Impact of the national rotavirus vaccination programme 1 year after its introduction in England and Wales: a time series analysis

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## ABSTRACT

**Objectives:** A monovalent oral rotavirus vaccine was introduced into the infant immunisation programme in England and Wales in July 2013. This study aimed to estimate the impact of the rotavirus immunisation programme on laboratory-confirmed rotavirus infections and hospital admissions for all-cause acute gastroenteritis (AGE) during the first year post-introduction.

**Design:** Time series analysis using data from the Public Health England (PHE) LabBase2 national laboratory reports data set and the Hospital Episodes Statistics (HES) database which holds records on all episodes of National Health Service (NHS) hospital care.

**Setting:** England and Wales between 2000 and 2014.

**Population:** For England and Wales, all laboratory-confirmed rotavirus infection reports (n=201,591) between July 2000 and June 2014, and all hospital admissions for all-cause AGE (n=2,251,424) between July 2007 and June 2014.

**Intervention:** Introduction of the infant rotavirus immunisation programme in July 2013.

**Main outcome measure:** Adjusted rate ratio (RR) comparing the rate of reported laboratory-confirmed rotavirus infections and all-cause AGE hospital admissions before and after the implementation of the infant rotavirus immunisation programme.

**Results:** In children under 1 year of age, the target group for vaccination, there was a 77% (RR 0.23, 95% CI 0.16 to 0.32, *p*<0.0001) decline in laboratory-confirmed rotavirus infections and a 26% (RR 0.74, 95% CI 0.65 to 0.84, *p*<0.0001) decline in all-cause AGE hospital admissions in 2013-2014 compared to the pre-vaccination era. Reductions were also observed in older children and adults, suggesting indirect benefits from rotavirus vaccination. In total, we estimated 10,884 laboratory-confirmed rotavirus infections and 50,427 all-cause AGE hospital admissions were averted in 2013-2014 which could be attributable to the infant rotavirus immunisation programme.

**Conclusions:** During the first post-vaccination year, we observed a substantial decline in rotavirus disease burden, most pronounced in the target age group, but with evidence of herd protection across all age groups.

**What is already known on this subject**

* The high protective efficacy (>85%) of themonovalent oral rotavirus vaccine, Rotarix®, against severe rotavirus gastroenteritis has been demonstrated in a number of large randomised controlled trials.
* Post-licensure studies for Rotarix® from the United States, Latin America, Australia and Europe have demonstrated its impact in real-world settings, with significant reductions in hospital admissions for rotavirus disease.
* The United Kingdom (UK) is the first country to use Rotarix® exclusively and, therefore, provides a unique opportunity to assess the early impact of this specific vaccine in an industrialised setting.

**What this study adds**

* Introduction of the infant rotavirus vaccination programme in July 2013 was associated with a substantial decline in rotavirus disease burden in England and Wales.
* The greatest impact was observed in the vaccine eligible cohort, infants under 1 year of age. Reductions were also observed among older age groups, indicating herd immunity.

## Introduction

Rotavirus is the most common cause of severe gastroenteritis among children under 5 years of age worldwide.[1](#_ENREF_1) Every child will experience at least one rotavirus infection by 5 years of age,[2](#_ENREF_2) with the peak incidence occurring among children aged 4 to 23 months.[3](#_ENREF_3) In England and Wales mortality due to rotavirus infection is extremely low.[4](#_ENREF_4) Nevertheless, before the introduction of rotavirus vaccination in July 2013, rotavirus gastroenteritis placed a huge burden on healthcare resources in England and Wales being responsible for an estimated 750,000 episodes of diarrhoea, 80,000 general practice (GP) consultations,[5](#_ENREF_5) and 14,300 hospital admissions in children under 5 years annually.[6](#_ENREF_6) The cost to the National Health Service (NHS) was estimated to be £14.2 million per year.[6](#_ENREF_6)

Rotarix® (GlaxoSmithKline Biologicals, Rixensart, Belgium), a monovalent live-attenuated human rotavirus vaccine, was added to the immunisation programme in England and Wales from 1st July 2013 to be given orally at 2 and 3 months of age. The vaccine is derived from the most common circulating wild-type rotavirus strain G1P[8],[7](#_ENREF_7) and is the only rotavirus vaccine used nationally. The high protective efficacy (>85%) of Rotarix® against severe rotavirus gastroenteritis has been demonstrated in a number of large randomised controlled trials in middle and high income countries.[7](#_ENREF_7)[8](#_ENREF_8) Post-licensure studies for Rotarix® from the United States (US), Latin America, Australia and Europe have demonstrated its impact in real-world settings, with significant reductions in hospital admissions for rotavirus disease.[9-12](#_ENREF_9) A 29% to 48% reduction in all-cause diarrhoea hospitalisations and a 35% to 81% reduction in rotavirus-specific hospitalisations has been reported from active surveillance in sentinel centres in Belgium, Austria, Australia, El Salvador and Brazil.[12-14](#_ENREF_12) Passive surveillance studies in Australia and Latin America have shown an 11% to 40% reduction in all-cause diarrhoea hospitalisations in children under 5 years of age.[12](#_ENREF_12)[15](#_ENREF_15)[16](#_ENREF_16) In many studies, these positive impacts were observed not only in the vaccine eligible population but also in unvaccinated older children, providing evidence of herd protection.[12](#_ENREF_12) Similar findings have been reported with RotaTeq® (Merck, Whitehouse Station, NJ, USA), the only other rotavirus vaccine available for use in Europe and the US. In Finland, one year after RotaTeq® was introduced, all-cause diarrhoea hospitalisations and all-cause diarrhoea outpatient visits among children under 5 years of age declined by 52% and 9%, respectively.[17](#_ENREF_17)

This study examined national data on vaccine coverage, hospitalisations for acute gastroenteritis (AGE) and reports of laboratory-confirmed rotavirus to evaluate the impact of the national rotavirus immunisation programme in England and Wales. Although the United Kingdom (UK) is not the first European country to introduce rotavirus vaccines into its national infant immunisation programme, it is the first to use Rotarix® exclusively and, therefore, provides a unique opportunity to assess the early impact of this specific vaccine in an industrialised setting.

## Methods

### Data source

#### Vaccine coverage

Early population vaccine coverage data for the rotavirus immunisation programme has been collected by Public Health England (PHE). PHE is an executive agency of the UK Department of Health responsible for the surveillance of vaccine preventable diseases in England and Wales. Monthly coverage data were extracted electronically from GP practice systems for children reaching the upper age for vaccination (25 weeks).[18](#_ENREF_18) GP practice participation has been high and ranged from 84% to 91% of all GP practices in England every month from October 2013 to June 2014 (representing around 44,000 to 50,500 children).[19](#_ENREF_19)

#### National Laboratory Reports (LabBase2)

Microbiology laboratories across England and Wales receive stool specimens for testing from clinicians seeing patients in hospital or primary care and report laboratory-confirmed rotavirus infections to PHE. Reporting by diagnostic laboratories is voluntary, but a recent survey in England and Wales indicated that laboratory testing and reporting practices are generally high and consistent year round.[20](#_ENREF_20) We extracted weekly counts (by date of specimen) of laboratory-confirmed rotavirus infections in all age groups between July 2000 and June 2014.

#### Hospital Episode Statistics (HES)

The Hospital Episodes Statistics (HES) database holds records on all episodes of National Health Service (NHS) hospital care in England and Wales.[21](#_ENREF_21) The data are recorded as consultant episodes, which are defined as the time period during which an admitted patient is under the care of a particular hospital consultant. The main reason for admission (primary diagnosis) and up to 19 secondary diagnoses are coded using the International Classification of Diseases version 10 (ICD-10).[22](#_ENREF_22) We extracted weekly counts of hospital admissions for all-cause AGE (ICD10 codes A00-A09 for infectious intestinal diseases, and K52.9 and P78.3 for unspecified non-infectious intestinal disease (Appendix Table A1)) for all age groups for all available years (July 2007 to June 2014). Coding of hospital episodes is based on clinical and microbiological information recorded by clinicians on discharge. Our case definition of all-cause AGE was deliberately broad as many patients with infectious AGE will not have been routinely tested for or obtained a specific microbiological diagnosis before discharge. Therefore, more specific infectious AGE diagnoses are potentially subject to misclassification within HES, and restricting our analysis to rotavirus-specific AGE admissions would substantially underestimate the clinical impact of the rotavirus vaccine on AGE. Unspecified non-infectious intestinal disease codes were used as previous studies have shown these codes are often associated with infectious causes, as they also exhibit the same seasonal pattern as infectious intestinal disease.[6](#_ENREF_6)[23](#_ENREF_23) Individuals may be admitted to hospital more than once for an ongoing episode of AGE. We treated admissions for AGE less than 28 days after a previous admission as part of the same ongoing episode.

#### Data Analysis

We analysed data by rotavirus epidemiological year, defined as running from July to June of the following year. To calculate rates we obtained mid-year population estimates for year and age from the Office of National Statistics.[24](#_ENREF_24) Data were analysed as a time-series of weekly counts of (1) laboratory-confirmed rotavirus infections and (2) hospital admissions for all-cause AGE. We fitted Negative Binomial models to counts with an offset for the denominator (population estimates by year and age), controlling for secular trends (as a function of year as a linear variable). A variable indicating post-vaccination era was used to determine the rate ratio (RR) in the 2013-2014 rotavirus season compared with the pre-vaccination era. Separate models were fitted for each of nine age groups (<1 year, 1 year, 2 years, 3 years , 4 years, 5-14 years, 15-44 years, 45-64 years and ≥65 years) for comparison with previous studies,[14](#_ENREF_14)[15](#_ENREF_15)[17](#_ENREF_17) whereby children under 1 year of age were the target group for vaccination. To investigate autocorrelation, we examined the residuals from the models (logged differences between observed and predicted numbers). Although there was some evidence of 1 and 2 week autocorrelations, models including these lag terms gave almost identical estimates and standard errors for the vaccine indicator variable so they were not included in final models. Averted laboratory-confirmed rotavirus infections and all-cause AGE hospital admissions were estimated by fitting the models to the pre-vaccination data only, then calculating the difference between the actual numbers observed and those predicted from these models for the 2013/2014 rotavirus season.

As rotavirus activity varies throughout the year with late winter/spring peaks, we investigated vaccine impact by level of rotavirus activity during the year. We created an indicator variable which took the value of 0 until vaccine introduction in July 2013 and then had three levels to indicate post-vaccination periods when historically rotavirus activity was low (Jul, Aug, Sep, Jun), medium (Oct, Nov, Dec, Jan, May) and high (Feb, Mar, Apr). The rate ratio (RR) was calculated in each of these post-vaccination periods compared to the pre-vaccination era.

Statistical significance was at the 5% level (two-sided). We analysed data with STATA IC 13.0 (StatCorp, College Station, TX).

## Results

A total of 201,591 laboratory-confirmed rotavirus infections were reported in England and Wales between July 2000 and June 2014. The source of the stool sample could be identified in 64% (n=129,344) of reports. Where the source was reported 39% (n=50,309) were from hospital inpatients, 7% (n=8,825) were from A&E or hospital outpatients, and 52% (n=66,667) were from primary care. Between July 2007 and June 2014, there were 2,251,424 hospital admissions for all-cause AGE, of which 0.7% were coded as rotavirus-specific AGE. Most infectious AGE in HES was coded as A09 “Diarrhoea and gastroenteritis of presumed infectious origin” (53% of all infectious AGE HES diagnoses, Appendix Table A2).

Figure 1A shows that the annual rate of laboratory-confirmed rotavirus infections was relatively stable during the pre-vaccination period from July 2000 to June 2013 and declined after vaccination was introduced in July 2013. This decline in disease coincided with the rapid attainment and maintenance of a national vaccine coverage level of 88% for a full vaccine course (two doses) by 25 weeks of age. Similar pre- and post-vaccination trends in laboratory-confirmed rotavirus infections were observed for samples originating from the three main sources, hospital inpatients, A&E or outpatients, and primary care. There was a secular increase in the annual rate of all-cause AGE hospital admissions during the pre-vaccination period from July 2007 to June 2013, followed by a decline between July 2013 and June 2014 (Figure 1B). Substantial attenuation in laboratory-confirmed rotavirus infections and all-cause AGE hospital admissions was seen across all age groups below 5 years of age but was most marked in infants under 1 year, the age group targeted for vaccination (Figure 2).

**Figure 1: Infant rotavirus vaccine coverage and weekly rate (per 1,000,000) of (A) laboratory-confirmed rotavirus infections reported, and (B) all-cause AGE hospital admissions in England and Wales, Jul 2000 to Jun 2014**

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Dashed blue line represents start of national universal rotavirus immunisation programme with Rotarix (1st July 2013).

\*Coverage assessment was for a full vaccine course (two doses) by 25 weeks of age.

## Figure 2: Weekly rate (per 1,000,000) by age group of (A) laboratory-confirmed rotavirus infections reported, and (B) all-cause AGE hospital admissions in England and Wales, Jul 2000 to Jun 2014



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\*Solid grey line represents mean weekly rate for pre-vaccination era. Dashed grey lines represents maximum and minimum weekly rate for pre-vaccination era. Solid black line represents weekly rate for post-vaccination rotavirus season (Jul 2013 to Jun 2014).

We found statistically significant reductions in laboratory-confirmed rotavirus infections and all-cause AGE hospital admissions in 2013-2014 compared to the pre-vaccination era in all age groups (Table 1). The largest reductions were seen in the youngest age groups. In infants under 1 year of age, the target group for vaccination, there was a 77% (RR 0.23, 95% CI 0.16 to 0.32, *p*<0.0001) decline in laboratory-confirmed rotavirus infections and a 26% (RR 0.74, 95% CI 0.65 to 0.84, *p*<0.0001) decline in all-cause AGE hospital admissions. In total, we estimated 10,884 laboratory-confirmed rotavirus infections and 50,427 all-cause AGE hospital admissions across all age groups were averted in 2013-2014 (Table 1).

Reductions in laboratory-confirmed rotavirus infections and all-cause AGE hospital admissions were focused during months of historically “high” rotavirus activity. During these months, the most substantial reductions were in infants under 1 year of age, with a reduction of 89% (RR 0.11, 95% CI 0.06 to 0.20, *p*<0.0001) and 49% (RR 0.51, 95% CI 0.47 to 0.55, *p*<0.0001) in laboratory-confirmed rotavirus infections and all-cause AGE hospital admissions, respectively (Figure 3).

**Table 1: Laboratory-confirmed rotavirus infections and all-cause AGE hospital admissions in 2013-14 compared with the pre-vaccination era in England and Wales, including estimated laboratory-confirmed rotavirus infections and all-cause AGE hospital admissions averted by the rotavirus vaccination programme**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Laboratory-confirmed rotavirus infections** | | | | | |
| Age group **(years)** | **Mean**  **2000-01 to 2012-13 (minimum)** | **2013-14** | **RR (95% CI)** | ***p* value** | **Number averted** |
| **<1** | 6,041 (5,310) | 1,402 | 0.23 (0.16-0.32) | <0.0001 | 4,810 |
| **1** | 5,417 (4,895) | 2,083 | 0.34 (0.23-0.50) | <0.0001 | 4,026 |
| **2** | 1,696 (1,402) | 604 | 0.36 (0.24-0.52) | <0.0001 | 1,087 |
| **3** | 617 (534) | 207 | 0.34 (0.23-0.50) | <0.0001 | 405 |
| **4** | 316 (257) | 112 | 0.35 (0.23-0.52) | <0.0001 | 210 |
| ≥5† | 788 (652) | 343 | 0.50 (0.37-0.67) | <0.0001 | 346 |
| All ages |  |  |  |  | 10,884 |
| **All-cause AGE hospital admissions** | | | | | |
| Age group(years) | **Mean**  **2007-08 to 2012-13 (minimum)** | **2013-14** | **RR (95% CI)** | ***p* value** | **Number averted** |
| <1 | 20,663 (20,131) | 15,101 | 0.74 (0.65-0.84) | <0.0001 | 5,256 |
| 1 | 14,678 (14,019) | 10,078 | 0.67 (0.54-0.82) | <0.0001 | 4,648 |
| 2 | 6,108 (5,760) | 4,524 | 0.73 (0.61-0.88) | <0.0001 | 1,565 |
| 3 | 3,490 (3,074) | 2,986 | 0.81 (0.69-0.94) | <0.0001 | 710 |
| 4 | 2,490 (2,197) | 2,402 | 0.88 (0.77-1.00) | 0.006 | 333 |
| 5-14 | 11,426 (10,446) | 11,782 | 0.92 (0.87-0.98) | <0.0001 | 1,020 |
| 15-44 | 64,381 (56,408) | 70,781 | 0.92 (0.90-0.94) | <0.0001 | 6,043 |
| 45-64 | 64,734 (53,920) | 71,082 | 0.88 (0.86-0.90) | <0.0001 | 9,484 |
| ≥65 | 133,468 (121,978) | 134,079 | 0.86 (0.83-0.90) | <0.0001 | 21,368 |
| All ages |  |  |  |  | 50,427 |

CI: confidence interval; RR: rate ratio

†We hypothesized that indirect protection may be afforded to adults of child-bearing age, so smaller age groups were initially considered. However, number of reported laboratory-confirmed rotavirus infections in older children and adult age groups were small so to maximise statistical power the ≥5 year old population was combined.

**Figure 3: Rate ratio and 95% CI for (A) laboratory-confirmed rotavirus infections and (B) all-cause AGE hospital admissions in 2013-14 compared with the pre-vaccination era in months of low, medium and high rotavirus activity in England and Wales**

**A**

**B**

\*Low rotavirus activity months: Jul, Aug, Sep, Jun; Medium rotavirus activity months: Oct, Nov, Dec, Jan, May; High rotavirus activity months: Feb, Mar, Apr

## Discussion

The introduction of the national rotavirus vaccination programme in July 2013 led to rapid attainment of high levels of vaccine coverage,[19](#_ENREF_19) and was associated with rapid and significant reductions in both laboratory-confirmed rotavirus infections and all-cause AGE hospital admissions in England and Wales. The greatest impact was observed in infants under 1 year of age, who were eligible to receive the vaccine as part of the national programme. Significant reductions were also seen in older infants, children and adults, indicating herd immunity, achieved through reduced viral transmission at a population level.

**Strengths and limitations**

The UK is the first country to use Rotarix® exclusively in its national infant immunisation programme. Therefore, this is the first study to be able to assess the early impact of this specific vaccine in an industrialised setting. Our study’s strength lies in its use of large historical nationally representative population-based datasets providing information on both the microbiological and clinical impact of rotavirus vaccination. As many patients with AGE (especially older children and adults) are not routinely tested to obtain a specific microbiological diagnosis,[25](#_ENREF_25) analysis of laboratory-confirmed rotavirus infections alone would substantially underestimate the clinical impact of the programme on AGE.

Our study has important limitations. Its design was descriptive and ecological and, therefore, the effects measured may be due to other factors not related to immunisation. First, rotavirus testing practices could have changed in the post-vaccination period. However, PHE sentinel surveillance across a number of NHS hospital microbiology laboratories in England indicates no change in the number of stool samples being tested for rotavirus in any age group during the 2013-14 rotavirus season compared to the previous year, although the proportion of rotavirus test-positives has declined significantly after vaccine introduction, (personal communication, Sarah Collins, November 2014). Second, the accuracy of HES diagnoses codes depends on clinical diagnoses recorded in patients’ medical records. Coding practices could have changed over time. Our case definition of all-cause AGE was deliberately broad to allow for potential variation in misclassification of more specific AGE diagnoses over time. Discharge diagnoses recorded in HES are regularly validated for consistency and undergo internal quality control.[26](#_ENREF_26)[27](#_ENREF_27) Last, there is natural year-to-year variability in the size of the rotavirus season. It remains a possibility that at least some of the observed decrease may be due to a less active rotavirus year, independent of vaccination effect. Indeed, in the Netherlands a low 2013/2014 rotavirus season was reported in the absence of rotavirus vaccination.[28](#_ENREF_28) Although the reductions we observed could be attributed to the natural seasonal fluctuations in rotavirus activity, they are significantly more pronounced than the historical long-term patterns typically observed for rotavirus in England and Wales over the past three decades. Furthermore, unlike in the Netherlands were they reported a general decline in rotavirus activity for all children under 5 years of age, we observed a greater impact in <1 year-olds, who were eligible to receive the vaccine as part of the national programme.

**Findings related to previous studies**

Our results are similar to reports from other countries with national rotavirus immunisation programmes. In the US, in the first year following the introduction of rotavirus vaccine (RotaTeq®) a 67% decline in the number of rotavirus-positive test results was observed.[29](#_ENREF_29) In Europe, rotavirus is estimated to be responsible for 21% to 58% of hospital admissions for AGE,[6](#_ENREF_6)[30](#_ENREF_30) and countries that have implemented a universal infant rotavirus immunisation programme have observed 65% to 84% reductions in rotavirus-specific hospitalisations in vaccine-eligible children following vaccine introduction.[13](#_ENREF_13)[14](#_ENREF_14)[31-39](#_ENREF_31) In Belgium, where coverage is estimated to be at least 90%, and 95% of children receiving a rotavirus vaccine are given Rotarix®,[36](#_ENREF_36) a 50% to 61% decline in the number of laboratory-confirmed rotavirus infections was observed across all age groups in post-vaccination years compared to the pre-vaccination era.[34](#_ENREF_34)[36](#_ENREF_36) These estimates are in line with our findings. A decline in hospitalisations for non-specific AGE diagnoses has also been observed in Australia,[40](#_ENREF_40) and the US.[41](#_ENREF_41) In the US study, there was a 39% decline in cause-unspecified AGE in children aged under 5 years following introduction of rotavirus vaccination.[41](#_ENREF_41) Reductions were also observed among unvaccinated older infants, children and adults, consistent with our findings.[40](#_ENREF_40)[41](#_ENREF_41)

Exploring the impact of rotavirus vaccination on all-cause AGE admissions can be considered equivalent to a vaccine-probe study, where prevented unspecific disease burden can be assumed to be caused by the agent the vaccine is targeted against. Indeed, it has been reported that rotavirus gastroenteritis was responsible for an estimated 14,300 hospital admissions in children under 5 years annually in England and Wales prior to rotavirus vaccination.[6](#_ENREF_6) Consistent with these findings, we estimated 12,512 all-cause AGE hospital admissions in children under 5 years were averted in 2013-2014. This reduction in hospitalisations is unexpectedly high considering only infants under 1 year of age were eligible for vaccination, and suggests that previous studies may have underestimated rotavirus-attributable hospital admissions in England and Wales, or that infants under 1 year of age play a much more important role in transmission of the virus within the population than previously thought.

**Implications and future research**

Our study has shown a substantial reduction in rotavirus disease burden within a few months of vaccine introduction in infants. However, it will be important to continue monitoring these trends over time to confirm the longer-term impact of rotavirus vaccination. The US experience suggests that the disease burden should continue to decline further across all age groups , although the duration of direct and indirect protection afforded by a young infant immunisation programme remains difficult to predict.[42](#_ENREF_42) Our estimated averted AGE hospitalisations could represent large healthcare cost savings attributable to the vaccination programme and should be accounted for in subsequent cost-effectiveness studies for Rotarix® in England and Wales, which have so far only considered cost benefits afforded by direct protection of children.[43](#_ENREF_43)[44](#_ENREF_44) In clinical trials, rotavirus vaccines have been shown to be more efficacious against severe rotavirus disease.[45](#_ENREF_45)[46](#_ENREF_46) It is therefore possible that the reduction in hospitalisations observed may be associated with a shift to more infections presenting in the community; this merits further study.

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## Appendix

## A1: ICD-10 codes for all-cause acute gastroenteritis (AGE)

|  |  |
| --- | --- |
| **All-cause AGE** | **ICD10 code in any diagnosis field** |
| **Infectious intestinal disease** |  |
| A00 | Cholera |
| A01 | Typhoid and paratyphoid fevers |
| A02 | Other salmonella |
| A03 | Shigellosis |
| A04.0-04.8 | Other bacterial intestinal infections |
| A04.9 | Bacterial intestinal infection, unspecified |
| A05.0-05.8 | Other bacterial foodborne intoxications |
| A05.9 | Bacterial foodborne intoxication, unspecified |
| A06 | Ameobiasis |
| A07.0-07.8 | Other protozoal intestinal diseases |
| A07.9 | Protozoal intestinal disease,unspecified |
| A08.0 | Rotaviral enteritis |
| A08.1 | Acute gastroenteropathy due to Norwalk agent |
| A08.2 | Adenoviral enteritis |
| A08.3 | Other viral enteritis |
| A08.4 | Viral intestinal infection, unspecified |
| A08.5 | Other specified intestinal infections |
| A09 | Diarrhoea and gastroenteritis of presumed infectious origin |
| **Unspecified non-infectious intestinal disease** |  |
| K52.9 | Non-infective gastroenteritis and colitis, unspecified |
| P78.3 | Non-infective neonatal diarrhoea |

## A2: Infectious intestinal disease, HES database Jul 2007 to Jun 2014

|  |  |  |
| --- | --- | --- |
| **Infectious intestinal disease** | **ICD10 code in any diagnosis field** | **No. (%) infectious intestinal disease codes** |
| A00 | Cholera | 0.01% |
| A01 | Typhoid and paratyphoid fevers | 0.23% |
| A02 | Other salmonella | 0.58% |
| A03 | Shigellosis | 0.09% |
| A04.0-04.8 | Other bacterial intestinal infections | 19.22% |
| A04.9 | Bacterial intestinal infection, unspecified | 0.21% |
| A05.0-05.8 | Other bacterial foodborne intoxications | 0.03% |
| A05.9 | Bacterial foodborne intoxication, unspecified | 0.08% |
| A06 | Ameobiasis | 0.07% |
| A07.0-07.8 | Other protozoal intestinal diseases | 0.28% |
| A07.9 | Protozoal intestinal disease,unspecified | 0.00% |
| A08.0 | Rotaviral enteritis | 1.58% |
| A08.1 | Acute gastroenteropathy due to Norwalk agent | 2.38% |
| A08.2 | Adenoviral enteritis | 0.15% |
| A08.3 | Other viral enteritis | 2.13% |
| A08.4 | Viral intestinal infection, unspecified | 20.32% |
| A08.5 | Other specified intestinal infections | 0.07% |
| A09 | Diarrhoea and gastroenteritis of presumed infectious origin | 52.56% |