the cumulative sum of differences. A period of constant rate of admissions shows up on a cusum plot as a straight line whose slope is equal to the difference between the initial average and the current average. The point at which there is a change in the fundamental average rate shows up as a change in slope on the cusum plot. If the new average rate is higher then the slope will be higher, etc.

The degree of statistical variation associated with daily admissions was calculated using the coefficient of variation which is calculated as the standard deviation divided by the average. This ratio was calculated for running 28 day and 365 day periods. A running average starts with the first time period and then moves forward one day and recalculates the average, etc.

Hospital Episode Statistics (HES) data for England in the form of standard tables covering the financial years 1998/99 to 2008/09 was obtained from the www.hesonline.nhs.co website. Data was extracted at the level of consultant specialty and for the primary diagnosis of the admission recorded using the International Classification of Diseases (ICD) high level diagnostic groups: http://www.hesonline.nhs.uk/Ease/servlet/ContentServer?siteID=1937&categoryID=207 (for specialty) http://www.hesonline.nhs.uk/Ease/servlet/ContentServer?siteID=1937&categoryID=202 (for diagnosis)

The term bed day is used to describe a patient with one overnight stay (midnight bed occupancy). Bed days can be converted into occupied beds by dividing the total bed days for the year by 365 (days/year). Occupied beds are a measure of bed demand and should not be confused with available beds which are the available bed pool within which care is delivered to the patients in occupied beds.

The HES standard data tables list admissions in two ways. Admissions are the count of one person admitted through to discharge. During the course of an admission the patient may be under the care of different consultants and so each admission can have one or more consultant episodes. Bed days are always counted via consultant episodes to ensure that the occupied beds are assigned to the correct consultant specialty. Each consultant episode may have a different primary diagnosis and the primary diagnosis for an admission is that for the first consultant episode. The average consultant episodes per admission are 1.39 for general medicine and 1.04 in elderly medicine. A footnote to each table or figure will explain which method of counting has been used.

Analysis to detect unusual changes in the trend in admissions and bed days at specialty level was conducted using time trends for each specialty. These trends were plotted and visually examined for evidence of a continuous trend or an unexpected step change. Due to the shift of mental health care to a community setting both admissions and bed days are declining. Evidence for a step change in these specialties comes from a distinct shoulder which moves the trend line after the step to the right of the previous trend. Due to the far higher number of diagnosis groups the initial screening was conducted using the ratio of admissions or bed days in 2003/04 v 2002/03 or 2008/09 v 2007/08. Potential candidates were then checked as described for the specialty trends.

A count of daily deaths from all causes (England and Wales) was provided by the Office of National Statistics (ONS). This data covered the period January 1989 to November 2000. Total annual deaths over this 12 year time period were relatively constant and this allowed the calculation of the average deaths applicable to each day of the year. Deaths over a particular time period could then be compared to the long-term average for the same day(s) of the year.

Prior to 2008/09 the sum of annual bed days in the HES data tables excluded the portion of bed days falling outside of the financial year for those admissions admitted in one year but discharged in the next. This led to an increase in the total bed days for 2008/09. The likelihood for an admission to cross the end of a financial year depends on its length of stay. The percentage increase in bed days in 2008/09 compared to 2007/08 was plotted against average length of stay using the ICD high level diagnostic groups. The slope of a linear relationship with an intercept at the origin gave a downward adjustment factor of 0.0068 x average length of stay, hence:

Actual percentage increase = observed percentage increase – 0.0068 x average length of stay.

Due to the simultaneous incremental effect of the step-increase in medical occupancy it was felt that this adjustment factor was likely to be an overestimate of the true correction required to adjust for the change in allocation of bed days. This change does not affect the count of admissions or the calculation of average length of stay.

Results

Specificity of the Effect

Previous studies have suggested that this phenomenon is specific to medical admissions [1,3,6,7]. Recently released 2008/09 HES data for England allows analysis of the last two step changes (financial year data 2003/04 v 2002/03 and 2008/09 v 2007/08) to validate the previous studies. Such analysis confirms that the step changes are specific to a limited number of inpatient specialties, namely; general and elderly medicine, accident & emergency (A&E) and possibly infectious diseases, clinical pharmacology and endocrinology. No step changes can be demonstrated in the medical sub-specialties of gastroenterology, cardiology, respiratory medicine, nephrology, neurology, dermatology, haematology or oncology; or in any surgical specialty or for orthopaedic trauma admissions. It is difficult to reach a conclusion for the specialty Paediatrics from the national data given the shifts in 'admissions' arising from the A&E four hour target.

Outside of the acute sector both admissions and bed days in adult mental health and old age psychiatry and possibly forensic psychiatry also exhibit the behaviour shown by general and elderly medicine while learning disability, child and adolescent psychiatry and psychotherapy do not demonstrate this behaviour. There may be a common mechanism behind the step increase in both the medical and the psychiatric admissions since there is no common administrative or policy link.

It should be noted that 'admissions' to the inpatient specialty A&E, should not be confused with a non-admitted A&E attendance, and are mainly to a variety of medical and surgical emergency assessment and observation units and as such include large numbers of zero day stay 'admissions' [9,10-12]. The extent of the step changes in admissions to general and elderly medicine across England are shown in Fig. 1. It is possible that such a change in admissions could be due to lower-acuity admissions; however, an increase due to this cause would not make an equally significant impact on total bed days. Analysis of bed days for England shows that the two step changes both resulted in an additional 1,200,000 bed days of occupied bed demand (analysis not shown). This is equivalent to over 3,200 extra occupied beds or four to five large hospitals worth of additional bed requirement.

Trend or step change?

A statistical method called the cumulative sum of differences (cusum) plot is an excellent way to clearly demonstrate if a step-change has occurred [13]. Use of this method is illustrated in Fig. 2 where three step changes can be seen.

Each straight line portion in the chart represents a period with a constant admission rate, where transition to a higher slope represents a higher admission rate. The average rate in the four periods are 24.1, 28.5, 31.5 and 35.3 admissions per day respectively (standard error of the mean is around ± 0.2) which represents step changes of 18%, 11% and 12% respectively. The slight fluctuations around the straight line portions are due to seasonal weather- and environment-based variation around the longer-term admission rate [1].

One suggestion for such a step change is that the dynamic behaviour of admissions has changed leading to a knock-on operational change. To test this possibility the coefficient of variation associated with daily medical admissions in Scotland (April 1986 to March 2008) and Reading (April 1994 to January 2009) was determined. There was no evidence of a change in the behaviour of admissions surrounding any of the step-changes, i.e. the admission rate steps up to the new level with admissions continuing to behave (from a dynamic viewpoint) in a similar way to that seen before the step change (results not shown).

Shifts in Diagnosis

A phenomenon of this magnitude must be demonstrated to have specificity in its mode of action apart from wider applicability to general & elderly medicine and certain mental health specialties. Table 1 presents the results of analysis of the changes in primary diagnosis which occurred after the 2002 and 2007 outbreaks using the 148 high-level International Classification of Diseases (ICD) diagnostic groups. A cluster of 48 diagnostic groups emerge which seem to be associated with the step change in admissions and bed occupancy. As can be seen from Table 1 some of this cluster only shows a step change for one outbreak rather than both however there is a core of 27 diagnostic groups which show a step change on both occasions.

Over the period 1998/99 to 2008/09 admissions (as consultant episodes) to the cluster of 48 diagnostic groups have increased from 14% to 16.7% of total admissions. In 2008/09 there were 2,632,400 overnight adult admissions in the cluster of 48 diagnostic groups and 2,625,500 in the medical group of specialties. From this we must conclude that the effect is of fundamental importance to medical care and that its scope extends to some extent into the medical aspects of care in other specialties, i.e. mental health, etc.

Excess of female to male admissions

In England the excess of females to males in the elderly age groups has been steadily declining since 1996 [14] and this is reflected in a declining ratio of females to males in total admissions. However as can be seen in Fig. 3 this trend does not apply to the cluster of 48 diagnostic groups where the proportion of excess female to male admissions shows step increases in 2003/04 and 2008/09. Between the years when the step changes occur there is evidence for some form of cyclic pattern as the excess of female admissions dilute out over time only to be elevated once again by the next step change. Such a pattern could be achieved if each step change resulted in an increase in female deaths which applied over an extended period after the outbreak.

Age

Age is a fundamental factor in the susceptibility to disease. Using the cluster of 48 diagnostic groups Fig. 4 demonstrates that both the 2002 and 2007 outbreak had an effect which increased with age. The magnitude of the step change seen in 2008/09 was greater than that seen in 2003/04. The step changes cannot be linked to any form of demographic change since typical year to year demographic growth for the age bands are as follows: 0-14 (-0.4% to 0.3%), 15-59 (0% to 0.4%), 60-74 (1.5% to 3.5%) and 75+ (0.9% to 1.2%) [14]. There does appear to be some effect upon children and the magnitude of the percentage step change is typically one-quarter of that seen in the 75+ age group which exhibited a 15.1% step increase in 2008/09.

Excess Deaths

A typical outbreak of an infectious disease would normally be expected to be associated with a period of excess to expected deaths [15]. While Fig. 2 shows a series of step changes the point of transition from one rate of emergency admissions to the new and higher rate is not instantaneous but occurs over an approximate six week period and this is known to be associated with a period of excess deaths [6]. Fig. 5 illustrates this for the 1996 step change which is the only occasion since 1993 when the step change occurred during the usual December/January peak of winter deaths (shown as the dashed line in Fig. 5). As can be seen the 1996 transition was characterised by a period of excess deaths which on this occasion continued for approximately one month after the higher rate of admissions had become fully established.

Regional and Local Variation

Regional variation is a recognised feature of infectious outbreaks [16-17]. A degree of north to south movement was deduced to be associated with the 1993 step change [3]. Analysis of the step changes in 1996, 2002 and 2007 shows that the mid point of the transition occurs earlier in Scotland and that the duration of the transition in Scotland takes around four to six months (a larger geographic area) while that for a single location (as measured in Reading) takes around six to eight weeks (results not shown).

At the level of individual hospitals across England the change in general and acute bed occupancy arising from the 2007 outbreak (2008/09 v 2007/08) shows a wide range from a 9% reduction through to a 17% increase [18]. The change in national bed occupancy for the previous three years exhibited a reduction of 5.7% to 2.6% per annum and this provides a baseline [18]. Taking the lower value of an expected reduction of 2.6% in 2008/09 reveals that 87% of hospitals had a change in occupied beds above this benchmark. The category general and acute includes all acute specialties (excluding maternity and mental health) and therefore reductions in non-medical bed occupancy can mask the totality of the effect in medicine, however, the main point of interest is that certain hospitals (locations) appear to have been affected worse than others and with only a minority (13%) going against the trend. A study of changes in the length of stay distribution may reveal hospital sites whose process of acute medical diagnosis and discharge was better equipped to handle the step change in admissions and resulting bed pressures [19].

Discussion

A recent review of the trends in emergency admission has established that a significant proportion of the higher than expected growth observed in the UK and elsewhere is due to zero day stay 'admissions', i.e. admitted and discharged on the same day [1]. The introduction of the A&E four hour target greatly accelerated this trend specifically in England due to different health policies in the devolved countries of Wales and Scotland [1,9-10]. This growth has been so high that zero day stay admissions can account for up to 90% of the observed total growth seen since the early 1990's even in the absence of the greater increase specific to England [1]. In essence, the boundary between inpatient and non-admitted care has been progressively eroded [11,12].

In the USA, such 'admissions' would be considered part of emergency department (ED) assessment and observation; and are counted and paid differently to otherwise genuine inpatient admissions [11]. Hence in the UK the high upward trend in zero day stay admissions has overwhelmed the underlying trend in overnight admissions. Exclusion of the confounding effect of zero day stay admissions is therefore a key feature of any analysis to reveal the true nature of the 'trends' in genuine overnight stay inpatient activity in the UK.

Exclusion of zero day stay admissions is not absolutely necessary to demonstrate that an unusual change has occurred and quarterly data covering all emergency 'admissions' for the residents covered by the South Central Strategic Health Authority in England exhibit abnormal shifts in the admission trends in 2002 and 2007, however, the step-nature of the change becomes blurred [20]. After excluding zero day admissions bursts of growth which typically increase the overall number of genuine overnight stay emergency admissions by around 10% can be demonstrated as per Figs. 1 and 2. Contrary to expectation the new and higher level of admissions continues until the next step change. Any form of administrative-based change would be quickly corrected via the usual adversarial processes that exist between primary and secondary care in England.

In England admissions to general and elderly medicine account for around 30% of emergency admissions and 42% of total emergency plus elective occupied beds. A 10% increase in this admission stream therefore represents a significant change in the demand for hospital inpatient treatment, and to a 3% to 4% increase in total bed-day related costs. There will also be considerable effects on physician workload, cost pressures specific to medical departments within hospitals and additional pressures placed upon ambulance services, A&E attendances and outpatient services. Indeed these profound changes have been proposed to contribute to a cycle of surplus and deficit observed within the NHS in England [21].

It is generally accepted that growth in the number of admissions follow trends over time which are determined by demographic change, re-admission for long-term conditions and the mix of social, primary and secondary care factors which go to determine the threshold to admission [1]. The concept of a step-change where admissions permanently step up to a new and higher rate will be unfamiliar territory. The essential nature of such a step-change associated with this phenomenon has been demonstrated in different ways. Analysis of the 1993 event used paired comparison between months of the year to demonstrate that a step change had occurred at some point in February/March [3]. Analysis of the events occurring since 1993 used a running 365 day total to demonstrate a succession of plateaus over many years [1,6-7]. While a running 365 day total mimics the incremental financial effects of such a change, it has the disadvantage of turning a step change into a ramp-like feature. A step change will lead to a ramp which is 365 days long while an 'infectious outbreak' lasting six weeks would lead to a ramp which is 394 days long, etc. The ramps observed in the previous analysis are around 390 days in length [1,6-7].

Based on the wider evidence presented in the results section it would seem that some form of previously unrecognised infectious outbreak is possible. The mid-point of each 'outbreak' occurs earlier in Scotland than England and full progression across Scotland takes around four to six months which is consistent with infectious spread among a population where there is a high proportion of remote highland and island communities (approximately 20% of the population) including islands of Skye, Shetland, Orkney and Outer Hebrides [22]. Elements of specificity to aspects of medicine and mental health alone, shifts in diagnosis, age- and gender-specificity, regional variation within England and a co-incident increase in decease are all highly suggestive of such a mechanism.

The proposed 1996 winter outbreak (Fig. 5) requires some comment. The winter of 1996 saw an outbreak of influenza which peaked in January; however, while influenza activity was only moderate there were a disproportionate number of deaths [23]. Hence we have the possibility that dual outbreaks of both influenza (typical spike increase in admissions) and the proposed infectious agent (step change in admissions) acted to cause the observed higher than expected deaths with the slightly later arrival of influenza accounting for the tail of higher deaths stretching from mid-January to mid-February.

The final issue is that of the apparent constant rate of admissions between the step changes. A constant rate can be achieved if the decline in the infected sub-population (via a higher rate of decease) roughly matches the underlying growth in need via demographic change in the non-infected population. Recall that it is the high growth in zero day stay 'admissions' that has led to confusion regarding the nature of the true trends. The view that the increase in medical admissions was largely a demand management problem (i.e. due to system deficiencies which can therefore be remedied) [2,24-26] has led the UK and other healthcare systems to invest considerable time and money into implementing solutions based on this premise, i.e. GP referral triage and a variety of admission avoidance schemes [2,23-25]. This does not imply that demand management strategies are ineffective or not required [24]; however, a recent Audit Commission report concluded that whatever demand management strategies were in place prior to the most recent 2007 step change were ineffective in preventing the (full-year) increase in hospital activity seen in 2008/09 [27]. Hence if the infectious disease hypothesis is correct, such demand management schemes may be largely of greatest effect in the years between the periodic outbreaks (and may largely affect the short stay component of demand) but cannot prevent the outbreak per se, i.e. we are treating symptoms arising from the outbreaks and not root causes.

It would seem that the evidence presented could be consistent with an infectious outbreak with a previously unrecognised scope of action. Whatever the cause, it raises questions regarding the accepted mechanisms for growth in medical admissions which have underpinned most of the forecasting conducted by government health departments around the world. Further national and international research is therefore required regarding this intriging phenomena.

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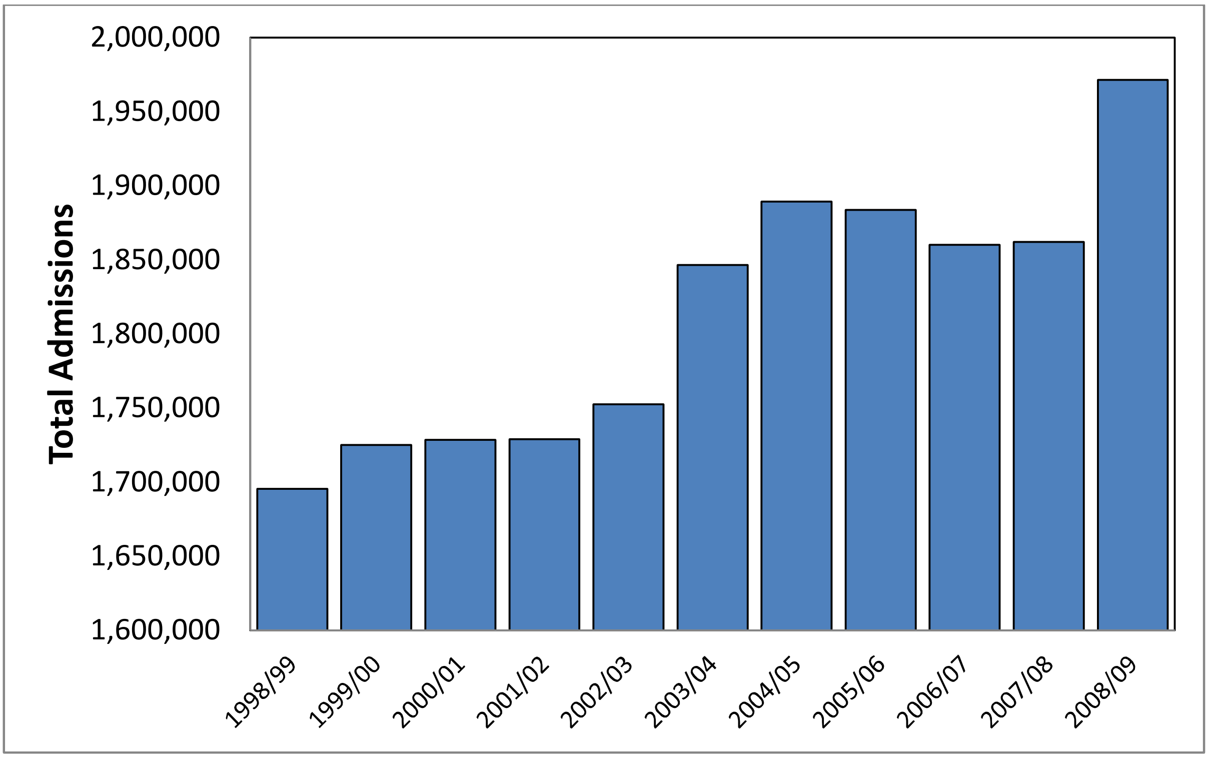
Table 1: A group of 48 high level diagnoses showing evidence of a step change for the residents of England (size of the step as a percentage).

ICD Codes	Description of Diagnostic Group	Bed days 03/04	Bed days 08/09	Admissions 03/04	Admissions 08/09	2008/09 ALOS	2008/09 Admissions
A20-A49	Certain bacterial diseases	114%	102%	107%	103%	12.9	24,746
A50-A64	Predominantly sexual infections	108%	141%	100%	99%	4.4	1,029
B20-B24	Human immunodeficiency virus disease	107%	102%	102%	104%	12.1	3,831
B25-B34	Other viral diseases	103%	112%	104%	111%	1.1	51,602
B35-B49	Mycoses	113%	111%	108%	105%	7	2,535
E15-E90	Endocrine nutritional and metabolic diseases	109%	110%	110%	112%	6.8	69,085
F10-F19	Disorders due to psychoactive substances	109%	104%	107%	101%	7.4	48,903
G00-G09	Inflammatory diseases, central nervous system	116%	113%	99%	107%	17	4,110
G10-G13	Other degenerative diseases (incl. Alzheimer)	115%	115%	96%	97%	43.2	10,276
G20-G26	Movement disorders (incl. Parkinsonism)	101%	111%	98%	105%	19.2	7,844
G40-G47	Epilepsy, migraine & other episodic disorders	98%	119%	103%	123%	3.2	110,470
H10-H13	Disorders of conjunctiva (incl. conjunctivitis)	117%	108%	109%	97%	1.5	1,539
I00-I09	Rheumatic heart disease	96%	119%	95%	115%	13.3	3,787
I10-I15	Hypertensive diseases	100%	104%	101%	110%	6.1	19,914
I26-I28	Pulmonary heart disease & circulation	100%	108%	102%	110%	9.2	20,719
I95-I99	Other & unspecified circulatory disorders	107%	104%	110%	109%	7.4	14,574
J00-J06	Acute upper respiratory infections	109%	98%	114%	101%	0.9	117,014
J10-J18	Influenza & pneumonia	112%	118%	109%	115%	11.2	133,768
J20-J22	Other acute lower respiratory infections	109%	109%	108%	112%	5.7	120,533
J40-J47	Chronic lower respiratory diseases	110%	106%	110%	110%	5.9	190,837
J60-J70	Lung diseases due to external agents	123%	110%	120%	105%	16.8	9,853
J80-J99	Other diseases of the respiratory system	103%	106%	104%	106%	9.3	53,241
K70-K77	Diseases of liver	106%	104%	103%	101%	11.7	21,341
K90-K93	Other diseases of the digestive system	100%	107%	102%	106%	5.6	51,602
L00-L14	Other infections and disorders of the skin	106%	105%	106%	103%	6.3	136,234
M40-M54	Dorsopathies	103%	102%	108%	110%	4.8	100,536
M60-M79	Soft tissue disorders	105%	103%	106%	107%	1.8	116,393
N00-N08	Diseases of the kidney	105%	107%	105%	108%	5.1	32,887
N17-N19	Renal failure	103%	104%	123%	103%	10.7	39,027
N20-N23	Urolithiasis	106%	100%	111%	105%	2.2	47,501
N25-N29	Other disorders of kidney & ureter	95%	113%	103%	108%	5.3	3,605
N30-N39	Other diseases of the urinary system	109%	111%	107%	108%	7.9	157,128
N99	Other disorders of the genitourinary system	114%	95%	107%	102%	4	2,853
R00-R09	Symptoms & signs - circulatory/respiratory	100%	99%	108%	107%	1.6	395,688
R20-R23	Symptoms & signs - skin & subcutaneous tissue	104%	102%	102%	106%	1.3	33,644
R25-R29	Symptoms & signs - nervous & musculoskeletal	103%	111%	105%	111%	6.5	20,583
R40-R46	Symptoms & signs - cognition, perception, etc	108%	108%	112%	113%	6.4	54,735
R47-R49	Symptoms & signs - speech & voice	106%	112%	100%	118%	4.2	6,318
R50-R68	General symptoms & signs	102%	106%	109%	110%	4.2	293,437
R69	Unknown & unspecified causes of morbidity	120%	158%	119%	110%	35.2	116,827
R70-R89	Abnormal findings of bodily fluids or samples	116%	98%	91%	109%	2.7	8,949
T36-T50	Poisonings by drugs & medicaments	107%	100%	112%	101%	1.3	111,600
T66-T78	Other and unspecified effects of external causes	104%	126%	114%	104%	1.8	12,971
T79	Certain early complications of trauma	115%	112%	97%	98%	8	2,104
T80-T88	Complications of surgical & medical care	108%	105%	107%	105%	7.2	137,642
T90-T98	Sequelae of injuries	92%	178%	71%	125%	17.9	137
Z00-Z13	Examination and investigation	96%	142%	102%	114%	1.8	64,579
Z80-Z99	Health hazards related to family	120%	140%	90%	77%	13.6	1,194

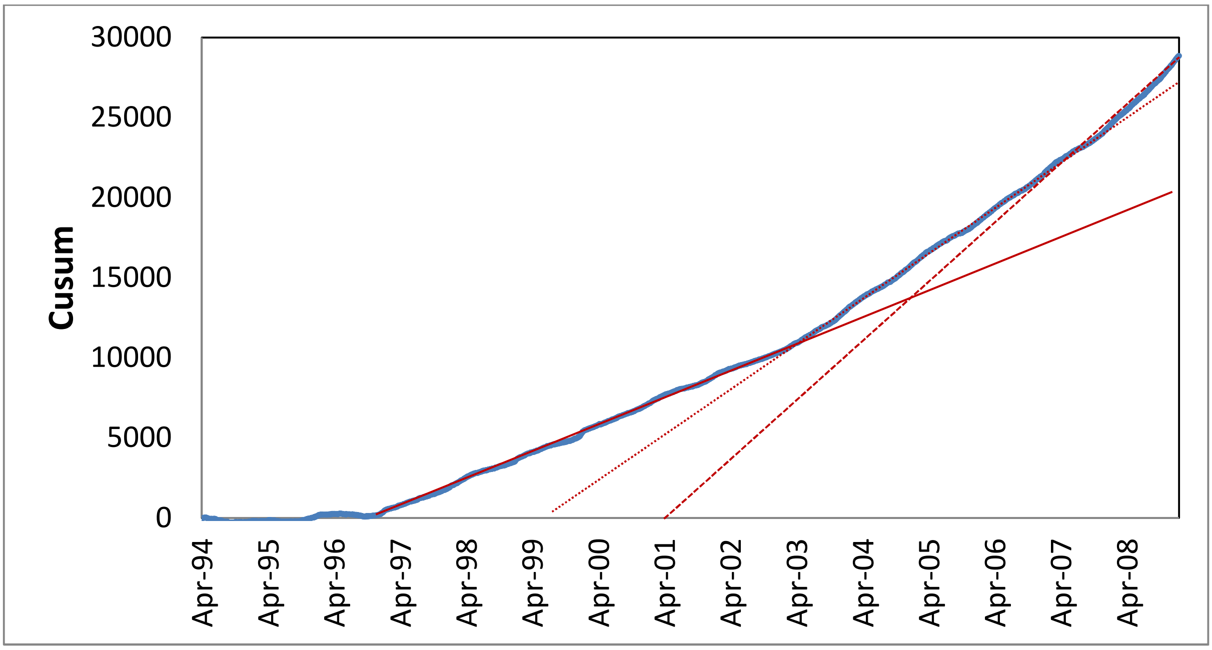
Footnote: Diagnoses in red bold show a step change in both admissions and bed days for both outbreaks, other diagnoses meet the criteria in some years or in one of the criteria. Columns headed 03/04 and 08/09 give the percentage increase in bed days or admissions seen between 2002/03 v 2003/04 and 2007/08 v 2008/09 respectively. ALOS = average length of stay for 2008/09. Note the frequency of diagnoses with a relatively high ALOS. Admissions and bed days include both elective and emergency admissions which represent a continuum of care especially in the medical specialties.

Fig. 1: Financial year total overnight admissions to general and elderly medicine in England showing step changes in 2003/04 and 2008/09.



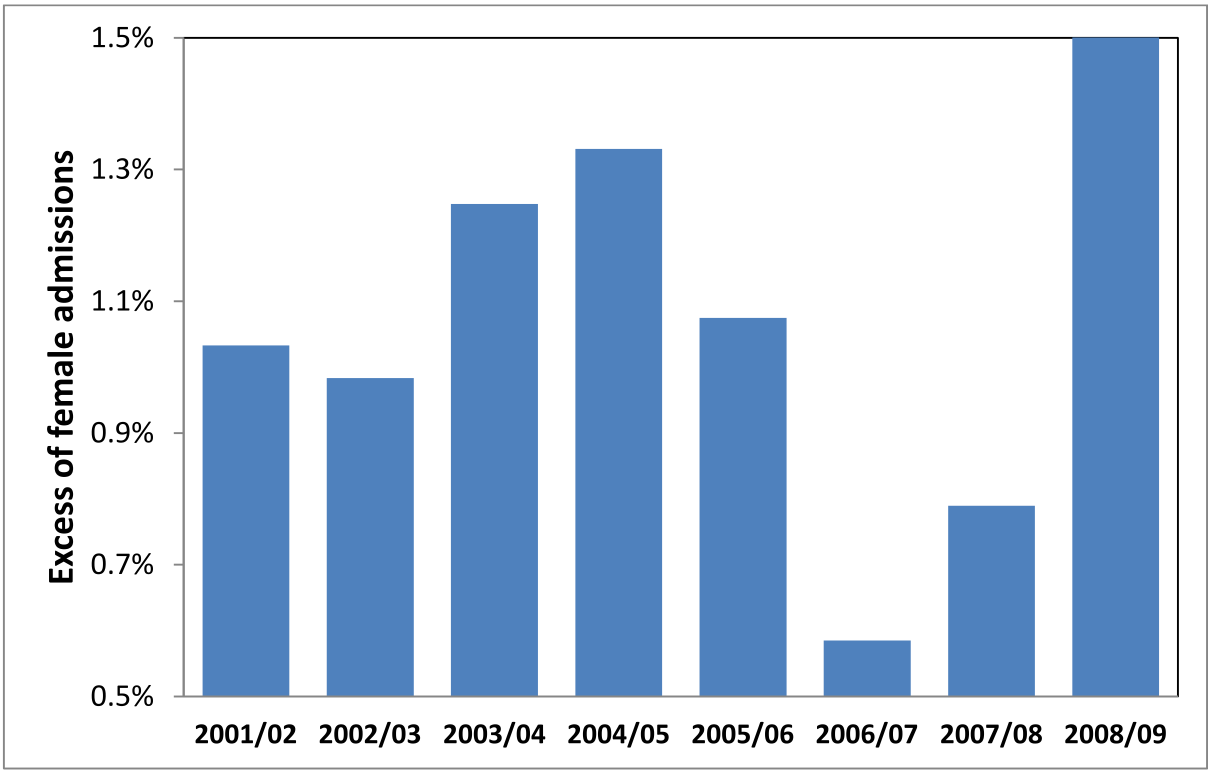
Footnote: The aim of using data from a standard HES tabulation is not to demonstrate a perfect step change but to demonstrate that a step-like change has occurred and that it is of the order of 100,000's of admissions. The standard HES tables do include some zero day stay emergency admissions although the bulk of the zero day stays will be in the specialty A&E (which is not included in these figures). Data from 2006/07 onward has been adjusted for the increasing sub-specialisation within medicine by the inclusion of the incremental increase in cardiology, gastroenterology and respiratory medicine. Both elective and emergency overnight admissions are included since these represent a continuum of overnight care (elective day case admissions are excluded).

Fig. 2: Cusum plot of medical admission rates at the Royal Berkshire Hospital.



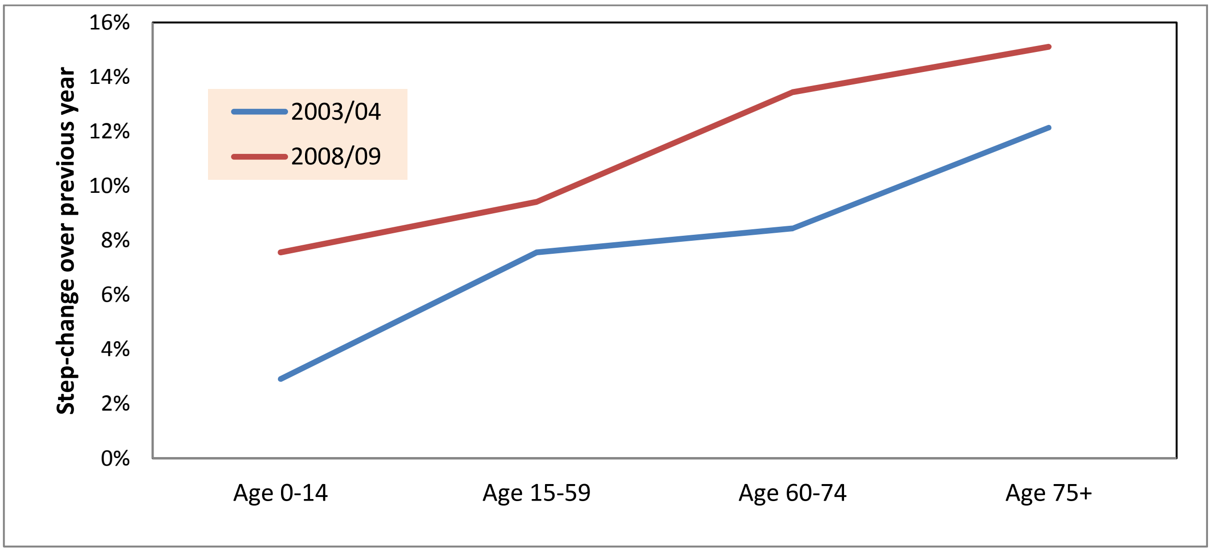
Footnote: The average daily admission rate of 24 per day seen during 1994 and 1995 was subtracted from daily admissions and a cumulative sum calculated. Each change in slope represents the point of transition to the new higher admission rate. This hospital no longer holds data prior to Apr-94 and so details of the 1993 step has been detailed separately [3]. All data excludes zero day stay admissions.

Fig. 3: Trends in excess of female admissions in the cluster of 48 diagnostic groups



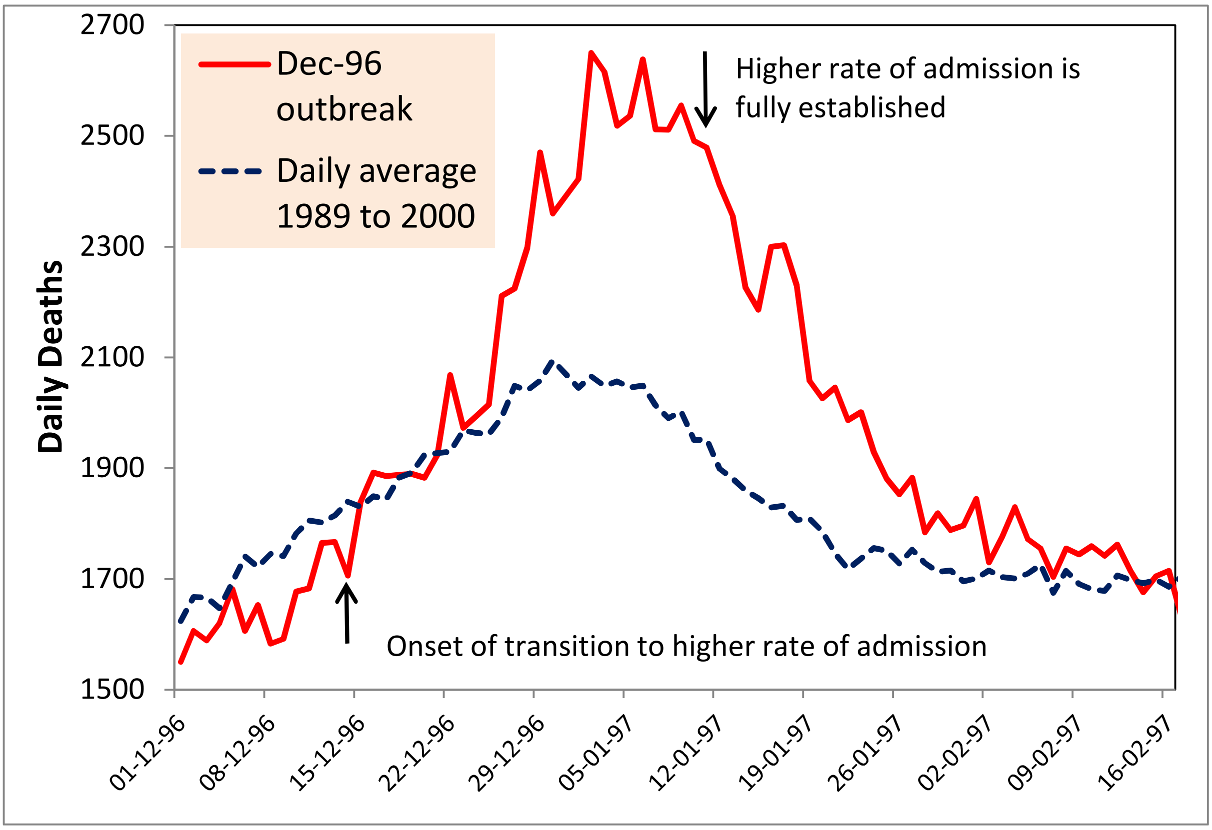
Footnote: Excess of female admissions = (female-male)/total. The standard HES specialty tables only list the count for gender in consultant episodes rather than admissions. This should not act to unduly skew the percentage of excess female admissions in any particular year. Note that there is a part-year effect in the 2007/08 data.

Fig. 4: Effect of age on the magnitude of the step changes seen within the cluster of 48 diagnostic groups



Footnote: The HES standard tables for age band include elective day case activity, i.e. endoscopies and other diagnostic activities. This acts to inflate the denominator and reduces the size of the apparent step change.

Fig. 5: Daily deaths in England and Wales and the dates of the step change observed in Reading for the 1996 step-change.



Footnote: The baseline 12 year average for deaths covers the years 1989 to 2000. During this time annual total deaths in England & Wales remained relatively constant. Excess deaths occur above the 12 year average; hence, the 15th of December in 1996 has been compared to the average of twelve 15th of December's between 1989 and 2000, etc. Since this particular outbreak occurred in winter the effect of weather and other winter viruses will need to be separated out to reveal the portion of the excess deaths solely attributable to the proposed infectious agent, although this has been partly achieved via comparison with the twelve year average.