

Who comes back with what: A retrospective database study on reasons for emergency re-admission to hospital in children and young people in England

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Abstract

Objective - To determine the proportion of children and young people (CYP) in England who are readmitted for the same condition.

Design - Retrospective cohort study

Setting – National administrative hospital data (Hospital Episode Statistics).

Participants - CYP (0-24 year olds) discharged after an emergency admission to the NHS in England in 2009/10.

Main outcome measures - Coded primary diagnosis classified in six broad groups indicating reason for admission (infection, chronic condition, injury, perinatal- or pregnancy-related, sign or symptom, or other). We grouped readmissions as ≤ 30 days, or between 31 days and 2 years after the index discharge. We used multivariable logistic regression to determine factors at the index admission that were predictive of readmission within 30 days.

Results - 9% of CYP were readmitted within 30-days. Half of the 30 day readmissions and 40% of the recurrent admissions between 30 days and 2 years had the same primary diagnosis group as the original admission. These proportions were consistent across age, sex and diagnostic groups, except for infants and young women with pregnancy-related problems (15-24 years) who were more likely to be readmitted for the same primary diagnostic group. CYP with underlying chronic conditions were readmitted within 30 days twice as often (OR: 1.93, 95% CI: 1.89 – 1.99) compared to CYP without chronic conditions.

Conclusions - Financial penalties for readmission are expected to incentivise more effective care of the original problem, thereby avoiding readmission. Our findings, that half of children come back with different problems, do not support this presumption.

Background

A large proportion (32%) of children and young people (CYP) who have an emergency hospital admission will have at least one further emergency admission during the next two years[1]. One in four of these patients are readmitted within 30 days of discharge.

Reimbursements for emergency readmissions within 30 days of discharge are restricted in the English NHS. The rule applies to all patients older than four years of age and was introduced in 2011/12 to “encourage providers and commissioners to manage emergency admissions better through well-planned discharges, participation in preventative initiatives, and greater involvement of experienced clinicians earlier in the decision-making process”[2]. Evidence from the US shows that adult patients come back with different diagnoses, suggesting that not all readmissions might be preventable[3–5]. A UK study of adults found similar results and deemed only 30% of readmissions to be potentially preventable[6].

Previous studies focussed on adult populations[7], hospital factors[5,8], or specific conditions[9–11] and therefore have limited applicability to hospital care for CYP.

We aimed to evaluate the hypothesis underlying the 30-day readmission rule that readmissions are often for the original problem, focussing on CYP. We assessed the proportion of CYP readmitted for the same problem within 30 days of discharge from a previous emergency admission.

Methods

Data source

We performed a retrospective cohort study using hospital administrative data for all inpatient admissions to NHS hospitals in England (Hospital Episode Statistics (HES))[12].

Population

We defined a cohort of CYP who were discharged from an emergency hospital admission between 1 April 2009 and 31 March 2010, the year before the readmission rule was introduced, when they were 0-24 year old, and used the HES-ID unique patient identifier to track subsequent emergency readmissions over the next two years[13]. For detail on how we defined admissions see appendix B and previous reports[1,14].

We extracted patient characteristics including age group (<1 year, 1-4 year, 5-15 year, and 16-24 year), ethnicity and area-level deprivation (measured by quintile of the index of multiple deprivation, IMD 2004[15,16]), at index admission, or if missing, from any admission between 2009 to 2011. We classified all patients with a valid Code of GP practice as registered with a GP. If variables differed between admissions, we used the mode.

We excluded CYP who had missing information on sex (1,410, 0.2%), IMD (13,027, 1.5%), or ethnicity (71,446, 8.3%) as these children were less likely to be linked longitudinally via their HES-ID. CYP with missing data could receive a different HES-ID on readmission, leading to missed matches. In the absence of patient identifiers, it is not possible to detect these patients[17]. As missing data often occurred in multiple variables, we excluded 72,542 CYP in total (8.4%)

Primary diagnosis at admission

We used the primary diagnosis of the first (and in most cases the only) finished consultant episode recorded during the admission to indicate the clinical reason for the index admission. The primary diagnosis is determined and entered by professional NHS coders after discharge and is defined as the main condition treated or investigated during the relevant episode of healthcare[19]. For statistical analysis, we defined six broad groups of ICD-10 diagnostic codes recorded in the primary diagnosis: infection[20], chronic condition[14], injury[21], pregnancy or perinatal-related[1], sign or symptom (ICD-10 chapter 18), or other for all residual diagnoses. To determine the impact of the grouping of codes, we

also grouped the primary diagnosis by 23 ICD-10 chapters (codes for groupings listed in Appendix B).

Analysis

We stratified analyses by age group. We determined the proportion of patients who had an emergency readmission within 30 days or between 31 days and 2 years of the date of discharge of the index admission discharge, for whom the primary diagnosis was in the same group of ICD10 codes (i.e. same of 6 groups, or ICD10 chapters) at both the index and recurrent admission. We only used the first recurrent admission, resulting in mutually exclusive 30-day readmission/<2 year recurrent admission groups. To limit the risk of disclosure, we only included the ten most commonly recorded ICD10 chapters for each age group, grouping the remainder of primary diagnosis groups in an 'other' category.

We used logistic regression to identify patient characteristics associated with 30-day readmissions, using information available on index admission (sex, age, indication, ethnicity, IMD quintile, underlying chronic conditions, and GP registration). We determined underlying chronic conditions by assessing inclusion of codes for chronic conditions[14] in any diagnosis code entered during an admission in the previous year (2008/09). We did not include this variable for infants. We compared CYP who had a 30-day readmission with CYP who had no recurrent admission or a recurrent admission later than 30 days after index admission discharge. We used robust standard errors for parameter estimates to correct for clustering by hospital.

We conducted a sensitivity analysis to determine whether the proportion of readmissions with diagnostic codes from a different group diminished when all 20 diagnostic fields (mean number recorded is 2.9 diagnosis codes, sd: 2.2) were considered at the index admission.

All analyses were performed using Stata SE version 13.0. The interactive bipartite graphs were created using D3 block #9796212 [22]. The Treemap was created using Google Charts.

Results

We included 866,221 children with at least one emergency admission. Emergency readmissions occurred within 30 days of discharge for 76,234 CYP (8.8% of index admissions) and between 30 days and 2 years for 193,988 CYP (22.4% of index admissions).

The primary diagnosis at index emergency admission varied by age (Figure 1). Infections accounted for half of the primary diagnoses in infants and children aged 1-4 years. The prevalence of injury admissions increased with age.

50% (infants) to 60% (16-24 year olds) of CYP who were readmitted within 30 days after index discharge had a primary diagnosis from the same broad coding group on both index and readmission (Table 1). For later recurrent admissions 35 to 40% had a similar primary diagnosis. Similar results were found for the code groupings by ICD-10 chapter.

Proportions of readmissions for the same primary diagnosis group as the index admission were similar to the overall findings (Figure 2, Appendix C). Young children (<1 year and 1-4 year) who had infection were more likely to come back with the same problem than was the case for other conditions (72% and 74%, respectively). Young women who had a pregnancy-related primary diagnosis at index admission came back with the same problem in 88% of 30-day readmissions.

Readmission within 30 days was more likely in CYP with underlying chronic conditions (OR: 1.93, 95% CI: 1.89–1.99, Figure 3 and eTable 1 in Appendix A), girls (OR: 1.04, 95% CI: 1.02–1.05), and more deprived CYP (most deprived compared to least deprived, OR: 1.06, 95% CI: 1.03–1.09, eTable 2 in Appendix A). Readmission was less likely in CYP who were not registered with a GP (OR: 0.88, 95% CI: 0.84–0.93), or had unstated ethnicity (OR: 0.60, 95% CI: 0.55–0.63). Similarly, CYP with missing data on IMD or ethnicity were less likely to be readmitted (data not shown).

For infants, chronic conditions were the strongest predictor for 30-day readmissions among the six primary diagnosis groups (OR: 3.31, 95% CI: 2.96–3.71), while overall perinatal/pregnancy related primary diagnoses were the strongest predictor (OR: 3.02, 95% CI: 2.92–3.11). Admissions with injury-related primary diagnoses were least likely to result in a 30-day readmission across all age groups. Overall, effect estimates were consistent across age groups, apart from sex which was reversed in infants and children age 1-4 years where girls were less likely to have a readmission (OR: 0.88, 95% CI: 0.85–0.90 and OR: 0.96, 95% CI: 0.93–1.00, respectively).

Sensitivity analysis

When all diagnostic fields were included for the index admission, the rates of recurrent admissions with the same indication as index admission increased to 71-77% for <30-day readmissions and 49-56% for later recurrent admissions for the broad groupings. For groupings by ICD-10 chapter, the proportion of readmissions with similar primary diagnoses increased to 59-70% for <30-day readmissions, and to 28-42% for later recurrent admissions (ranges reflect different age groups, eTable 3 in Appendix A).

Discussion

Overall, 8.8% of CYP who had an emergency hospital admission between 1 April 2009 and 31 March 2010 were readmitted within 30 days. CYP with an emergency readmission had the same primary diagnosis at readmission and index admission in 50-60% of 30-day readmissions (infants and 16-24 year olds, respectively). In recurrent admissions that happen between 30 days and two years after index admission discharge, 35-40% of CYP had the same primary diagnosis.

We found that children aged 1-4 years were less likely than older children to have readmissions for the same indication as index admission, supporting the exemption from the 30-day readmission rule for children up to age 4 years. However, the difference with older

age groups was small. This suggests that extending the age exemption to older age groups or abolishing the penalty tariff would not have a significant effect on the number of readmissions for similar diagnoses.

Our findings are consistent with studies in adults: in a US study using Medicare data on patients aged 65 years and older, only 40-50% of patients had a similar indication on readmission compared to their index admission[23]. In addition, two US studies found that rates of readmission varied by condition, with rates ranging from 21% to 86%[7,24]. The latter estimate is closer to our estimate of 66-75% when considering all diagnoses recorded at index admission.

A UK study on readmission found that 30% of readmissions were broadly related to the previous admission[6]. Their estimate is likely lower than our finding of 50% as they also included elective index admissions and used a different classification method.

Several studies have found increases in readmission rates associated with children with chronic conditions[25,26]: a US study found that patient had chronic conditions in 78% of readmissions. [27].

Strengths and limitations

We found that CYP who had missing data on ethnicity and/or IMD were less likely to be readmitted compared to CYP without missing data on these variables. This may be associated with incomplete or erroneous identifiers, thereby reducing the chance of linkage to a subsequent admission[16,28].

Our results are likely to overestimate the proportion of CYP who are readmitted with the same problem because of our relatively broad groupings and hospital coding practices. For instance, patients who have been admitted with an infection as a primary diagnosis on original and readmission are classified as having the same problem, while in fact they could have had two unrelated infections (e.g. an urinary tract infection and a lower respiratory tract

infection). Although we expect this limitation to affect the grouping by ICD10 chapter to a lesser extent, it could still apply (e.g. admissions for acute tonsillitis (J03) and asthma (J45) which would both be classified as diseases of the respiratory system).

In addition, we performed sensitivity analyses where we included all diagnoses entered during index admission. However, our results were very similar, indicating that readmissions are often for reasons not recorded on index admission, either as primary, or subsidiary diagnosis.

Coding from a previous admission could have influenced primary diagnosis code entry at a subsequent readmission as hospital coders often have access to information from previous hospital visits or the full medical record upon data entry (personal communication with University College London Hospital clinical coding department). As financial reimbursements favour certain high tariff diagnoses, coders could favour similar primary diagnosis codes that attract high tariffs, for instance in patients with chronic conditions. Similarly, if coders are aware of the rules for readmission penalties, this could influence coded diagnoses. However, there are strict rules in order to ensure consistent and fair coding.

In addition, our sensitivity analysis, where we included all diagnoses codes recorded on index admission rather than just the primary diagnoses, showed similar results to the main results, albeit with slightly higher proportions of similar diagnoses. This strengthens our overall finding and suggests that hospitals do not 'game' readmission reimbursements by entering similar primary diagnoses for both the index and subsequent readmissions.

Due to the nature of HES data, we were unable to determine whether children were admitted to paediatric wards or observation units.

Finally, we have limited our analyses to emergency admissions and first readmissions, excluding CYP who had elective index admissions or multiple readmissions, as this was beyond the scope of this paper.

Policy context

Policy makers need to balance potential benefits and harms of using tariffs to disincentivise hospital readmissions. The NHS England engagement documents for the 2015/16 National Tariff announced that they will review the 30-day readmission penalty (as well as the marginal rate rule, which sets a baseline level of emergency admissions above which providers are paid 30% of the national price for admissions) for subsequent years[31]. The NHS in England is one of many healthcare systems to use tariffs to disincentivise hospital readmissions. Our results suggest that reduction in payments for readmissions may penalise provision of care which is not directly amenable to intervention during the index admission. However, further research on more recent data after the introduction of this rule is needed to confirm this. In addition, these penalties may impact most on children with chronic conditions. Our findings likely reflect the variety of health problems occurring in children, although further evaluation is needed in non-NHS settings.

Implications for policy and practice

Our findings, that around half of readmissions are for a different condition, suggest that indiscriminate penalties for all readmissions are poorly supported by evidence. The variation in proportion of readmission that occur for the same reason as on index admission across different conditions found in various studies further suggest the evidence available does not support unselective policy measures. For health care providers, the findings suggest that services need to address holistic care needs in addition to the problem at the index admission, to reduce the frequency and severity of subsequent episodes of ill health. However, whether more effective and holistic care should be measured in terms of reduced (re)admissions, or should be delivered in the community or hospital is far from certain. Undoubtedly, reduced readmissions reduce health care costs but are not clearly linked to improved quality of care in children[32]. There is also a lack of evidence for effective interventions to reduce readmissions[33]. A recent systematic review on interventions to

reduce 30-day readmissions identified 43 studies testing various pre- and post-discharge interventions as well as interventions that bridged the transition from hospital to primary care, none of which were consistently associated with a reduced risk for 30-day readmissions[34]. This review excluded studies involving children. A few interventions aimed at CYP[35], such as structured discharge procedures for asthmatic children[36], clinical pathways for infants with bronchiolitis[37], or a transition care programme for young adults with type 1 diabetes[38], have achieved reductions in readmission rates. However, these interventions included small patient groups and have limited reproducibility[39].

Given the uncertain evidence, policy makers should prioritise evaluation of the 30-day readmission rule and reconsider disincentivising hospital readmissions until the benefits of the policy can be established.

Footnotes

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Data sharing statement: Additional data can be accessed in the appendices. Source data can be accessed by researchers applying to the Health and Social Care Information Centre for England. Copyright © 2015, Re-used with the permission of the Health and Social Care Information Centre. All rights reserved.

Transparency declaration: The lead author affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

What is already known on this topic:

- In children and young people, recurrent admissions make up 41% of all emergency admissions and account for 66% of bed days over a 2 year period.
- The UK government has implemented financial incentives to decrease the number of 30-day readmissions as these are deemed to be avoidable failures of hospital care
- Research in adults found that 30 to 50% of 30-day readmissions (depending on indication on index admission) were for a different primary diagnosis from the original admission

What this study adds:

- Half the children and young people who were readmitted within 30 days came back with a different primary diagnosis
- Emergency re-admissions within 30 days were twice as likely in children with underlying chronic conditions: they occurred in 16% of patients with, compared to 8% of patients without chronic conditions.
- Our findings do not support the presumption that financial penalties for readmission incentivise more effective care of the original problem.

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Tables

Table 1: Proportion of recurrent admissions that have the same primary diagnosis as the index admission		
6 Groups	<30 day	≥30 day, <2 years
Infants (0 years)	10,724 (57.5)	16,255 (36.8)
1-4 year	11,610 (60.9)	23,311 (43.7)
5-15 year	9,789 (60.5)	16,510 (43.0)
16-24 year	26,446 (61.9)	44,244 (41.1)
ICD-10 chapter		
Infants (0 years)	9,337 (50.1)	9,313 (21.1)
1-4 year	9,677 (52.8)	17,175 (32.2)
5-15 year	9,382 (58.0)	15,194 (39.6)
16-24 year	25,670 (60.1)	41,081 (38.2)

Figures

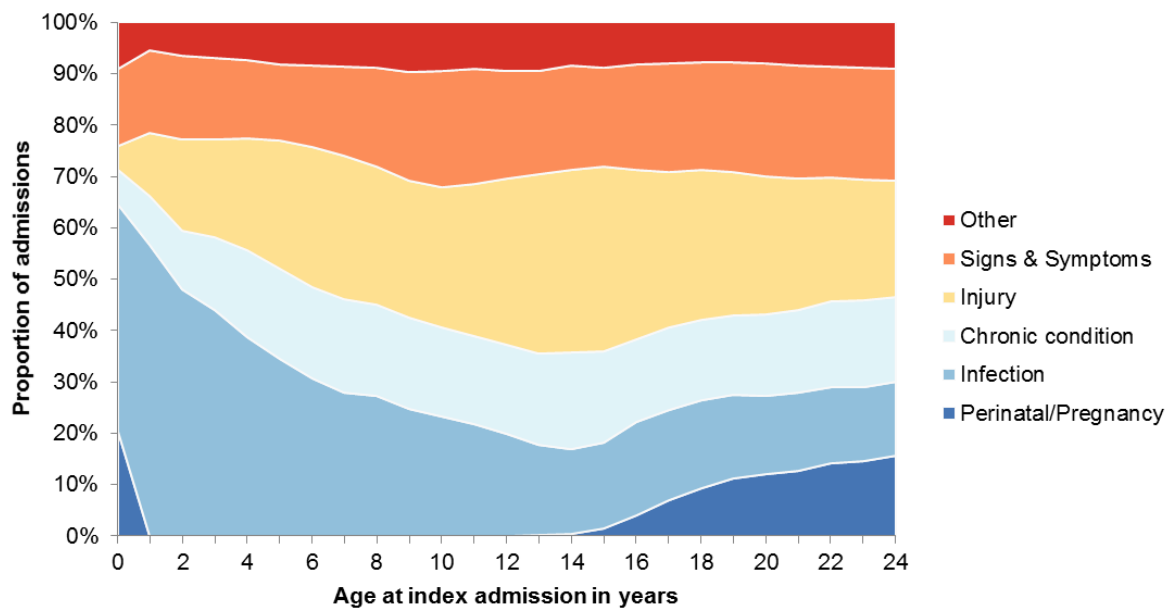


Figure 1: primary diagnosis at first emergency admission in 2009

Infants

Click here for: [Grouping by ICD-10 chapter](#)

Click here for: [1 - 4 years](#), [5 - 15 years](#), or [16 - 24 years](#)

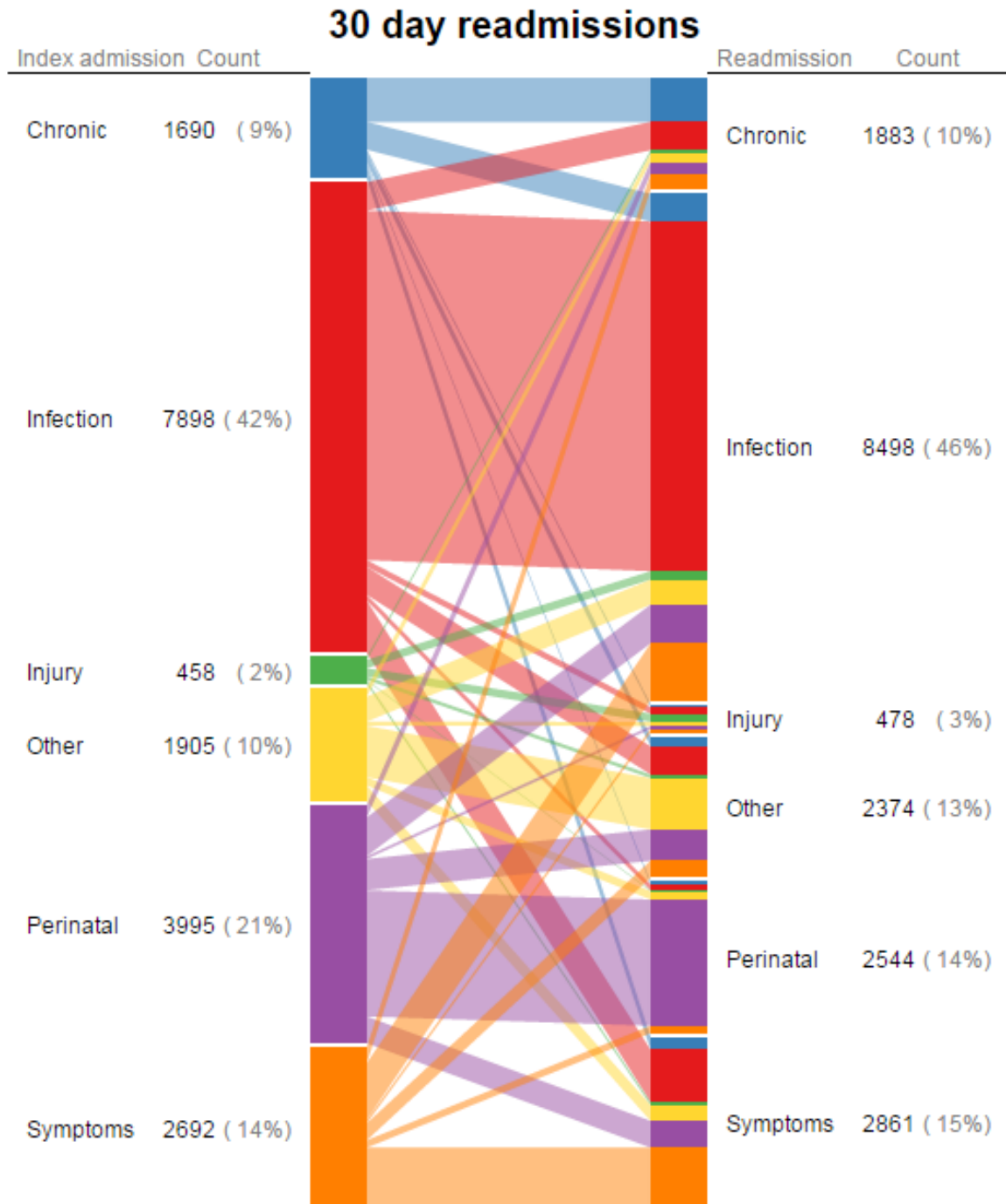


Figure 2: Primary diagnosis at index and readmission for infants (6 broad groups). Small numbers (<10 patients) were rounded up to ten to preserve patient anonymity.

TreeMap of predictors of readmission

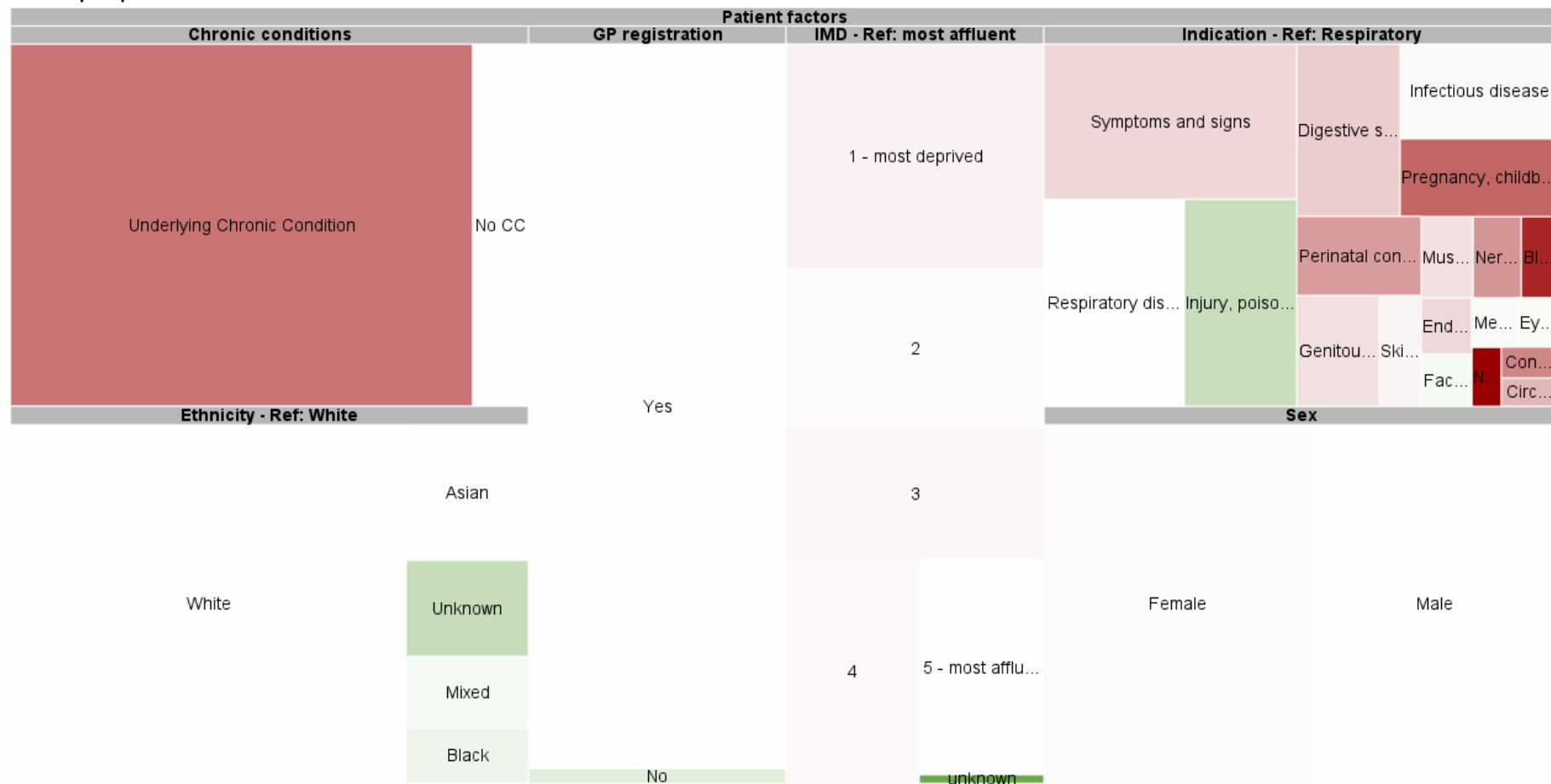


Figure 3: Treemap of predictors of 30-day readmissions – size reflects prevalence of different patient factor, colour represents estimated effect size of risk factors that increase (red) or decrease (green) the likelihood of readmission, calculated using multivariable logistic regression. Details on prevalence (eTable 1) and effect size (eTable 2) available in appendices. ([Interactive version](#))

Appendix A – Additional tables

eTable 1: Number and percentage of children with 30-day readmission by age group and covariates included in analysis					
Age group (% who are readmitted within 30 days, total)	Infants (12.2%, 152,558)	1-4 years (7.7%, 197,227)	5-15 years (7.4%, 213,800)	16-24 years (8.8%, 302,636)	Overall (8.8%, 866,221)
GP registration					
Yes	18,001 (12.2)	14,968 (7.7)	15,727 (7.5)	25,838 (9.0)	74,534 (8.9)
No	533 (11.0)	146 (5.4)	119 (4.0)	774 (4.9)	1,572 (6.0)
Sex					
Boys	10,948 (12.8)	8,648 (7.8)	8,045 (6.8)	9,085 (7.1)	36,726 (8.3)
Girls	7,586 (11.4)	6,466 (7.5)	7,801 (8.2)	17,527 (10.0)	39,380 (9.3)
Primary diagnosis group					
Infection	8,151 (11.6)	7,472 (7.6)	3,729 (7.3)	3,597 (7.2)	22,949 (8.5)
Chronic condition*	1,976 (17.4)	2,688 (11.0)	4,001 (10.2)	5,143 (9.9)	13,808 (10.9)
Injury	398 (5.9)	1,293 (4.1)	2,655 (4.2)	4,652 (5.9)	8,998 (5.0)
Perinatal / pregnancy	3,519 (12.8)	-	52 (11.3)	5,084 (15.2)	8,657 (14.0)
Symptoms	2,612 (11.5)	2,606 (8.3)	3,943 (9.6)	5,872 (9.3)	15,033 (9.5)
Other	1,878 (13.7)	1,053 (8.6)	1,466 (7.8)	2,264 (9.2)	6,661 (9.6)
Underlying chronic condition*					
Yes	6,646 (22.9)	2,060 (15.2)	2,137 (15.4)	3,620 (15.6)	14,463 (15.8)
No	12,386 (9.7)	13,077 (7.1)	13,710 (6.9)	22,889 (8.2)	62,062 (8.3)
Ethnicity					
White	14,136 (12.5)	11,089 (7.8)	12,151 (7.6)	21,225 (9.1)	58,601 (9.0)
Black	576 (10.3)	602 (7.0)	599 (7.4)	1,090 (10.1)	2,867 (8.7)
Asian	1,914 (12.7)	1,701 (8.5)	1,474 (8.5)	1,791 (9.8)	6,880 (9.8)
Mixed	1,030 (11.4)	886 (7.5)	676 (7.5)	1,050 (8.3)	3,642 (8.6)
Missing	874 (9.4)	826 (6.0)	936 (4.9)	1,448 (5.3)	4,084 (5.9)
IMD quintile					
1 - most deprived	5,829 (12.8)	4,353 (7.5)	4,159 (7.2)	8,843 (9.6)	23,184 (9.2)
2	4,038 (12.2)	3,178 (7.6)	3,129 (7.3)	5,976 (8.9)	16,321 (8.8)
3	3,237 (12.1)	2,755 (8.1)	2,895 (7.6)	4,703 (8.9)	13,590 (8.9)
4	2,823 (11.9)	2,448 (7.8)	2,797 (7.8)	3,767 (8.5)	11,835 (8.8)
5 – most affluent	2,524 (11.5)	2,305 (7.7)	2,785 (7.7)	3,128 (7.9)	10,742 (8.4)
Missing	83 (4.8)	75 (3.6)	81 (3.1)	195 (3.0)	434 (3.3)
* Chronic conditions as primary diagnosis group are based on the primary diagnosis on index admission, while underlying chronic conditions are based on admissions during the year prior to index admission					

eTable 2: Variables associated with risk of readmission within 30 days

Age group	Infants	1-4 years	5-15 years	16-24 years	Overall
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
GP registration					
Yes	Ref	Ref	Ref	Ref	Ref
No	0.91 (0.83 – 1.00)	0.80 (0.67 – 0.95)	0.68 (0.56 – 0.82)	0.68 (0.63 – 0.73)	0.88 (0.84 – 0.93)
Sex					
Boys	Ref	Ref	Ref	Ref	Reference
Girls	0.88 (0.85 – 0.90)	0.96 (0.93 – 1.00)	1.13 (1.10 – 1.17)	1.14 (1.11 – 1.17)	1.04 (1.02 – 1.05)
Primary diagnosis group					
Infection	2.06 (1.86 – 2.29)	1.82 (1.71 – 1.93)	1.80 (1.71 – 1.90)	1.17 (1.12 – 1.23)	1.67 (1.62 – 1.71)
Chronic condition	3.31 (2.96 – 3.71)	2.86 (2.67 – 3.06)	2.26 (2.14 – 2.39)	1.64 (1.58 – 1.71)	2.08 (2.02 – 2.14)
Injury	Ref	Ref	Ref	Ref	Ref
Perinatal / pregnancy	2.11 (2.15 – 2.70)	-	2.28 (1.70 – 3.06)	2.44 (2.33 – 2.56)	3.02 (2.92 – 3.11)
Symptoms	2.02 (1.81 – 2.25)	2.03 (1.89 – 2.17)	2.35 (2.24- 2.48)	1.51 (1.45 – 1.57)	1.92 (1.87 – 1.98)
Other	2.41 (2.15 – 2.70)	2.15 (1.98 – 2.34)	1.89 (1.77 – 2.02)	1.52 (1.44 – 1.61)	1.95 (1.88 – 2.01)
Underlying chronic condition					
Yes	3.48 (3.34 – 3.62)	2.11 (2.00 – 2.22)	2.08 (1.98 – 2.19)	2.01 (1.92 – 2.11)	1.93 (1.89 – 1.99)
No	Ref	Ref	Ref	Ref	Ref
Ethnicity					
White	Ref	Ref	Ref	Ref	Ref
Black	0.77 (0.70 – 0.84)	0.88 (0.81 – 0.96)	0.94 (0.86 – 1.02)	1.05 (0.98 – 1.12)	0.91 (0.87 – 0.95)
Asian	0.98 (0.93 – 1.03)	1.09 (1.03 – 1.15)	1.09 (1.03 – 1.16)	1.04 (0.99 – 1.09)	1.03 (1.00 – 1.05)
Mixed	0.89 (0.83 – 0.95)	0.97 (0.90 – 1.05)	1.01 (0.93 – 1.09)	0.93 (0.87 – 0.99)	0.94 (0.91 – 0.98)
IMD quintile					
1 - most deprived	1.15 (1.09 – 1.21)	0.96 (0.91 – 1.01)	0.90 (0.85 – 0.94)	1.12 (1.08 – 1.17)	1.06 (1.03 – 1.09)
2	1.08 (1.03 – 1.14)	0.98 (0.92 – 1.03)	0.90 (0.86 – 0.95)	1.06 (1.01 – 1.10)	1.02 (1.00 – 1.05)
3	1.06 (1.00 – 1.12)	1.04 (0.98 – 1.11)	0.96 (0.91 – 1.02)	1.09 (1.04 – 1.14)	1.05 (1.02 – 1.07)
4	1.04 (0.98 – 1.10)	1.02 (0.96 – 1.08)	1.00 (0.95 – 1.06)	1.06 (1.01 – 1.11)	1.04 (1.01 – 1.07)
5 – most affluent	Ref	Ref	Ref	Ref	Ref
Age	0.96 (0.95-0.97)*	0.89 (0.88 – 0.90)	1.03 (1.03 – 1.04)	1.02 (1.01 – 1.02)	1.00 (1.00 – 1.00)

*For infants, age is split up in seven age categories rather than years (<1 day, 1-6 days, 7-28 days, 29-90 days, 3-6 months, 6-9 months, 9-12 months)

eTable 3: Sensitivity analysis: proportion of recurrent admissions where the indication was included as a primary or subsidiary diagnosis on index admission

6 Groups	<30 day	≥30 day, <2 years
Infants (0 years)	14,192 (70.8)	24,021 (48.7)
1-4 year	13,359 (75.2)	31,376 (56.1)
5-15 year	11,866 (73.9)	21,783 (49.1)
16-24 year	21,983 (76.8)	43,753 (51.8)
ICD-10 chapter		
Infants (0 years)	11,650 (58.1)	13,685 (27.7)
1-4 year	11,176 (62.9)	22,399 (40.1)
5-15 year	10,326 (66.7)	18,309 (42.1)
16-24 year	20,212 (70.5)	36,462 (42.3)

Appendix B – Methodology

Emergency admission definition

An admission was defined by continuous periods in hospital that could consist of several finished consultant episodes (FCEs – a period of hospital stay under a single consultant). Admissions that occurred within one day of the date of discharge or included a hospital transfer were considered as a single admission. For infants, we only considered emergency admissions that were at least seven days after their postnatal discharge. Admissions were classed as emergency admissions based on the 'method of admission' variable in HES, which classifies admissions as elective, emergency, maternity or birth admissions.

Primary diagnosis group: six broad groupings

We classified indications for emergency admission using two classification methods. First, we grouped indications in six broad groups for admission: infections, chronic conditions, injuries, perinatal conditions (for the <5 year group) or pregnancy-related (for girls aged >10 years), signs or symptoms, or other. These six groupings were based on existing, published code lists [1–4] for the first four groups. As codes from the ICD-10 chapter 'Symptoms, signs and abnormal clinical and laboratory findings' made up a significant proportion of residual diagnosis codes, we created a separate category for these codes. Remaining codes were grouped as 'other'.

The code list for chronic conditions defined a chronic condition as any health problem requiring follow-up by health services in more than 50% of cases, where follow-up could be repeated hospital admission, specialist follow-up through outpatient department visits, medication, or use of support services such as physiotherapy. Chronic conditions were grouped according to the likely clinical pathways or specialist input required to manage the conditions. The list of ICD-10 codes was developed in collaboration with and reviewed by a clinical panel.

As the codes lists used for our grouping were developed separately, there was some overlap between the six groups. For instance, ICD-10 code O24.0 for pre-existing insulin-dependent diabetes mellitus in pregnancy was included in both the chronic condition and pregnancy-related code lists. We developed decision rules to determine how to group ICD-10 codes which were included in multiple categories.

We first categorised codes relating to pregnancy or perinatal conditions. If codes from this group were included in code list for injuries, infections or chronic conditions (e.g. O23 – Infections of genitourinary tract in pregnancy), we reclassified the code as part of the new group.

Next, we extracted codes relating to injury admissions. Similar to the pregnancy and perinatal condition diagnosis codes, codes were reclassified as infection or chronic condition when codes were also included in those code lists (e.g. T43 – Poisoning by psychotropic drugs was reclassified as self-harm and included as a chronic condition).

Codes that were grouped as both an infection and a chronic condition (e.g. B20 – Human immunodeficiency virus [HIV] disease resulting in infectious and parasitic diseases) were classified as chronic conditions.

Codes were categorised as ‘Signs and symptoms’ or ‘Other’ if they were not included in any of the four other code lists (e.g. R11 – Nausea and vomiting – was categorised as an infection code, as per Baker et al.[1]).

Indications: ICD-10 chapter

In addition, we grouped indications by ICD-10 chapter. We grouped chapters 19 and 20 (‘Injury, poisoning and certain other consequences of external causes’ and ‘External causes of morbidity and mortality’) together as both chapters refer to injuries. Due to small numbers we also grouped chapters 7 and 8 (‘Diseases of the eye and adnexa’ and ‘Diseases of the ear and mastoid process’) together.

For the interactive data visualisation, we included only the ten most common ICD-10 chapters for each group, and grouped the residual chapters in one ‘other’ group.

- 1 Baker MG, Barnard LT, Kvalsvig A, *et al.* Increasing incidence of serious infectious diseases and inequalities in New Zealand: a national epidemiological study. *The Lancet* 2012;**379**:1112–9. doi:10.1016/S0140-6736(11)61780-7
- 2 Hardelid P, Dattani N, Davey J, *et al.* Overview of child deaths in the four UK countries. HQIP bit.ly/hardelidreport
- 3 González-Izquierdo A, Cortina-Borja M, Woodman J, *et al.* Maltreatment or violence-related injury in children and adolescents admitted to the NHS: comparison of trends in England and Scotland between 2005 and 2011. *BMJ Open* 2014.
- 4 Wijlaars L, Hardelid P, Woodman J, *et al.* Contribution of recurrent admissions in children and young people to emergency hospital admissions: retrospective cohort analysis of hospital episode statistics. *Arch Dis Child* 2014.

Appendix C – Static representation of interactive Figure 2

For Figure 2, we have created an interactive data visualisation. As we could not submit this via the online submission system, we have created this appendix to give reviewers a flavour of what it looks like.

Figure 2 cross-tabulates the primary diagnosis group on index admission, and associated primary diagnoses upon readmission. Results are grouped by age group, and available for the six diagnosis groups (chronic conditions, infections, injury, perinatal/pregnancy-related, signs & symptoms, and other) and by ICD-10 chapter (Figure C1).

By hovering over an index admission diagnosis category, e.g. infection, the Figure will display only those readmissions associated with that index admission diagnosis group (Figure C2). Counts and percentages are also updated to reflect the selection.

Readers can also opt to select a diagnosis group from the readmissions to see which primary diagnoses were recorded on index admission (Figure C3).

Who comes back with what? Infants

Infants

Click here for: [Grouping by ICD-10 chapter](#)

Click here for: [1 - 4 years](#), [5 - 15 years](#), or [16 - 24 years](#)

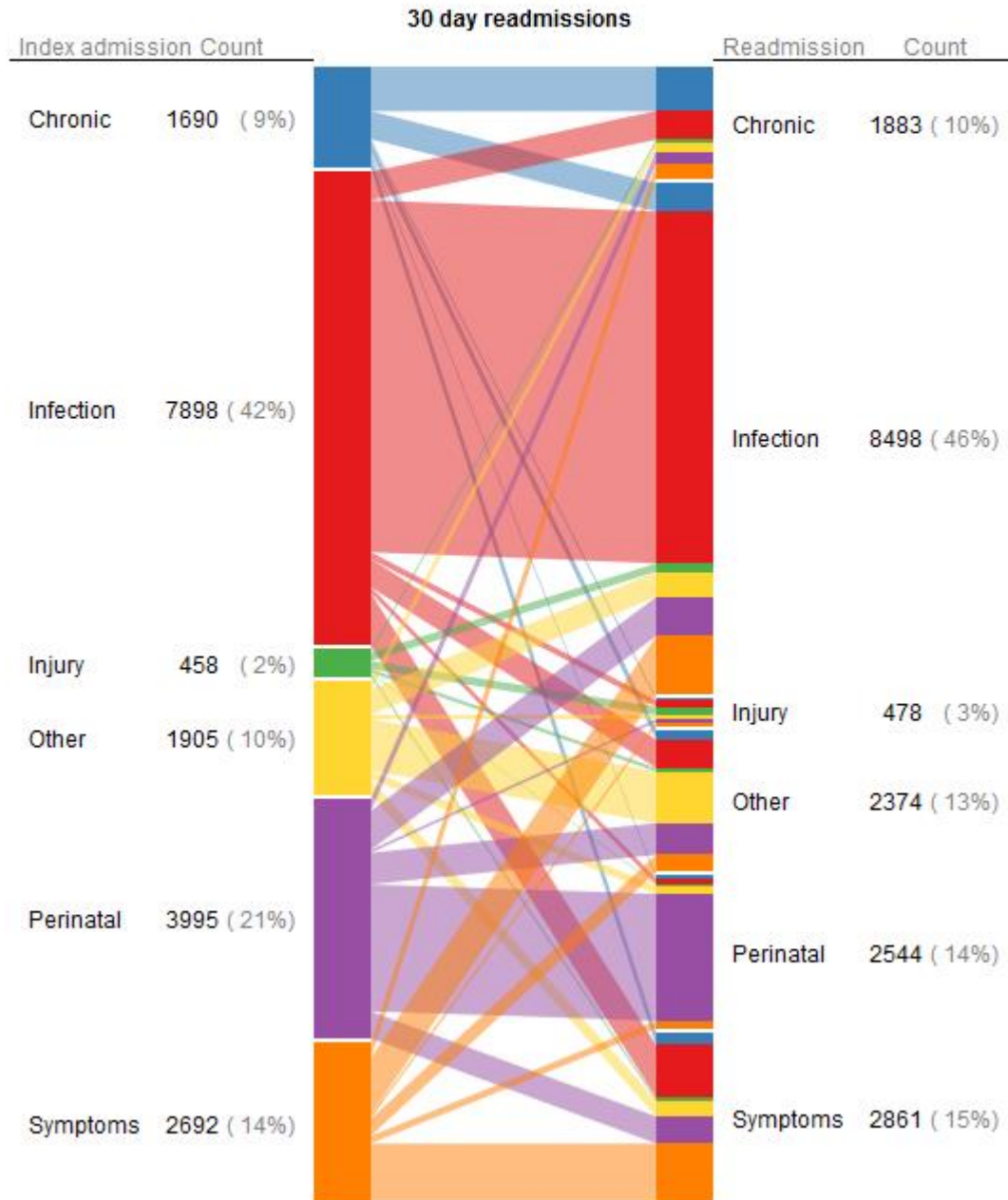


Figure C1: Overview of primary diagnoses on index and readmission for infants, in six diagnosis groups

Who comes back with what? Infants

Infants

Click here for: [Grouping by ICD-10 chapter](#)

Click here for: [1 - 4 years](#), [5 - 15 years](#), or [16 - 24 years](#)

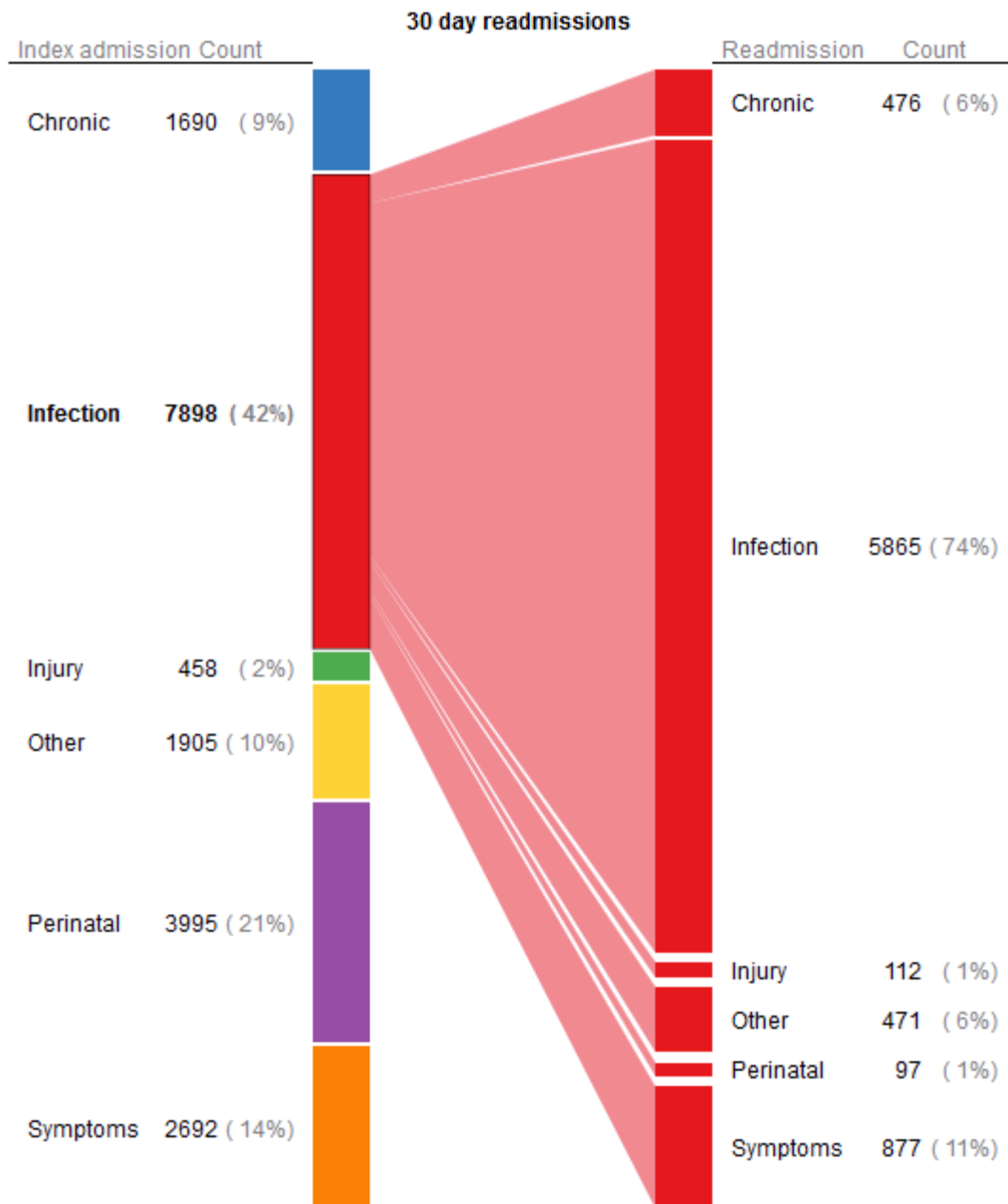


Figure C2: Overview of primary diagnoses on index and readmission for infants, in six diagnosis groups, selecting readmission diagnoses associated with an infection diagnosis on index admission

Who comes back with what? Infants

Infants

Click here for: [Grouping by ICD-10 chapter](#)

Click here for: [1 - 4 years](#), [5 - 15 years](#), or [16 - 24 years](#)

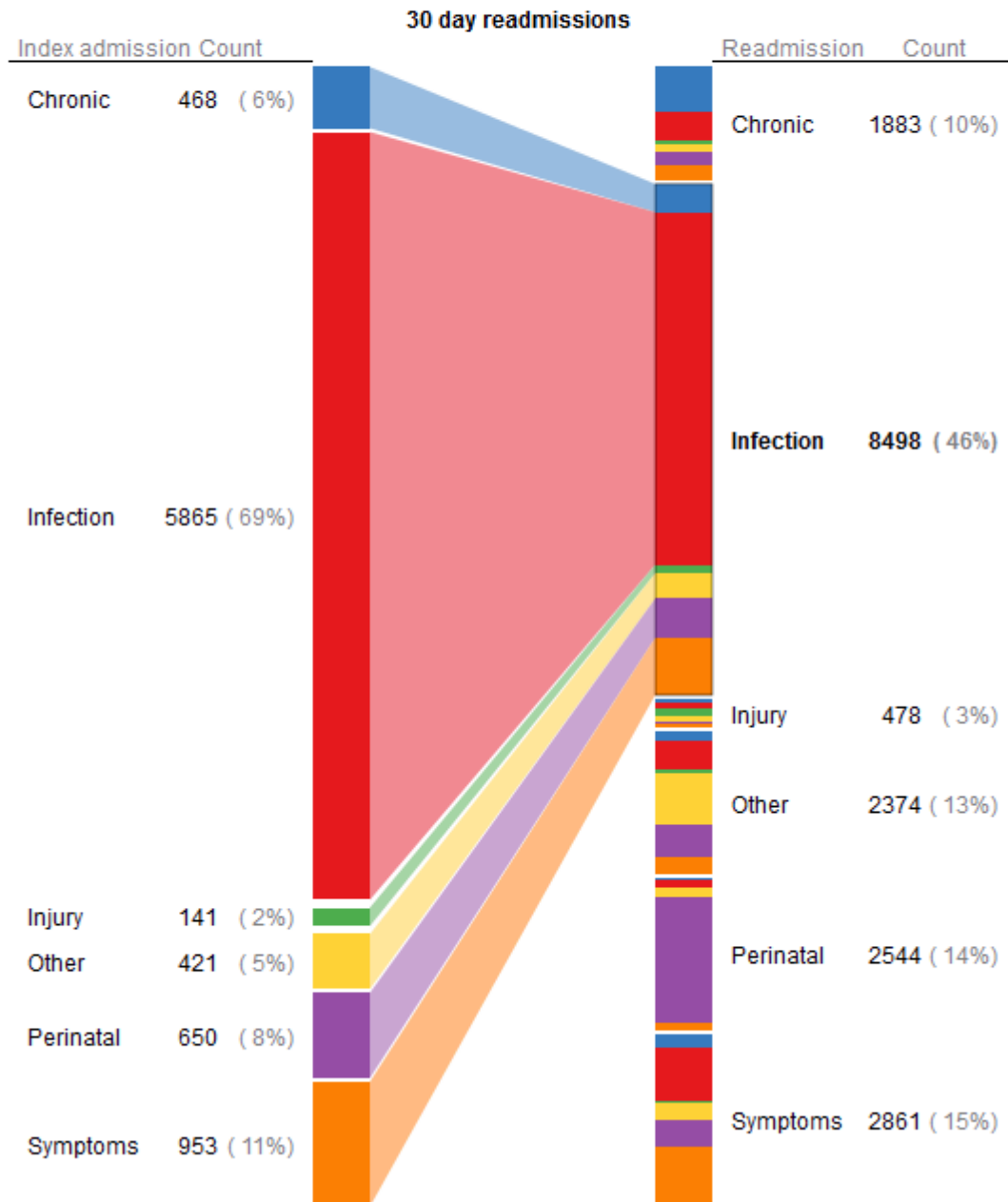


Figure C3: Overview of primary diagnoses on index and readmission for infants, in six diagnosis groups, selecting index admission diagnoses associated with an infection diagnosis on readmission