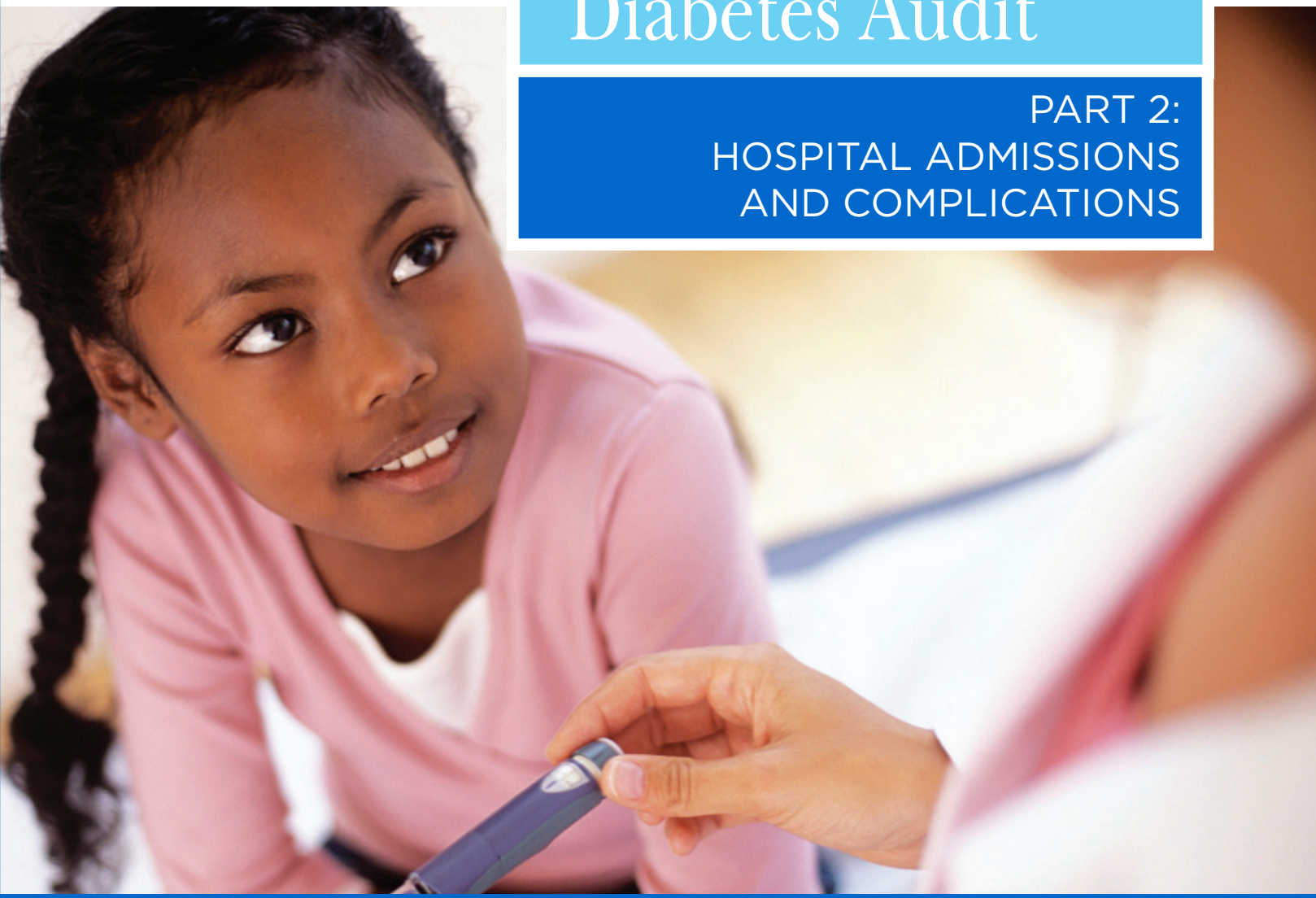
NPDA
National Paediatric Diabetes Audit

PART 2: HOSPITAL ADMISSIONS AND COMPLICATIONS



National Paediatric Diabetes Audit Report 2012-15: Part 2

July 2017

HQIP
Healthcare Quality Improvement Partnership

RCPCH
Royal College of Paediatrics and Child Health
Leading the way in Children's Health

National Paediatric Diabetes Audit 2015-16

Report 2:

Hospital Admissions

July 2017

Report produced by the

National Paediatric Diabetes Audit

Royal College of Paediatrics and Child Health

Contents

Foreword

I am pleased to introduce the National Paediatric Diabetes Audit Report: Hospital Admissions, the second analysis of admissions data published by the Royal College of Paediatrics and Child Health. For the first time, data submitted by healthcare professionals working in paediatric diabetes units has been combined with Hospital Episode Statistics (HES) and data from the Patient Episode Database for Wales (PEDW) to provide a robust picture of diabetes-related admissions in England and Wales. The report provides an analysis of the numbers and reasons for diabetes-related hospital admissions and socio-demographic factors associated with them, in addition to recommendations aimed at reducing potentially avoidable hospital in-patient stays.

The results show that the national improvements in diabetes control and completion of health checks highlighted by successive core national NPDA reports have not been accompanied by reductions in the number of diabetes related admissions to hospital. Furthermore, the report does not demonstrate any improvement in the rate of ketoacidosis in those with newly diagnosed Type 1 diabetes across three consecutive years.

Core NPDA reports have consistently identified that children and young people living in the most deprived areas have poorer diabetes outcomes than those in the least deprived areas, and this trend is also reflected in this admissions report, with those in the most deprived areas being at higher risk of admission.

I commend the audit to all those who wish to see improvements in services for children and young people with diabetes. The implications of poor diabetes management in early life on life-long health, and the impact of adversity are important considerations for Government, commissioners, healthcare providers, clinicians, and families.

Efforts to improve national diabetes control over the past six years have been very successful and the same commitment and energy driving these must now be directed towards reducing national admission rates.

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Medical Directorate
NHS England

1. Key Findings and Recommendations

All diabetes- related admissions

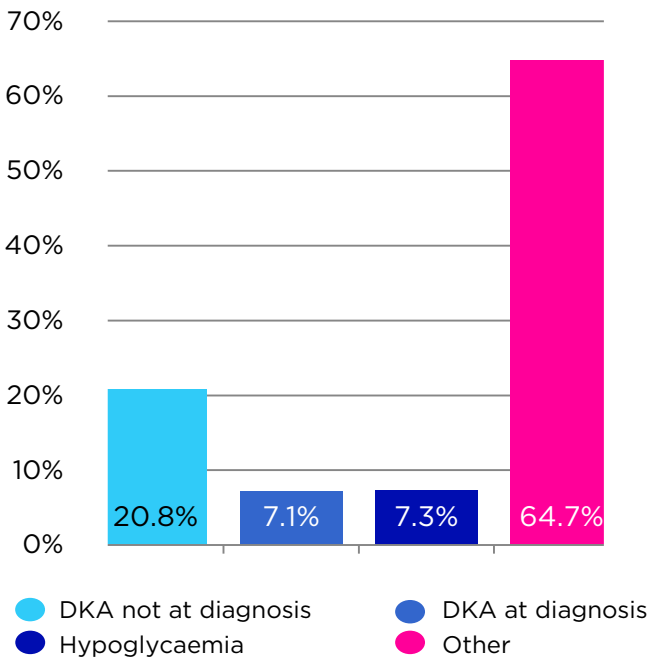
9856, 10,058, 10,800
Total number of diabetes-related admissions of children and young people in the 2012-13, 2013-14, and 2014-15 audit years, respectively, for all types of diabetes

Admission rates were stable between 2012-2015
Increases in number mirrored increases in the numbers of children and young people with diabetes

Increased admission rates were observed in females, teenagers, and those living in deprived areas

>90% of all admissions were of children and young people with Type 1 diabetes

Type 1 diabetes-related admissions



Multidisciplinary Paediatric Diabetes teams should:

- Ensure that all families and children and young people with diabetes receive structured education for self-management during inter-current illness and episodes of hypoglycaemia that includes:
  - Use of 'sick day rules'
  - Use of blood ketone testing from diagnosis.
  - Use of nationally agreed hypoglycaemia management guidelines.
- Be aware of the patient characteristics associated with greater risk of admission and develop anti-admission strategies tailored to meet the needs of these groups

Nearly ¼ of all children and young people with Type 1 diabetes were admitted
for diabetes-related reasons within each audit year between 2012-15

¾ admissions were single admissions
A quarter were one of two or more admissions of the same patient within the same audit year

40% of admissions were within the first year following diagnosis of diabetes
Including DKA at diagnosis

There was considerable variation of admission rates between units With the majority of units having an admission rate between 10-40% of all patients within each year

Most admissions were for 'other' reasons
The majority of 'other' reasons were coded 'without complications'. Comparison with data submitted by units suggested that this diagnostic code most commonly related to admissions for stabilisation of diabetes

Commissioners should:

- Examine variance in local admission rates and service models in order to identify and support necessary improvements.
- Ensure that PDUs are resourced to provide 24hr specialist diabetes advice to families and children and young people with diabetes to try and avoid hospital admission. The Best Practice Tariff in England requires that this should also include 24 hour expert advice to fellow health professionals on the management of patients with diabetes admitted acutely, with a clear escalation policy as to when further advice on managing diabetes emergencies should be sought, and that the provider of expert advice must be fully trained and experienced in managing paediatric diabetes emergencies.

Primary care practitioners should:

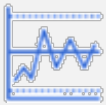
- Have access to the Diabetes Specialist Team to whom they can refer when deciding if a patient requires admission to hospital, and access to blood glucose and ketone testing to identify patients at risk of diabetic ketoacidosis needing hospital admission.

Admissions for DKA at diagnosis of Type 1 diabetes

DKA at diagnosis occurred in ~ 23% of new cases of Type 1 diabetes
This rate was stable between 2012-2015

A quarter of all DKA admissions were at diagnosis of Type 1 diabetes

Females, children aged 0-4 and those living in the most deprived areas
Had higher rates of DKA at diagnosis



There was variation in admission rates for DKA at diagnosis between regions
And between the same regions in different years

Campaigns to aid early diagnosis of Type 1 diabetes by raising awareness of signs and symptoms of diabetes should be reinvigorated and strongly supported by all stakeholders e.g. Diabetes UK's 4 'T's campaign

Admissions of children and young people with Type 1 diabetes for DKA not related to diagnosis

DKA was present in 21% of admissions
This rate was stable between 2012-2015

~15% of all children and young people with an HbA1c> 80mmol/mol had a DKA admission within each audit year
Only 0.2-1.1% of those with an HbA1c <48 mmol/mol were admitted with DKA

Females, adolescents and those living in the most deprived areas
Had higher rates of DKA not at diagnosis

Risk factors for DKA not related to diagnosis

Logistic regression revealed that the following patient characteristics were associated with increased risk of admission:

Age < 5 years old

With those aged 5-9 having a 35% reduced risk compared to those aged 0-4

Duration of diabetes >1 year

With the greatest risks for children and young people diagnosed 3-4 years (63% increased risk) and 5-9 years before the audit (64% increased risk) compared to those diagnosed less than a year before the audit period

Female gender

With females at 33% increased risk compared to males

Poor diabetes control

With a twelvefold increased risk of admission amongst children and young people with a median HbA1c >80 mmol/mol compared to those with a median HbA1c<58 mmol/mol

Deprivation

With 31% lower risk for children and young people living in the least deprived areas compared to those in the most deprived areas

Insulin pump usage

With a 27% increased risk of admission associated with insulin pumps compared to insulin injections

Mannitol or hyper tonic saline was used in 12-13% of all DKA admissions

To treat or prevent cerebral oedema

Admissions of children and young people with Type 1 diabetes for hypoglycaemia

Hypoglycaemia was present in ~7% of admissions

This rate was stable between 2012-2015

~ 2% of all children and young people with Type 1 diabetes had an admission with hypoglycaemia in each audit year

Children aged 0-4, those living in a deprived areas and those with poorer diabetes control

Had higher rates of hypoglycaemia

Risk factors for admission with hypoglycaemia

Logistic regression revealed that the following patient characteristics were associated with increased risk of admission:

Younger age

With those aged 5-9 having a 35% reduced risk compared to those aged 0-4

Longer duration of diabetes

With a 19% increased risk if diagnosed 5-9 years before compared to those diagnosed less than 1 year before each audit period

Deprivation

with 42% lower risk for children and young people living in the least deprived areas compared those in the most deprived areas

Poor diabetes control

With 33% increased risk for those with a median HbA1c between 58-80 mmol/mol compared to those with a median <58 mmol/mol

Admissions of children and young people with Type 1 diabetes for 'other reasons'

~19% of all children and young people with Type 1 diabetes were admitted for 'other' reasons within each audit year

Using NPDA definitions for admission in this group, nearly half were related to stabilisation of diabetes

Younger children, those living in the most deprived areas, and those diagnosed less than one year before the each audit period

Had higher rates of admission

Risk factors for admission for 'other' reasons

Logistic regression revealed that the following patient characteristics were associated with increased risk of admission:

Age <4 years old

With lower risk for all age groups compared to the youngest

Duration of diabetes < 1 year

With > 70% lower risk associated with longer duration

Female gender

With females at 25% increased risk compared to males

Poor diabetes control

with 90% increased risk for those with median HbA1c >80 mmol/mol compared to those with a median HbA1c <58 mmol/mol

Deprivation

With 26% lower risk for children and young people living in the least deprived areas compared to those in the most deprived areas

Insulin pump usage

With a 23% increased risk of admission associated with insulin pumps compared to insulin injections

Poor diabetes control was associated with increased risks of all types of admission

Multidisciplinary paediatric diabetes teams should:

- Aim for all children to achieve the 48 mmol/mol HbA1c target set by NICE (individualised for the child) from diagnosis with emphasis on self-management education, and psychological support.
- Actively work towards improving the blood glucose levels of children and young people that are currently out of target range.
- Pay particular attention to the care needs of the vulnerable sub-group with persistently high HbA1c levels. Appropriate engagement, education, technology and psychosocial support for this subgroup are paramount so that they are not lost to follow up and are helped as individuals to improve their diabetes control.
- Provide each child with an individualised care plan to achieve the best possible level of HbA1c given the many reasons for the gradual increase of HbA1c with duration of diabetes.
- Be aware of the socioeconomic and patient demographic factors associated with poorer diabetes control (adolescence, non-white ethnicity, female gender, and living in a deprived area), and adapt communications and structured education provision in order to be able to meet the different needs of vulnerable subgroups.
- Inform patients and their families of the increased risk of admission associated with HbA1c levels greater than target.

Commissioners should:

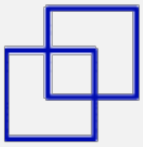
- Be aware of the socioeconomic and patient demographic factors associated with poorer diabetes control (adolescence, non-white ethnicity, female gender, and living in a deprived area), and ensure services catering to higher percentages of patients from vulnerable subgroups are resourced sufficiently to meet their needs.
- Be aware of the cultural diversity amongst the paediatric diabetes population and ensure community groups and schools are sufficiently aware and trained to help young people to further improvements in diabetes control especially amongst vulnerable subgroups.
- Allow the usage of treatment regimens tailored to suit the individual needs of the patient to provide the best possible diabetes control in line with local prescribing policy and in keeping with NICE (2015) guidance, and acknowledge and address barriers where funding issues arise.

Insulin pump use was associated with increased risk of admission

The increased risk of admission with DKA amongst children and young people with Type 1 diabetes on insulin pump therapy was surprising as this has not been demonstrated elsewhere.

- Awareness of this finding requires further surveillance at local level and ongoing audit surveillance to see if this is a continued trend.
- Implementation of insulin pump therapy should be carefully considered and monitored.
- The raised risk of admission should be discussed carefully with families at initiation of pump therapy and education with regards to DKA or avoidance of other admissions is paramount.

Data completeness



Only 33.4% of all admissions had a match on the same date in both the HES/PEDW and NPDA datasets

Admissions data submitted by many PDUs or found in the HES/PEDW dataset had no matches when the datasets were combined. This raises questions about data completeness and quality of either dataset if used independently.

Multidisciplinary paediatric diabetes teams should:

- Ensure all diabetes-related admissions are recorded and submitted to the NPDA.
- Work with the relevant sections of their Trusts/Health Boards to improve coding of diabetes-related admissions for the Hospital Episodes Statistics and Patient Episode Data for Wales data.

The NPDA team will:

- Provide a summary of admissions entered by PDUs upon submission to enable them to identify missing data

2. Introduction

The NPDA is commissioned by the Healthcare Quality Improvement Partnership (HQIP), funded by NHS England and the Welsh Government and delivered by the Royal College of Paediatrics and Child Health (RCPCH) as part of the national clinical audit and patient outcomes programme (NCAPOP).

Part 1 of the NPDA annual report summarises diabetes related outcomes and the completion rates of key healthcare checks as recommended by NICE guidelines.

This report (Part 2) summarises hospital admission data for children and young people with diabetes over three annual audit cycles between the 1st April 2012 and the 31st March 2015.

Admissions to hospital among children and young people with diabetes place a large burden on NHS resources and patient and family wellbeing, and can be considered as a quality of care or performance indicator. This report investigates acute emergency hospital admissions where the primary diagnosis is related to diabetes in children and young people cared for in Paediatric Diabetes Units (PDUs) in England and Wales.

Key audit questions:

- How many children and young people are being admitted to hospital each year with diabetes related causes?
- What are the causes for hospital admission?
- What patient factors are associated with risk of hospital admission?
- Is there regional variation in hospital admission rates?
- Have there been changes to admission rates over time?

3. Methodology

Hospital admission data were obtained from two sources and triangulated to produce a combined dataset for all events over a three year audit period, 1st April 2012 – 31st March 2015:

1. The NPDA dataset: hospital admission events submitted to the NPDA by PDUs as part of their annual submission of audit data.
2. HES/PEDW dataset: Hospital Episode Statistics (HES) and Patient Episode Database for Wales (PEDW) data obtained by linking NHS number for children and young people with diabetes submitted to the NPDA.

The NPDA dataset includes hospital admissions where the cause is defined as:

- Diabetic ketoacidosis
- Hypoglycaemia
- Stabilisation of diabetes
- Ketosis without acidosis
- Surgical procedures
- Other causes

The HES/PEDW dataset was limited to admissions with specific ICD-10 codes related to diabetes in any of the primary diagnoses within each patient admission and included:

- Diabetic ketoacidosis (ICD-10 code E101)
- Hypoglycaemia (ICD-10 codes E160, E161 and E162)
- Admissions 'without complications' (ICD- 10 code E109)

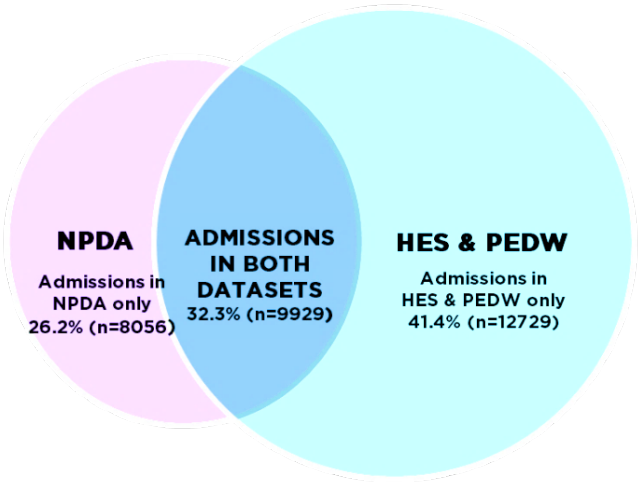
Datasets were cleaned and merged, matching on admission date, NHS number and audit year. In order to avoid double counting of admissions recorded within both the NPDA and HES/PEDW datasets, exact matches were treated as a single admission. Cases without a match in both datasets were treated as additional admissions.

The NPDA dataset contains a single cause for each admission as listed above, whereas the HES/PEDW dataset may contain multiple causes against each admission. This report focuses on admissions where the primary reason for admission was diabetes- related.

If both datasets were complete, there would be an overlap of 100% between the admissions identified from the NPDA dataset and the HES/PEDW dataset. Data incompleteness in the NPDA dataset and coding errors in the HES/PEDW dataset will lead to incompatibilities. In order to establish the agreement between both datasets, matching was performed to identify which admissions appeared in both datasets.

Figure 1 shows that around a third of total admissions were found in both datasets (exact match on admission date). More than 40% were only found in the HES/PEDW dataset alone and a further quarter was found in the NPDA dataset only.

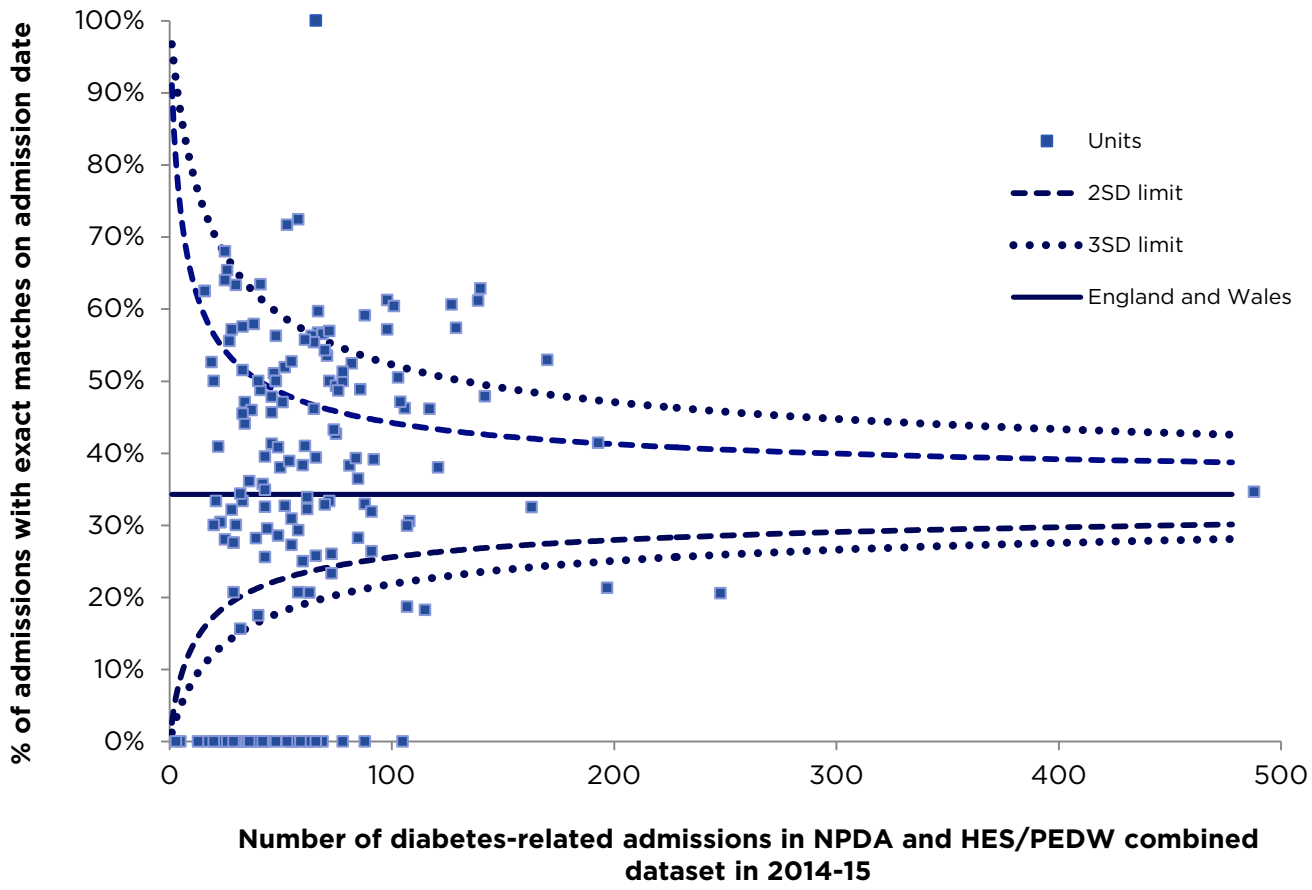
Figure 1: Number of diabetes admissions recorded on the primary diagnostic code in the HES/PEDW and within the NPDA dataset April 2012-March 2015; overlap indicates exact match on the admission date



This methodology is different to previous NPDA reports on hospital admissions and therefore direct comparisons cannot be made. The 2011/12 NPDA admissions report (RCPCH, 2013) summarised HES/PEDW-identified admissions only, and found 6,210 admissions in England and Wales with a primary diabetes- related diagnosis. This was around 3000-4000 fewer admissions found in each audit year between 2012/13 and 2014/15 when PDU submitted data was included in analysis, confirming that comparison should not be made with previous results.

There was large variability in the overlap of hospital admissions from NPDA and HES/PEDW datasets between PDUs, ranging from 0% to 100%. This variability was found over the three audit years. Figure 2 shows a funnel plot demonstrating the PDU variability in overlap by total admission number for each PDU for 2014/15,

Figure 2: Proportion of HES/PEDW diabetes-related admissions on primary diagnostic codes with exact matches in the NPDA dataset on admission date in 2014-15, by PDU



Multidisciplinary paediatric diabetes teams should:

- Ensure all diabetes-related admissions are recorded and submitted to the NPDA
- Work with the relevant sections of their Trusts/Health Boards to improve coding of diabetes-related admissions for the Hospital Episodes Statistics and Patient Episode Data Wales data

The NPDA team will:

- Provide a summary of admissions entered by PDUs upon submission to enable them to identify missing data

4. Diabetes-related hospital admissions: all diabetes types

The NPDA collects data relating to all children and young people being cared for within PDUs in England and Wales, with any type of diabetes. This section presents analysis of all of their admissions with a primary, diabetes-related diagnosis.

4.1 Hospital admissions amongst children and young people with diabetes

There were a total of 30,714 diabetes-related hospital admissions of children and young people with all types over diabetes between 2012-2015. Table 1 shows the breakdown by nation and regional network across three audit years identified within the combined NPDA/HES/PEDW dataset broken down by year.

Table 1: Total number and percentage (of the total) of all diabetes-related admissions in England, Wales and Regional Networks by audit year

Country	2012-13		2013-14		2014-15	
	N	%	N	%	N	%
England	9374	95.1	9518	94.6	10240	94.8
Wales	482	4.9	540	5.4	560	5.2
East of England	1096	11.1	1075	10.7	1109	10.3
East Midlands	524	5.3	468	4.7	517	4.8
London and South East	2171	22.0	2260	22.5	2211	20.5
North East	431	4.4	417	4.1	559	5.2
North West	1642	16.7	1580	15.7	1862	17.2
South Central	970	9.8	1076	10.7	1031	9.5
South West	726	7.4	772	7.7	809	7.5
West Midlands	901	9.1	897	8.9	1063	9.8
Yorkshire and The Humber	913	9.3	973	9.7	1079	10.0
TOTAL DIABETES-RELATED ADMISSIONS	**9856**		**10058**		**10800**	

Although the total number of admissions increased over the three audit years, the rate remained stable as the number of children and young people with diabetes increased by a similar percentage over this period.

4.2 All diabetes-related hospital admissions for all diabetes types, broken down by patient characteristics

4.2.1 Gender

There were a greater proportion of diabetes related hospital admissions for all diabetes types in females compared to males (Table 2), with consistency in this trend over the three years. This is in contrast to the number of NPDA registrations where there is a predominance of male children and young people with diabetes.

Table 2: Percentage and number of all diabetes-related admissions by gender, 2012-15

Gender	2012-13	2013-14	2014-15
Male	45.9 (4524)	45.6 (4583)	45.5 (4919)
Female	54.0 (5318)	54.4 (5468)	54.2 (5858)
Not known	0.1 (14)	0.1 (7)	0.2 (23)

4.2.2 Age group

Table 3 shows the total number and proportion of all diabetes-related admissions by age-group. It shows little year on year variation. There was a greater proportion of admissions of young people in their teenage years with little variation over the three audit years. There was a greater proportion of admissions in the 0-4 year age range being double their representation within the NPDA, with the 5-9 and 10-14 year age groups being more representative. Caution should be taken in interpretation of the reduced admission rates in the 15-19 year old age range compared to their representation within the NPDA as transition is occurring in this age group and admission data from those remaining under paediatric care may be unrepresentative.

Table 3: Percentage and number of all diabetes-related admissions by age group, 2012-15

Age	2012-13	2013-14	2014-15	% representation in NPDA 2014/15
0-4 years	12.1 (1195)	12.0 (1205)	11.0 (1191)	6.0
5-9 years	22.2 (2189)	20.8 (2094)	20.2 (2180)	20.8
10-14 years	43.8 (4319)	42.3 (4256)	42.3 (4563)	40.7
15-19 years	21.7 (2141)	24.5 (2463)	26.0 (2812)	32.1
20-24 years	0.1 (12)	0.4 (40)	0.5 (54)	0.3

4.2.3 Ethnicity

Table 4 shows that there was no difference in admission trends for children and young people within each ethnic category across the three years.

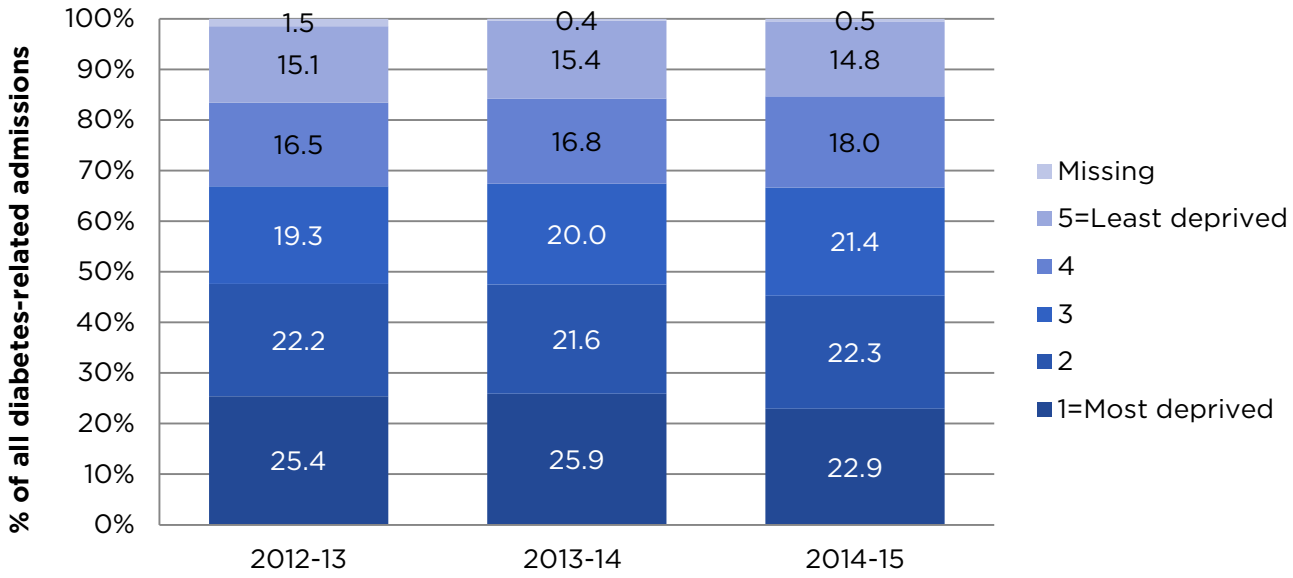
Table 4: Percentage and number of all diabetes-related admissions by ethnic group, 2012-15

Ethnicity	2012-13	2013-14	2014-15	% of total admissions with stated ethnicity in 2014/15
White	73.0% (6722)	71.9% (6665)	73.9% (7340)	85.0%
Asian	5.6% (512)	5.8 % (538)	5.5% (542)	6.3%
Black	2.5% (233)	2.3% (215)	2.8% (283)	3.3%
Mixed	2.9% (268)	3.0% (279)	3.0% (282)	3.3%
Other	1.3% (122)	1.5% (141)	1.9% (189)	2.2%
Not stated or missing	14.6% (1345)	15.5% (1436)	13.1% (1301)	-

4.2.4 Deprivation

Figure 3 shows the proportion of all diabetes-related admissions by deprivation quintile[1] based on postcode across the three audit years, demonstrating a clear increase in proportion of admissions from least to most deprived, which was consistent across the three years.

Figure 3: Proportion of diabetes-related hospital admissions by deprivation quintile, 2012-15



4.2.5 Diabetes-related admissions by diabetes type

Table 5 shows the breakdown of all diabetes-related admissions by diabetes type for the three audit years. The majority of hospital admissions were of children and young people Type 1 diabetes (>92% for all three years).

[1] https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015

Table 5: Percentage and number of diabetes-related admissions by diabetes type, 2012-2015

Diabetes type	2012-13	2013-14	2014-15
Type 1 Insulin-Dependent Diabetes Mellitus	93.4 (9202)	92.2 (9274)	92 (9937)
Type 2 Non-Insulin-Dependent Diabetes Mellitus	1.7 (170)	1.6 (157)	1.8 (197)
Cystic Fibrosis Related Diabetes	0.6 (64)	1.2 (120)	0.7 (79)
Monogenic forms of Diabetes	1.9 (192)	1.7 (175)	1.8 (194)
Other specified Diabetes Mellitus	0.5 (48)	1.7 (171)	1.7 (186)
Not Specified Diabetes Mellitus	0.9 (92)	1.1 (111)	1.5 (164)
Missing	0.9 (88)	0.5 (50)	0.4 (43)

Further breakdown of admission cause are presented for children and young people with Type 1 diabetes only as small numbers in the other diabetes groups do not permit meaningful analysis.

4.3 Summary: Diabetes-related hospital admissions for all types of diabetes

9856, 10,058, 10,800
Total number of diabetes-related admissions of children and young people in the 2012, 2013, and 2016 audit years, respectively, for all types of diabetes

Admission rates were stable between 2012-2015
Increases in number mirrored increases in the numbers of children and young people with diabetes

Increased admission rates were observed in females, teenagers, and those living in deprived areas

>90% of all admissions were of children and young people with Type 1 diabetes

Please see pages 2-7 for recommendations.

5. Type 1 diabetes-related admissions

This section covers the causes of admission to hospital for children and young people with a diagnosis of Type 1 diabetes only.

5.1 Type 1 diabetes-related admissions, by admission reason

Table 6 shows the number and percentage of admissions in children and young people with Type 1 diabetes by cause and audit year for England and Wales.

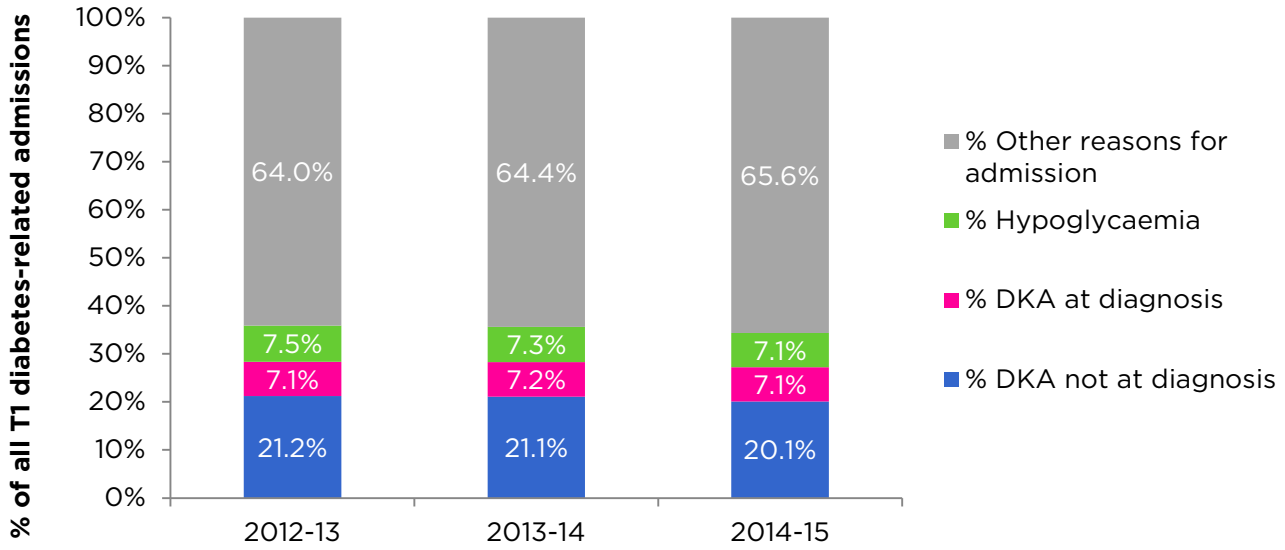
Table 6: Reasons for Type 1 diabetes-related admissions in England and Wales, 2012-2015 (denominator=all diabetes-related admissions of children and young people with Type 1 diabetes)

Time period & country	Number of Type 1 diabetes-related admissions	% DKA not at diagnosis (n)	% DKA at diagnosis (n)	% Hypoglycaemia (n)	% Other reasons for admission (n)
2012-13					
England	8733	21.3 (1860)	6.9 (600)	7.4 (645)	64.0 (5591)
Wales	469	19.6 (92)	10.7 (50)	9.0 (42)	62.9 (295)
Total	9202	21.2 (1952)	7.1 (650)	7.5 (687)	64.0 (5886)
2013-14					
England	8749	21.2 (1858)	7.3 (642)	7.0 (616)	64.4 (5631)
Wales	525	18.1 (95)	5.5 (29)	11.0 (58)	65.5 (344)
Total	9274	21.1 (1953)	7.2 (671)	7.3 (674)	64.4 (5975)
2014-15					
England	9393	20.1 (1884)	7.1 (667)	6.9 (647)	65.8 (6176)
Wales	544	20.6 (112)	6.6 (36)	9.9 (54)	63.6 (346)
Total	9937	20.1 (1996)	7.1 (703)	7.1 (701)	65.6 (6522)

N.B Some admissions recorded in the HES/PEDW dataset had more than one primary diagnosis code attached to them, or had an inconsistent admission cause when compared to NPDA reason provided. In this scenario all codes/reasons for admission were included in analysis (although these were not treated as additional admissions). Therefore, the total number of admission reasons does not add up to the total number of admissions and percentages do not add up to 100%.

Figure 4 shows there was little change in the proportion of admissions by cause over the three audit years. Approximately 28% of all admissions in children and young people with Type 1 diabetes related to DKA (either at diagnosis or post diagnosis), 7% related to hypoglycaemia, and 65% related to other causes.

Figure 4: Causes of admission to hospital in children and young people with Type 1 diabetes, 2012-15



'Other' reasons for admission included:

From the NPDA dataset ketosis without acidosis, stabilisation of diabetes, surgical admissions, other reasons.
From the HES/PEDW dataset diabetes with: coma, renal complications, ophthalmic complications, neurological complications, peripheral circulatory complications, multiple complications, without complications, other complications.

Please see Chapter 11 for more details of admissions for 'other reasons'.

5.2 Breakdown of all Type 1 admissions by socio-demographic characteristics

5.2.1 Gender

There was a female predominance for admission to hospital for those with Type 1 diabetes (Table 7). This is in contrast to NPDA registrations where there is a predominance of male children and young people with diabetes.

Table 7: Percentage and number of all diabetes-related admissions of children and young people with Type 1 diabetes by gender, 2012-15 (denominator=all diabetes-related admissions of children and young people with Type 1 diabetes)

Gender	2012-13	2013-14	2014-15
Male	47.2 (4317)	47.2 (4375)	56.9 (4657)
Female	52.8 (4872)	58.2 (4894)	52.9 (5257)
Not known	0.1 (13)	0.1 (5)	0.2 (23)

5.2.2 Age

Table 8 shows that the age group with the highest number of diabetes-related admissions were aged 10-14 years.

Table 8: Percentage and number of all diabetes-related admissions of children and young people with Type 1 diabetes by age group, 2012-2015

Age	2012-13	2013-14	2014-15	% representation in NPDA 2014/15
0-4 years	12.4 (1141)	12.6 (1166)	11.3 (1119)	6.1
5-9 years	21.3 (1963)	21.6 (1999	21.2 (2110)	21.3
10-14 years	44.7 (4115)	41.6 (3858)	41.7 (4139)	40.9
15-19 years	21.4 (1971)	23.9 (2212)	25.3 (2516)	31.4
20-24 years	0.1 (12)	0.4 (39)	0.5 (53)	0.3

Those aged 15-19 had a smaller proportion of admissions compared to their representation within the NPDA, indicating that this age group was at lower risk of admission. Conversely, those aged 0-4 had a higher proportion of admissions compared to their proportional representation within the NPDA and therefore a higher risk of admission.

However, caution should be taken in interpretation of the reduced admission rates in the 15-19 year old age range compared to their representation within the NPDA as transition is occurring in this age group and admission data from those remaining under paediatric care may be unrepresentative.

5.2.3 Deprivation

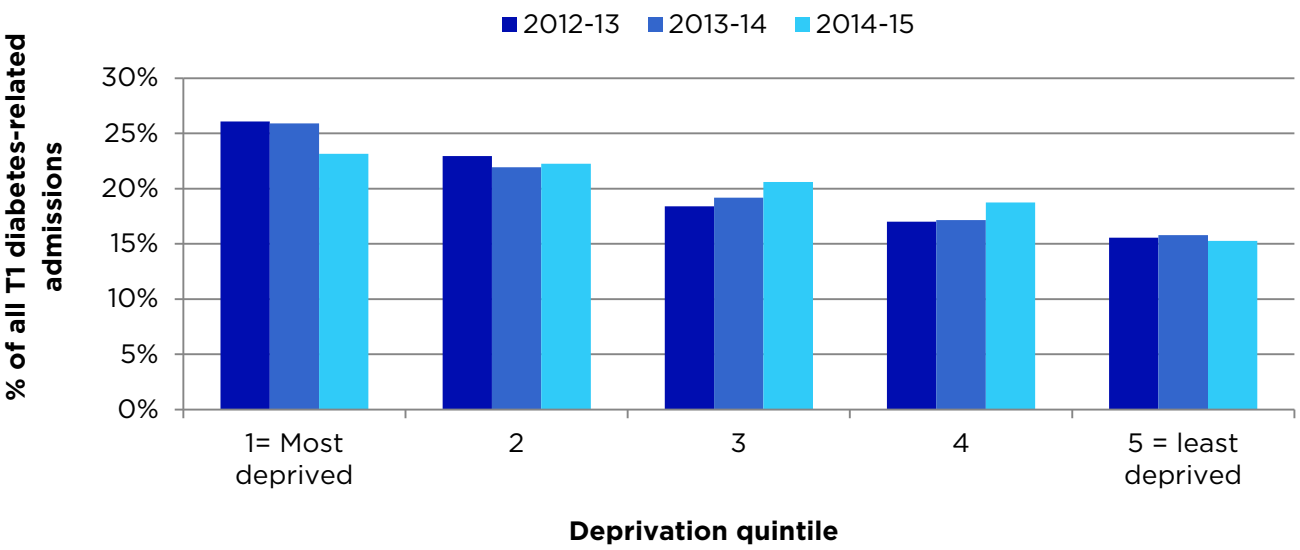
Table 9 shows that there were more admissions of children and young people with Type 1 diabetes living in more deprived areas than those in the least deprived areas.

Table 9: Number of all diabetes-related admissions of children and young people with Type 1 diabetes by deprivation quintile, 2012-15

Audit year	Deprivation quintile					Total with known quintile
	1= Most deprived	2	3	4	5= Least deprived	
2012-13	2363	2079	1667	1541	1411	9061
2013-14	2395	2028	1773	1586	1460	9242
2014-15	2288	2200	2036	1852	1508	9884

Figure 5 shows that children and young people living in the more deprived areas had a proportion of all diabetes related admissions, with no variation in this trend across the three audit years.

Figure 5: Percentage of all Type 1 diabetes-related admissions by deprivation quintile



5.2.4 Ethnicity

A breakdown of all diabetes-related admissions for Type 1 by ethnicity for the three audit years is shown in Table 10. There were no clear differences in admission rates for different ethnic backgrounds for children and young people with Type 1 diabetes compared to the paediatric diabetes breakdown for ethnicity.

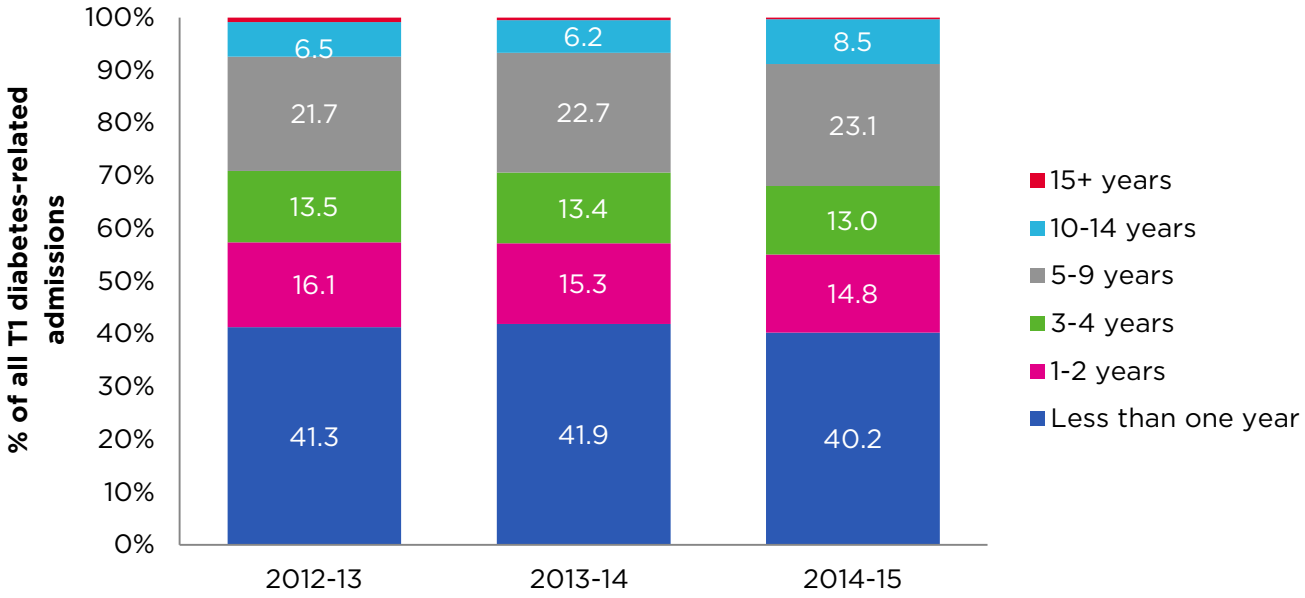
Table 10: Percentage and number of all diabetes-related admissions of children and young people with Type 1 diabetes by ethnic group, 2012-15

Ethnicity	2012-13	2013-14	2014-15	% of total admissions with stated ethnicity in 2014/15
White	73.0 (6722)	71.9 (6665)	73.9 (7340)	85.0
Asian	5.6 (512)	5.8 (538)	5.5 (542)	6.3
Black	2.5 (233)	2.3 (215)	2.8 (283)	3.3
Mixed	2.9 (268)	3.0 (279)	3.0 (282)	3.3
Other	1.3 (122)	1.5 (141)	1.9 (189)	2.2
Not stated or missing	14.6 (1345)	15.5 (1436)	13.1 (1301)	-
Total	**(9202)**	**(9274)**	**(9937)**	-

5.2.5 Duration of diabetes

Figure 6 shows the breakdown of all diabetes-related admissions in children and young people with Type 1 diabetes by duration of diagnosis. Greater frequency of admissions of children and young people in the first year following diagnosis of Type 1 diabetes is likely due to admissions around the time of diagnosis related to stabilisation and/or DKA.

Figure 6: Percentage of admissions of children and young people with Type 1 diabetes by duration of diagnosis, 2012-15



5.3 Number of Type 1 diabetes-related admissions per patient – excluding DKA at diagnosis

Admissions to hospital post diagnosis of Type 1 diabetes can be viewed as a performance indicator for the PDU managing the patient's care.

Table 11 shows the percentage and number of admissions per patient admitted for each audit year excluding those related to DKA at diagnosis, as a proportion of the total number of admissions. It shows that the majority (around three quarters) of all patients who were admitted during each audit year had a single diabetes-related admission. There is little change in these proportions over the three years of the audit.

Table 11: Percentage and number of Type 1 diabetes-related admissions per patient, excluding DKA at diagnosis (denominator = total number of patients with at least one admission within each audit year)

Number of admissions	2012-13	2013-14	2014-15
1 admission	74.3 (4242)	74.8 (4387)	73.9 (4568)
2 admissions	16.3 (931)	16.0 (938)	16.7 (1030)
3 admissions	4.6 (263)	4.9 (289)	5.0 (307)
4 or more admissions	4.8 (276)	4.3 (253)	4.5 (276)
Total	**(5712)**	**(5867)**	**(6181)**

Table 12 shows the percentage and number of all children and young people with Type 1 diabetes who had one or more admissions in each audit year. It shows that ~24% of all children and young people with Type 1 diabetes had a diabetes-related admission, excluding those due to DKA at diagnosis within each audit year, with admission rates similar across all audit years.

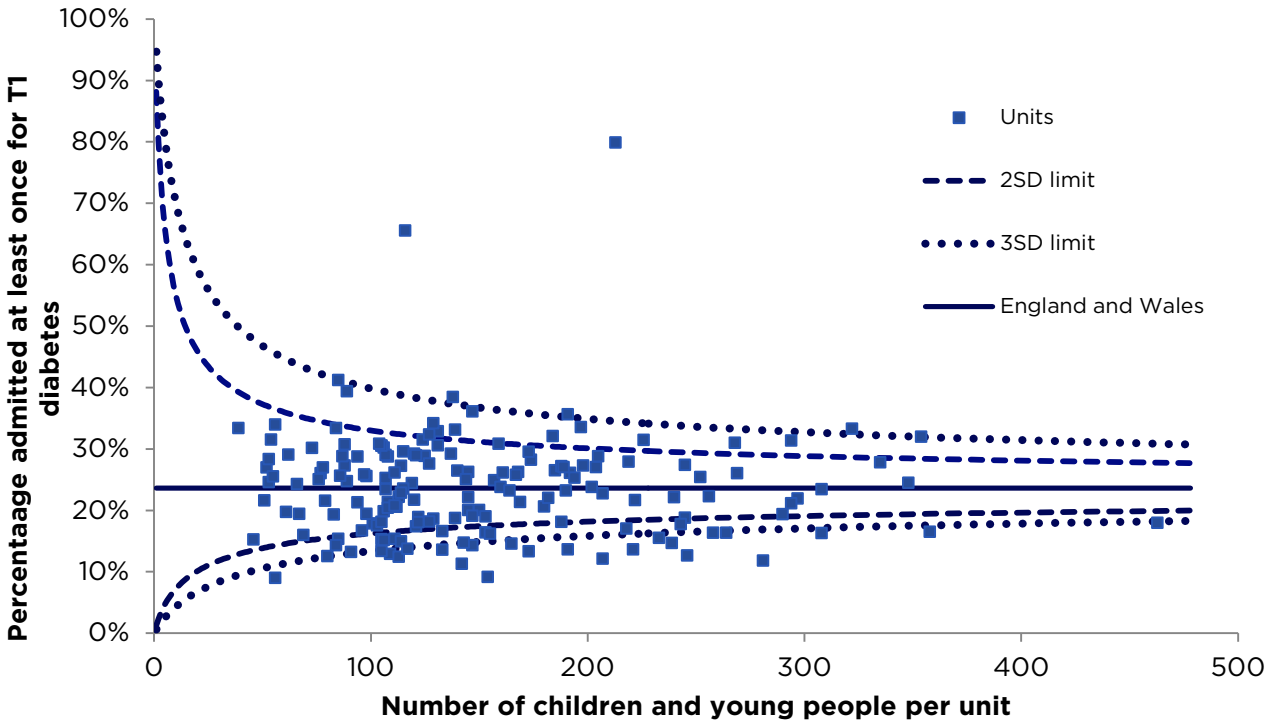
Table 12: Proportion (as a percentage of the total number of children and young people with Type 1 diabetes) and number having one or more admissions per audit year, excluding DKA at diagnosis, 2012-15 (denominator= all children and young people with Type 1 diabetes included in the NPDA)

Number of admissions	2012-13	2013-14	2014-15
1 admission	17.9 (4242)	17.5 (4387)	17.5 (4568)
2 admissions	3.9 (931)	3.7 (938)	3.9 (1030)
3 admissions	1.1 (263)	1.2 (289)	1.2 (307)
4 or more admissions	1.2 (276)	1.0 (253)	1.1 (276)
1 or more admissions	24.2% (5712)	23.4% (5867)	23.6% (6181)
Total	**(23649)**	**(25113)**	**(26161)**

5.4 Type 1 admissions (excluding DKA at diagnosis) by unit

Figure 7 shows variation in the percentage of patients with one or more hospital admissions excluding DKA at diagnosis within the audit year in 2014/15 as a proportion of the total number of those with Type 1 diabetes (variation in other audit years was similar). Most units were within 3 standard deviations of the mean admission rate for England and Wales for diabetes-related reasons in 2014-15. However, there are several outliers with much higher or lower rates of admission than other units in England and Wales.

Figure 7: Percentage of children and young people admitted to hospital for reasons related to Type 1 diabetes (excluding DKA at diagnosis) in 2014-15, by unit



5.5 Summary: Admissions related to Type 1 diabetes

Nearly ¼ of all children and young people with Type 1 diabetes were admitted

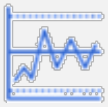
For diabetes-related reasons within each audit year between 2012-15

¾ admissions were single admissions

A quarter were one of two or more admissions of the same patient within each audit year

40% of admissions were within the first year following diagnosis of diabetes

Including DKA at diagnosis



There was considerable variation of admission rates between units

With the majority of units having an admission rate between 10-40% of all patients within each year

Most admissions were for 'other' reasons

The majority of 'other' reasons were coded 'without complications'. Comparison with data submitted by units suggested that this diagnostic code most commonly related to admissions for stabilisation of diabetes (see chapter 10)

Please see pages 2-7 for recommendations

6. DKA admissions of children and young people with Type 1 diabetes

6.1 All DKA admissions amongst children and young people with Type 1 diabetes

Table 13 shows the percentages and number of admissions with DKA for children and young people with Type 1 diabetes in England and Wales broken down to show the proportions of those for DKA on diagnosis, or recurrent DKA. Approximately 25% of DKA admissions are related to the diagnosis of diabetes. Although there is predominance for female admissions for DKA not at diagnosis, this trend is reversed for DKA at diagnosis. Younger children were more likely to have DKA at diagnosis whereas older children were more at risk of other episodes of DKA. DKA admission rates either at diagnosis or thereafter are higher amongst children and young people living in the most deprived areas. There were no clear tends in DKA admissions in different ethnic categories.

Table 13: Percentage and number of DKA admissions at diagnosis, and not at diagnosis, amongst children and young people with Type 1 diabetes in different audit periods, broken down by patient characteristics, 2012-15 (denominator= all DKA admissions)

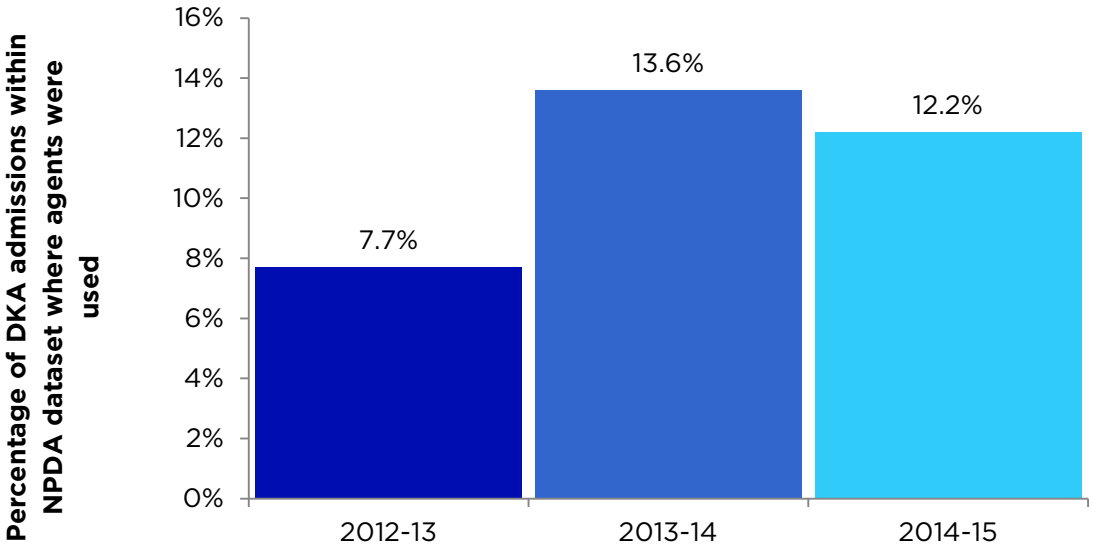
Patient characteristic	2012-13		2013-14		2014-15	
	%(n) DKA not at diagnosis	%(n) DKA at diagnosis	%(n) DKA not at diagnosis	%(n) DKA at diagnosis	%(n) DKA not at diagnosis	%(n) DKA at diagnosis
Country						
England	75.6 (1860/2460)	24.4 (600/2460)	74.3 (1858/2500)	25.7 (642/2500)	73.9 (1884/2551)	26.1 (667/2551)
Wales	64.8 (92/142)	35.2 (50/142)	76.6 (95/124)	23.4 (29/124)	75.7 (112/148)	24.3 (36/148)
Sex						
Male	70.3 (799/1137)	29.7 (338/1137)	70.9 (829/1170)	29.1 (341/1170)	67.9 (813/1197)	32.1 (384/1197)
Female	78.8 (1150/1460)	21.2 (310/1460)	77.3 (1123/1452)	22.7 (329/1452)	79.1 (1182/1495)	20.9 (313/1495)
Not known	60 (3/5)	40 (2/5)	50 (1/2)	50 (1/2)	14.3 (1/7)	85.7 (6/7)
Age on 1st day of audit						
0-4 years	24.6 (61/248)	75.4 (187/248)	26.8 (70/261)	73.2 (191/261)	21.9 (47/215)	78.1 (168/215)
5-9 years	51.7 (185/358)	48.3 (173/358)	44 (153/348)	56 (195/348)	41.8 (153/366)	58.2 (213/366)
10-14 years	77.5 (869/1122)	22.5 (253/1122)	77.7 (829/1067)	22.3 (238/1067)	76.4 (832/1089)	23.6 (257/1089)
15-19 years	95.7 (831/868)	4.3 (37/868)	94.9 (870/917)	5.1 (47/917)	93.4 (923/988)	6.6 (65/988)
20-24 years	100 (6/6)	0 (0/6)	100 (31/31)	0 (0/31)	100 (41/41)	0 (0/41)
Ethnicity						
White	74 (1409/1903)	26 (494/1903)	75.8 (1347/1777)	24.2 (430/1777)	73.7 (1448/1964)	26.3 (516/1964)
Asian	68 (70/103)	32 (33/103)	70.7 (106/150)	29.3 (44/150)	66.9 (89/133)	33.1 (44/133)
Black	79.7 (51/64)	20.3 (13/64)	75.4 (46/61)	24.6 (15/61)	71.6 (58/81)	28.4 (23/81)
Mixed	83.1 (69/83)	16.9 (14/83)	80.4 (78/97)	19.6 (19/97)	78.3 (54/69)	21.7 (15/69)
Other	69.4 (25/36)	30.6 (11/36)	63.6 (28/44)	36.4 (16/44)	55.6 (25/45)	44.4 (20/45)
Not stated or missing	79.4 (328/413)	20.6 (85/413)	70.3 (348/495)	29.7 (147/495)	79.1 (322/407)	20.9 (85/407)
Deprivation quintile						
1=Most deprived	73.2 (489/668)	26.8 (179/668)	76.8 (558/727)	23.2 (169/727)	75.9 (492/648)	24.1 (156/648)
2	77.5 (497/641)	22.5 (144/641)	75 (451/601)	25 (150/601)	76 (476/626)	24 (150/626)
3	76 (380/500)	24 (120/500)	74.6 (391/524)	25.4 (133/524)	76.4 (434/568)	23.6 (134/568)
4	74.3 (301/405)	25.7 (104/405)	74.3 (307/413)	25.7 (106/413)	70.4 (321/456)	29.6 (135/456)
5=Least deprived	73.4 (267/364)	26.6 (97/364)	69.2 (240/347)	30.8 (107/347)	68 (266/391)	32 (125/391)
Missing	75 (18/24)	25 (6/24)	50 (6/12)	50 (6/12)	70 (7/10)	30 (3/10)
ALL DKA ADMISSIONS	**75.0 (1952/2602)**	**25.0 (650/2602)**	**74.4 (1953/2624)**	**25.6 (671/2624)**	**74.0 (1996/2699)**	**26.0 (703/2699)**

6.2 Use of agents during DKA admissions to treat/prevent cerebral oedema

DKA admissions can be associated with acute life threatening complications such as cerebral oedema. The NPDA has collected data on the use of mannitol/hypertonic saline and bicarbonate during a DKA admission as a proxy for a clinical decision that a child may have or be developing cerebral oedema and/or DKA severity.

The proportions of those admissions involving the use of hypertonic saline or mannitol are shown in Figure 8 and show that the use of hypertonic saline or mannitol increased between 2012-13 and 2013-14 audit years, reducing again slightly in 2014-15. It is unclear whether the increase was due to patients presenting with greater severity of DKA, or whether data quality has improved. It is not possible to comment on whether rates of cerebral oedema are changing as this is purely a proxy measure.

Figure 8: Use of hypertonic saline and/or mannitol for DKA in patients with Type 1 diabetes, as reported in NPDA admissions data, 2012-15 (%)[1,2]



[1] DKA admissions found only in HES/PEDW are not included in this analysis because HES/PEDW do not measure the use of such agents.
[2]Only 10 patients across the three audit years received bicarbonate, so the data are not shown.

7. Trends in DKA admissions at diagnosis of Type 1 diabetes

DKA at diagnosis of diabetes can be considered as a quality indicator in its own right, as it may reflect the speed with which diabetes is diagnosed by healthcare professionals prior to being referred to a PDU. For the purpose of this report, the NPDA has defined DKA at diagnosis as any DKA episode occurring within 10 days of the date of diagnosis. The tolerance of 10 days was selected to allow for discrepancies between the date of diagnosis provided by PDU and the date of admission provided by HES/PEDW. The likelihood of a new admission with DKA within 10 days of the diagnosis of diabetes is extremely low unless it is related to the diagnosis.

7.1 Trends in DKA at diagnosis admissions amongst newly diagnosed patients

Table 14 describes the numbers and percentage of newly diagnosed children and young people with diabetes where DKA was present at diagnosis between 2012-15.

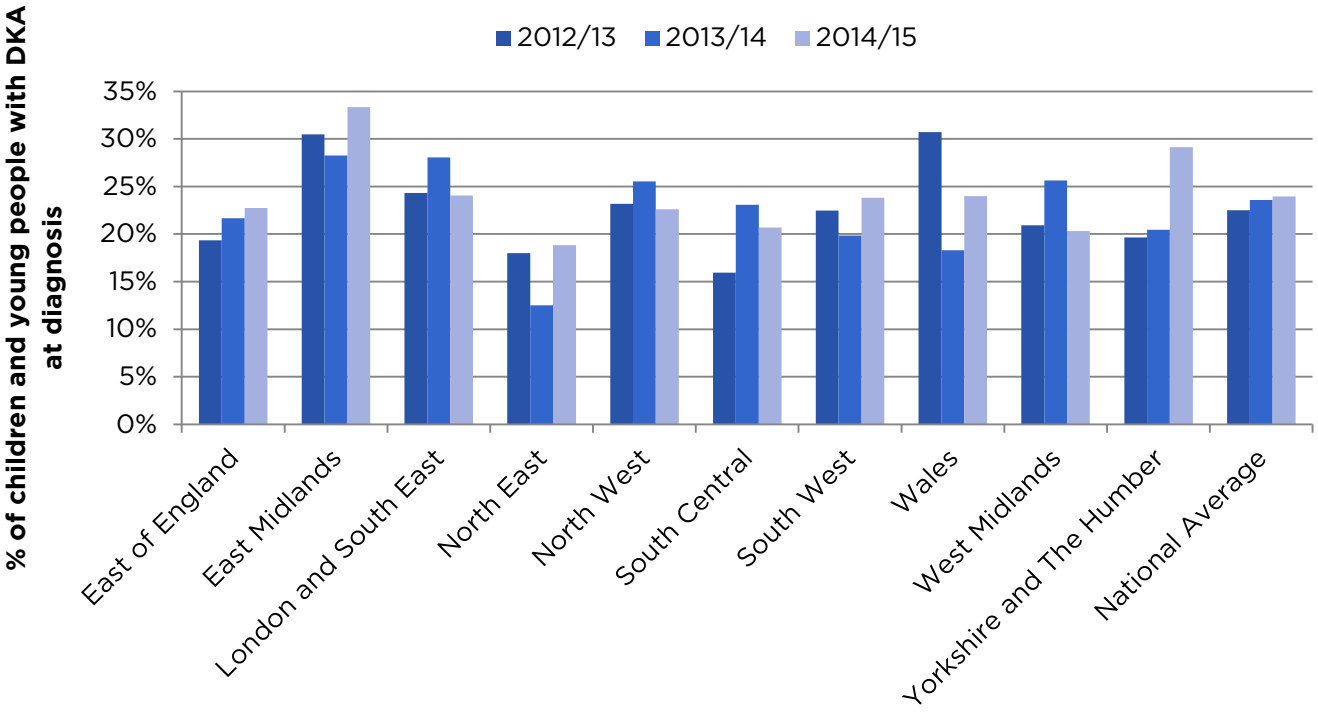
Although the number of children and young people presenting with DKA at diagnosis has increased, the relative proportion of all those diagnosed has remained stable at ~23% over the three year audit period. This rate is higher than previously reported by the NPDA in 2011-12 but previous reports did not include triangulated data and therefore likely represented an underestimation of the true rate.

Table 14: Regional breakdown of numbers of children and young people diagnosed with Type 1 diabetes within each audit year, and number of cases of DKA at diagnosis within each region, 2012-2015

	2012/13	2013/14	2014/15
England and Wales n/children and young people diagnosed in the audit year	**599/2663 (22.5%)**	**625/2652 (23.6%)**	**663/2770 (23.9%)**
England	552/2510	599/2510	628/2624
Wales	47/153	26/142	35/146
East of England	48/248	55/254	70/308
East Midlands	64/210	52/184	62/186
London and South East	133/547	158/563	138/574
North East	25/139	14/112	26/138
North West	83/358	85/333	80/354
South Central	40/251	60/260	55/266
South West	51/227	50/252	56/235
West Midlands	63/301	60/234	53/261
Yorkshire and The Humber	45/229	65/318	88/302

Figure 9 shows significant variation in rates of DKA at diagnosis of Type 1 diabetes between regions, and within regions between audit years.

Figure 9: Percentage of children and young people diagnosed with Type 1 diabetes within each audit year with DKA on diagnosis by region, 2012-15



7.2 DKA at diagnosis, broken down by patient characteristics

Table 15 shows the demographics of children and young people with Type 1 diabetes presenting with DKA at diagnosis. There are clear trends in deprivation with those living in the most deprived areas being more at risk of presenting with DKA at diagnosis. Younger age and female gender were also associated with a greater risk of DKA at diagnosis, but there were no clear ethnicity trends over the three years.

Table 15: Percentage and number of children and young people with Type 1 diabetes admitted with DKA at diagnosis who were diagnosed within the audit year, broken down by patient characteristics, 2012-15 (denominator= all children and young people diagnosed within the audit year)

Patient characteristic	2012-13	2013-14	2014-15
England and Wales	**22.5 (599/2663)**	**23.6 (625/2652)**	**23.9 (662/2770)**
Country			
England	22 (552/2510)	23.9 (599/2510)	23.9 (627/2624)
Wales	30.7 (47/153)	18.3 (26/142)	24 (35/146)
Sex			
Male	21.7 (315/1450)	22.2 (313/1411)	24.3 (365/1504)
Female	23.4 (282/1206)	25.1 (311/1238)	23.4 (292/1247)
Not known	(<5/7)	(<5/3)	(5/19)
Age on day of audit (years)			
0-4 years	30.2 (168/557)	31.9 (177/554)	29.1 (157/539)
5-9 years	19.9 (164/826)	21.3 (186/875)	21.2 (202/951)
10-14 years	21.8 (233/1067)	22.2 (218/982)	23.1 (243/1051)
15-19 years	16 (34/212)	18.3 (44/241)	26.3 (60/228)
Ethnicity			
White	23.1 (454/1969)	22.1 (402/1819)	24.3 (482/1985)
Asian	20.5 (30/146)	28.3 (41/145)	29.9 (43/144)
Black	25.5 (13/51)	28.6 (12/42)	28.8 (23/80)
Mixed	19.4 (12/62)	26.5 (18/68)	21.5 (14/65)
Other	25.6 (11/43)	30.4 (14/46)	22.4 (17/76)
Not stated or missing	20.2 (79/392)	25.9 (138/532)	19.8 (83/420)
Deprivation quintile			
1=Most deprived	25.6 (158/618)	27.3 (162/593)	27.3 (150/549)
2	26.4 (133/503)	25.7 (135/525)	24.6 (138/560)
3	23.1 (112/485)	23.4 (121/517)	24.9 (126/507)
4	19.3 (97/503)	19.3 (101/522)	22.4 (127/567)
5=Least deprived	18.6 (93/501)	20.8 (100/481)	21 (118/562)
Missing	11.3 (6/53)	42.9 (6/14)	12 (3/25)

Figure 10 shows that those aged 0-4 were at greatest risk of DKA at diagnosis within each audit year.

Figure 10: Percentage of those diagnosed within each audit year with DKA at diagnosis of Type 1 diabetes within each age group, 2012-15

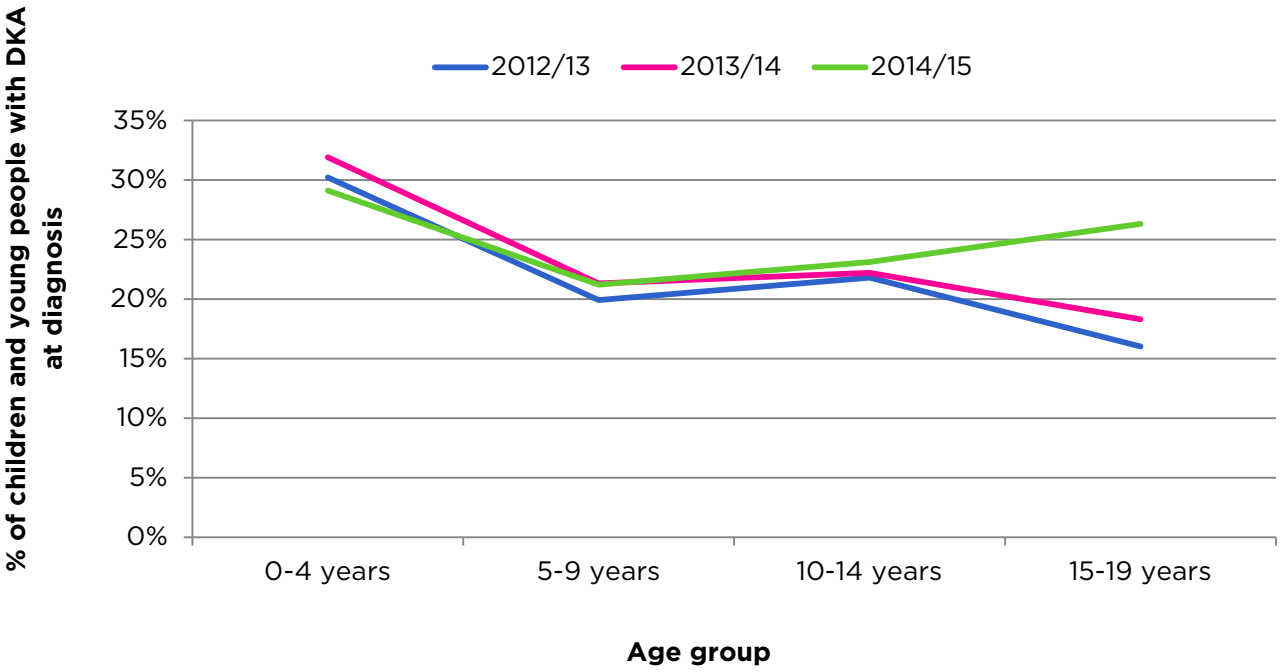
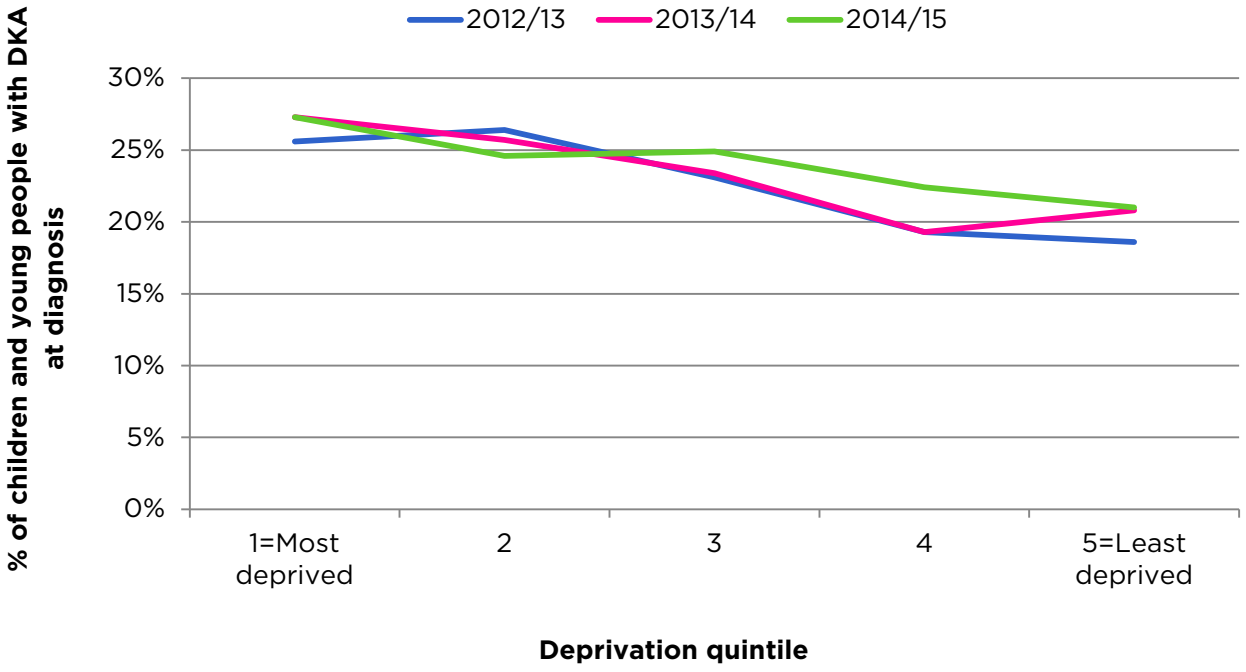


Figure 11 shows that risk of DKA at diagnosis increased with deprivation within each audit year.

Figure 11: Percentage of those diagnosed within each audit year with DKA at diagnosis of Type 1 diabetes within each deprivation quintile, 2012-15

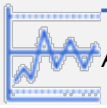


7.3 Summary: Admissions for DKA at diagnosis of Type 1 diabetes

DKA at diagnosis occurred in ~ 23% of new cases of Type 1 diabetes
This rate was stable between 2012-2015

A quarter of all DKA admissions were at diagnosis of Type 1 diabetes

Females, children aged 0-4 and those living in the most deprived areas
Had higher rates of DKA at diagnosis



There was variation in admission rates for DKA at diagnosis between regions
And between the same regions in different years

Recommendation: Campaigns to aid early diagnosis of Type 1 diabetes by raising awareness of signs and symptoms of diabetes should be reinvigorated and strongly supported by all stakeholders e.g. Diabetes UK's 4 'T's campaign

Please see pages 2-7 for a full summary of recommendations.

8. DKA admissions not related to diagnosis in children and young people with Type 1 diabetes

DKA admissions following diagnosis of diabetes can be considered as a performance indicator for PDUs as many of these admissions represent an inability to self-manage diabetes at home.

8.1 Trends in DKA admissions, not at diagnosis

Table 16 shows the percentage and number of DKA admissions not at diagnosis over the three year audit period. There was little change in the proportion of admissions for DKA not at diagnosis of approximately 21%.

Table 16: Percentage and number of all admissions in children and young people with Type 1 diabetes due to DKA (excluding DKA at diagnosis), 2012-2015

Statistic	2012-13	2013-14	2014-15
%	21.2	21.1	20.1
n/all diabetes related admissions	1952/9202	1953/9274	1996/9937

8.2 Proportion of DKA admissions, not at diagnosis, by treatment regimen

Table 17 shows DKA admission rates broken down by insulin regimen. Data quality improved over the three audit years as shown by the reduction in missing data. Children and young people on three or fewer injections per day had a higher rate of DKA admission compared to those on four or more injections or pumps.

Table 17: Percentage and number of admissions due to DKA (excluding at diagnosis) of children and young people with Type 1 diabetes by treatment regimen, 2012-2015 (denominator= all diabetes-related admissions)

Treatment regimen	2012-13	2013-14	2014-15
	%(n)	%(n)	%(n)
1-2 insulin injections per day	24.0 (153/637)	25.2 (190/753)	33.5 (210/627)
3 insulin injections per day	34.4 (116/337)	29.0 (70/241)	32.5 (96/295)
4+ insulin injections per day	20.1 (1035/5151)	20.7 (1111/5357)	19.9 (1177/5921)
Insulin Pump therapy	21.0 (263/1255)	22.1 (285/1288)	19.5 (337/1725)
Missing/invalid	21.2 (387/1822)	18.2 (297/1635)	12.9 (176/1369)

8.3 Proportion of DKA admissions, not at diagnosis by HbA1c target category

Table 18 shows the breakdown of DKA admissions, not at diagnosis, by HbA1c target. This clearly demonstrates an increased rate of DKA admission with poorer diabetes control. For DKA admissions (not including at diagnosis), >40% had an HbA1c >80mmol/mol, whereas <5% had an HbA1c <58mmol/mol.

Table 18: Percentage and number of admissions due to DKA (excluding at diagnosis) amongst children and young people with Type 1 diabetes by HbA1c category, 2012-2015 (denominator all Type 1 diabetes-related admissions)

Median HbA1c in audit year	2012-13	2013-14	2014-15
	%(n)	%(n)	%(n)
≤48 mmol/mol	2.3 (10/428)	1.8 (9/506)	0.7 (4/582)
≤53 mmol/mol	2.4 (19/776)	2.4 (23/951)	2.5 (27/1090)
<58 mmol/ mol	4.8 (61/1273)	4 (60/1486)	4 (69/1730)
≥69 mmol/mol	33.5 (1563/4663)	35.4 (1584/4470)	34.6 (1616/4675)
> 75 mmol/mol	38.5 (1413/3669)	39.5 (1381/3495)	39.1 (1401/3582)
> 80 mmol/ mol	41.7 (1263/3027)	42.9 (1226/2858)	41.9 (1259/3007)

8.4 Incidence of DKA not at diagnosis amongst all children and young people with Type 1 diabetes, broken down by patient characteristics

Table 19 shows the percentage and number of children and young people with Type 1 diabetes who were admitted at least once with DKA within each audit year, by patient characteristic. Increased rate of admission was associated with poorer diabetes control and with deprivation, female sex, older age, and longer duration of diabetes (Figures 14-16).

Table 19: Percentage and number of children and young people with Type 1 diabetes admitted to hospital with DKA at least once, not at diagnosis, by patient characteristic, 2012-15 (denominator = number of children and young people with Type 1 diabetes in each audit year)

	2012-13	2013-14	2014-15
	%(n)	%(n)	%(n)
England and Wales	5.6 (1321/23649)	5.2 (1310/25113)	5.1 (1331/26161)
Country			
England	5.6 (1257/22271)	5.2 (1240/23703)	5.0 (1250/24773)
Wales	4.6 (64/1378)	5.0 (70/1410)	5.8 (81/1388)
Deprivation quintile			
1=Most deprived	6.5 (314/4812)	6.8 (353/5222)	6.6 (317/4778)
2	6.9 (315/4545)	6.3 (309/4906)	6.0 (319/5310)
3	5.8 (261/4468)	5.2 (253/4866)	5.3 (284/5341)
4	4.7 (214/4527)	4.3 (211/4892)	4.0 (210/5307)
5=Least deprived	4.2 (204/4915)	3.5 (179/5137)	3.7 (195/5277)
Missing	3.4 (13/382)	5.6 (5/90)	4.1 (6/148)
Sex			
Male	4.7 (579/12402)	4.4 (581/13153)	4.3 (583/13707)
Female	6.6 (740/11219)	6.1 (728/11932)	6.0 (747/12411)
Not known	7.1 (2/28)	3.6 (1/28)	2.3 (1/43)
Age on day of audit (years)			
0-4 years	3.3 (52/1563)	3.6 (57/1568)	2.4 (38/1585)
5-9 years	2.9 (146/5065)	2.5 (134/5276)	2.4 (132/5537)
10-14 years	5.6 (604/10737)	5.4 (578/10742)	5.3 (575/10820)
15-19 years	8.3 (516/6227)	7.2 (537/7491)	7.1 (583/8158)
20-24 years	5.3 (3/57)	11.1 (4/36)	4.9 (3/61)
Ethnicity			
White	5.4 (937/17210)	4.9 (893/18127)	5.2 (966/18727)
Asian	4.6 (50/1089)	5.5 (67/1219)	4.8 (63/1301)
Black	8.2 (32/392)	6.9 (29/422)	7.2 (35/484)
Mixed	7.8 (45/574)	8.1 (51/630)	5.5 (35/641)
Other	5.8 (19/330)	5.3 (19/356)	4.0 (17/422)
Not stated or missing	5.9 (238/4054)	5.8 (251/4359)	4.7 (215/4586)

	2012-13 % (n)	2013-14 % (n)	2014-15 % (n)
Duration of diabetes on day 1 of the audit year			
Less than one year	2.4 (132/5397)	2.2 (123/5488)	1.9 (111/5719)
1-2 years	5.2 (263/5024)	4.6 (245/5277)	4.4 (244/5519)
3-4 years	6.6 (282/4260)	5.7 (254/4443)	5.8 (264/4558)
5-9 years	6.9 (457/6659)	7.1 (517/7253)	6.6 (499/7515)
10-14 years	8.0 (171/2137)	6.2 (153/2454)	7.6 (200/2619)
15+ years	9.3 (16/172)	9.1 (18/198)	5.6 (13/231)
Treatment regimen			
1-2 insulin injections per day	5.7 (88/1548)	5.2 (83/1588)	6.7 (78/1167)
3 insulin injections per day	6.2 (60/963)	5.5 (43/788)	6.7 (53/794)
4 or more insulin injections per day	5.4 (728/13397)	5 (743/14754)	5.1 (789/15515)
Insulin pump therapy	5.9 (206/3521)	5.1 (262/5123)	4.8 (303/6358)
Missing/invalid	5.6 (239/4228)	6.3 (179/2860)	4.6(108/2327)
HbA1c median in audit year			
≤48 mmol/mol	1.1 (10/924)	0.7 (8/1184)	0.2 (3/1398)
≤53 mmol/mol	0.9 (18/2009)	0.7 (19/2554)	0.7 (22/3137)
<58 mmol/ mol	1.4 (55/3956)	1.0 (47/4783)	1.0 (59/5713)
≥69 mmol/mol	9.1 (1012/11074)	9.2 (1021/11131)	9.8 (1031/10501)
> 75 mmol/mol	11.9 (887/7480)	11.8 (864/7317)	12.8 (872/6803)
> 80 mmol/ mol	14.1 (771/5459)	14 (746/5318)	15.4 (766/4982)

Figure 12 shows that in general, the rate of admission with DKA increased with duration of diabetes.

Figure 12: Proportion of children and young people with Type 1 diabetes admitted for DKA at least once (not at diagnosis), by duration of diagnosis, 2012-15

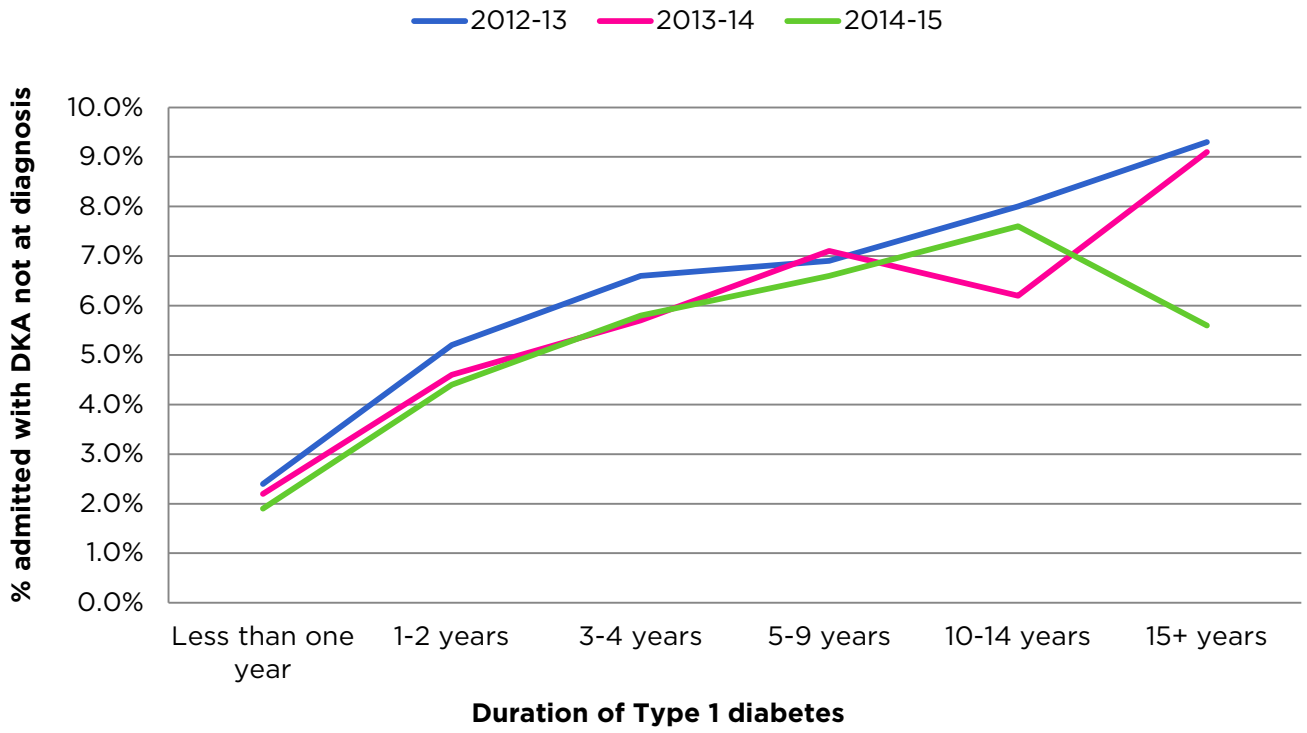


Figure 13 shows that there was a lo ı the least deprived areas compared to those in the most deprived areas, and that this was consistent across the three audit years.

Figure 13: Proportion of children and young people with Type 1 diabetes admitted at least once for DKA (not at diagnosis), by deprivation quintile, 2012-15

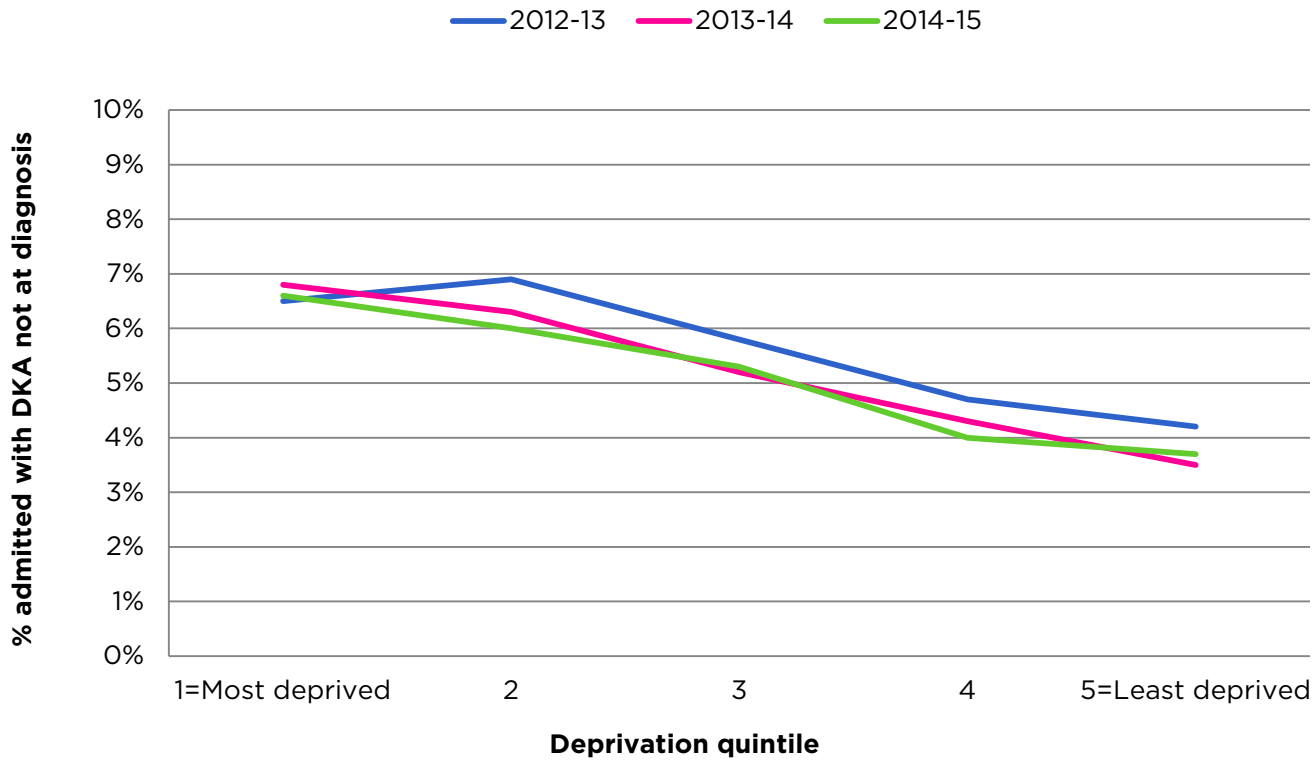


Figure 14 shows that there was a higher admission rate amongst those aged 10-19 compared to younger children.

Figure 14: Proportion of children and young people with Type 1 diabetes admitted for DKA at least once (not at diagnosis) by age group, 2012-15

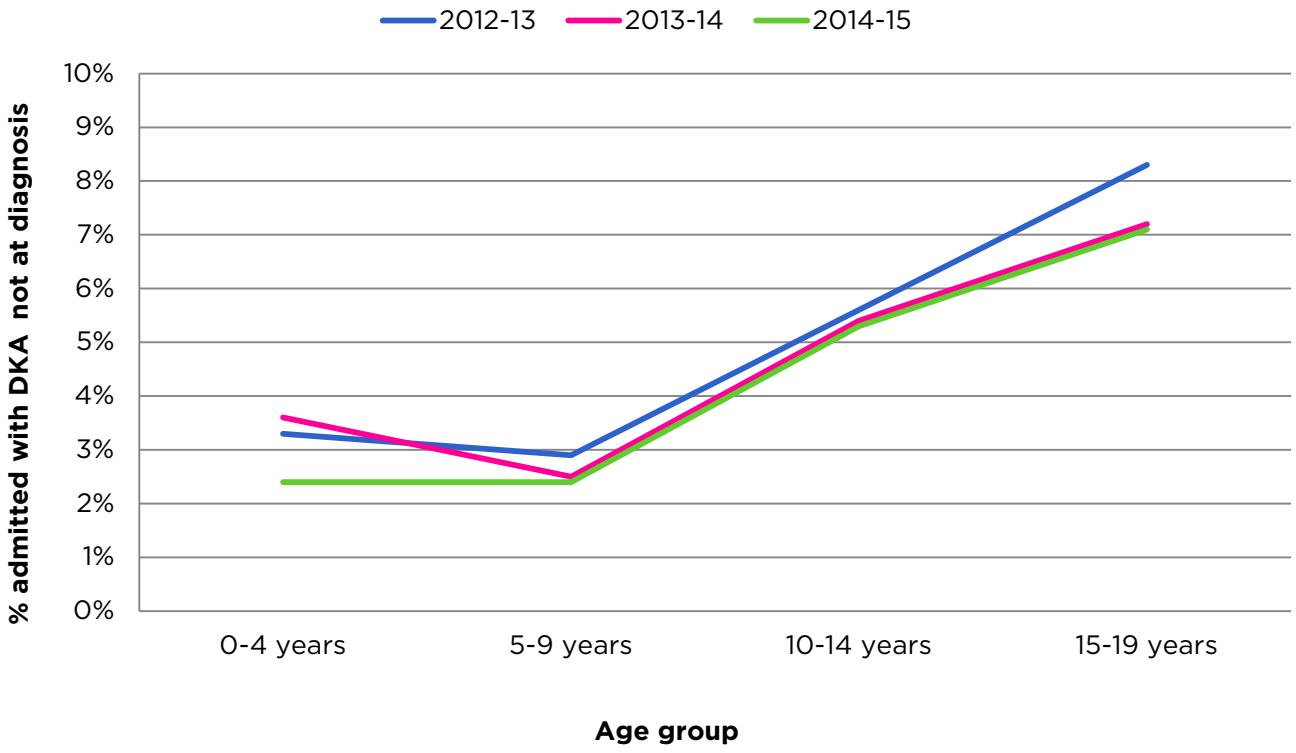


Table 20: Median HbA1c of children and young people who were admitted with DKA (not at diagnosis) compared to those who had no admission, 2012-15

	2012-13 mmol/mol (n)	2013-14 mmol/mol (n)	2014-15 mmol/mol (n)
Admitted in audit period	88.0 (1249)	86.0 (1237)	86.0 (1292)
Not admitted in audit period	68.3 (20703)	67.0 (22286)	66.0 (23222)

Table 20 shows that those admitted with DKA not at diagnosis had poorer diabetes control, with a median difference of 20mmol/mol between those admitted and those who were not.

8.5 Socio-demographic and diabetes-related risk factors for DKA admission (not at diagnosis) for children and young people with Type 1 diabetes

This patient-level analysis explored associations of socio-demographic and diabetes-related characteristics of all children and young people with Type 1 diabetes and admission for DKA (excluding at diagnosis), combining data for all audit years. The analysis used Generalised Estimating Equations to adjust for within-PDU and within-patient effects in conjunction with logistic regression. The technical document explaining how the analysis was done, and the full results, can be found on the NPDA website.

Table 21 shows the association of each characteristic with DKA admission, after adjusting for the influence of all the other characteristics in the table. Although there are clear significant associations with some characteristics, NPDA and HES/PEDW data are cross-sectional and it is difficult to claim that one characteristic is *causing* the increased or decreased odds of admission. Table 20 therefore shows the strength of the *association* between DKA admission and each factor.

The finding of a small increased risk of admission for DKA (27%) over the three year audit period amongst children and young people with existing Type 1 diabetes on insulin pump therapy was surprising. This was after taking into account other confounding variables such as gender, age, duration, ethnicity, deprivation and HbA1c levels which also had influence on DKA admission rates. Awareness of this finding is important as more and more children and young people with Type 1 diabetes are opting for insulin pump therapy. The NPDA would recommend that this raised risk is discussed carefully with families at initiation of pump therapy and education with regards to DKA avoidance is paramount. This finding also requires further surveillance at local level and ongoing national audit monitoring to see if this is a continued trend.

Table 21: Summary of socio-demographic and diabetes-related risk factors associated with DKA admission (not at diagnosis) across three audit years using logistic regression analysis

Characteristic	Risk effects	Magnitude of risk
Audit year	No risk	No risk
Age group	Lower risk for 5-9 years compared to 0-4 years.	35% reduced risk
Sex	Higher risk for females compared to males.	33% increased risk
Ethnicity	No risk	No risk
Deprivation quintile: (1=most deprived, 5=least deprived)	Lowering risk with lowering deprivation	• 12% lower risk for middle quintile compared to first quintile • 28% lower risk for fourth quintile compared to first • 31% lower risk for fifth quintile compared to first quintile
Duration of diabetes	Higher risk associated with increased duration of diabetes	• 46% increased risk if diagnosed 1-2 years before the audit • 63% increased risk if diagnosed 3-4 years before the audit • 64% increased risk if diagnosed 5-9 years before the audit • 48% increased risk if diagnosed 10+ years before the audit
HBA1C Median	Increasing risk with increasing HbA1c	• 277% increased risk if HbA1c is 58-80 mmol/mol compared to <58 mmol/mol • 1233% increased risk if HBA1C is >80 mmol/mol compared to <58 mmol/mol
Regimen	Increased risk for insulin pumps compared to insulin injections	27% increased risk

8.6 Summary: Admissions of children and young people with Type 1 diabetes for DKA not related to diagnosis

DKA was present in 21% of admissions
This rate was stable between 2012-2015

~15% of all children and young people with an HbA1c> 80mmol/mol had a DKA admission within each audit year
Only 0.2-1.1% of those with an HbA1c <48 mmol/mol were admitted with DKA

Females, adolescents and those living in the most deprived areas
Had higher rates of DKA at diagnosis

There was variation in admission rates for DKA at diagnosis between regions
And between the same regions in different years

Risk factors for DKA not related to diagnosis

- Younger age
- Female gender
- Deprivation
- Duration of diabetes >1 year
- Poor diabetes control
- Insulin pump usage

Please see pages 2-7 for a summary of recommendations.

9. Hypoglycaemia admissions of children and young people with Type 1 diabetes

This section describes hospital admissions for children and young people with diabetes where the cause of admission was related to hypoglycaemia.

9.1 Trends in hypoglycaemia admissions

Table 22 shows the number and proportion of all diabetes-related admissions attributable to hypoglycaemia. Overall there is little change over the three year audit period.

Table 22: Percentage and number of Type 1 diabetes-related admissions due to hypoglycaemia

Statistic	2012-13	2013-14	2014-15
%	7.5	7.3	7.1
No. hypoglycaemia admissions/total Type 1 diabetes-related admissions	687/9202	674/9274	701/9937

Table 23 shows the breakdown of admissions with hypoglycaemia and insulin regimen. There were no appreciable differences between admission rates for patients on different insulin regimens.

Table 23: Percentage and number of hypoglycaemia admissions amongst children and young people with Type 1 diabetes by treatment regimen, 2012-15 (denominator all Type 1 diabetes-related admissions)

Treatment regimen	2012-13	2013-14	2014-15
	%(n)	%(n)	%(n)
1-2 insulin injections per day	11.6 (74/637)	7.7 (58/753)	4.8 (30/627)
3 insulin injections per day	8.6 (29/337)	12 (29/241)	8.8 (26/295)
4 or more insulin injections per day	7.2 (371/5151)	7.4 (395/5357)	7.1 (418/5921)
Insulin Pump therapy	9 (113/1255)	8.2 (105/1288)	9.5 (164/1725)
Missing/invalid	5.5 (100/1822)	5.3 (87/1635)	4.6 (63/1369)

Table 24 shows the breakdown of hypoglycaemia admissions by HbA1c category. There was no real change in the frequency of admission with hypoglycaemia over the three year audit period and little relationship with median HbA1c. However, children admitted with hypoglycaemia appeared to have slightly better diabetes control in terms of median HbA1c compared to those who were not admitted with hypoglycaemia.

Table 24: Percentage and number of hypoglycaemia admissions amongst children and young people with Type 1 diabetes by HbA1c status, 2012-15 (denominator= all diabetes-related admissions)

HbA1c median (groups)	2012-13	2013-14	2014-15
	%(n)	%(n)	%(n)
≤48 mmol/mol	3.7 (16/428)	5.3 (27/506)	5.8 (34/582)
≤53 mmol/mol	4.4 (34/776)	7 (67/951)	6.2 (68/1090)
<58 mmol/ mol	7.6 (97/1273)	7.7 (115/1486)	6.3 (109/1730)
≥69 mmol/mol	7.5 (350/4663)	6.5 (292/4470)	6.7 (311/4675)
> 75 mmol/mol	6.3 (232/3669)	5.4 (189/3495)	5.5 (196/3582)
> 80 mmol/ mol	5.9 (179/3027)	4.3 (123/2858)	4.8 (143/3007)
Median HbA1c (n)			
Admitted for hypoglycaemia	70.0 mmol/mol (655)	67.6mmol/mol (646)	67.2 mmol/mol (665)
Not admitted for hypoglycaemia in audit period	74.5 mmol/mol (7106)	73.0 mmol/mol (7241)	71.6 mmol/mol (7893)

9.2 Incidence of hypoglycaemia admissions amongst those with Type 1 diabetes, broken down by socio-demographics

Table 25 shows the incidence of admission with hypoglycaemia amongst those with Type 1 diabetes broken down by patient characteristics. The denominator for this sub-section is all children and young people with Type 1 diabetes in the NPDA; the numerator is the number of patients who were admitted with hypoglycaemia during the audit period, broken down by socio-demographics, HbA1c group and time since diagnosis.

Table 25: Percentage and number of children and young people with Type 1 diabetes admitted to hospital with hypoglycaemia at least once in each audit year as a proportion of the total number of those with Type 1 diabetes, by socio-demographic and diabetes characteristics, 2012-15

	2012-13	2013-14	2014-15
England and Wales	2.5 (587/23649)	2.3 (575/25113)	2.3 (596/26161)
Country			
England	2.5 (550/22271)	2.2 (531/23703)	2.2 (553/24773)
Wales	2.7 (37/1378)	3.1 (44/1410)	3.1 (43/1388)
Age group			
0-4 years	5.6 (87/1563)	5.6 (88/1568)	5.8 (92/1585)
5-9 years	3 (153/5065)	3.1 (166/5276)	2.5 (138/5537)
10-14 years	2.4 (258/10737)	1.9 (204/10742)	2.1 (231/10820)
15-19 years	1.4 (87/6227)	1.5 (116/7491)	1.7 (135/8158)
20-24 years	3.5 (2/57)	2.8 (1/36)	0 (0/61)
Sex			
Male	2.3 (282/12402)	2 (265/13153)	2.3 (310/13707)
Female	2.7 (304/11219)	2.6 (310/11932)	2.3 (283/12411)
Not known	3.6 (1/28)	0 (0/28)	7 (3/43)
Ethnicity			
White	2.5 (430/17210)	2.4 (428/18127)	2.3 (436/18727)
Asian	2.8 (30/1089)	2 (24/1219)	2.9 (38/1301)
Black	3.6 (14/392)	4.3 (18/422)	3.1 (15/484)
Mixed	2.8 (16/574)	2.5 (16/630)	3.6 (23/641)
Other	3 (10/330)	0.8 (3/356)	2.1 (9/422)
Not stated or missing	2.1 (87/4054)	2 (86/4359)	1.6 (75/4586)
Deprivation quintile			
1=Most deprived	3.4 (164/4812)	3.1 (160/5222)	2.8 (135/4778)
2	3 (135/4545)	2.2 (106/4906)	2.9 (153/5310)
3	2.3 (102/4468)	2.2 (105/4866)	2 (107/5341)
4	2.2 (98/4527)	2.4 (119/4892)	2.1 (114/5307)
5=Least deprived	1.6 (77/4915)	1.6 (83/5137)	1.6 (84/5277)
Duration of diabetes			
Less than one year	2.6 (143/5397)	2.6 (144/5488)	2.6 (151/5719)
1-2 years	2.3 (117/5024)	2.5 (133/5277)	2.3 (128/5519)
3-4 years	2.7 (116/4260)	2.2 (97/4443)	2.3 (105/4558)
5-9 years	2.6 (173/6659)	2.2 (162/7253)	2.3 (172/7515)
10-14 years	1.7 (37/2137)	1.5 (37/2454)	1.4 (37/2619)
15+ years	0.6 (1/172)	1 (2/198)	1.3 (3/231)
HBA1C median (groups)			
≤48 mmol/mol	1.2 (11/924)	1.9 (22/1184)	1.9 (26/1398)
≤53 mmol/mol	1.4 (29/2009)	2.2 (55/2554)	1.7 (54/3137)
<58 mmol/ mol	2.2 (86/3956)	2.1 (100/4783)	1.6 (93/5713)
≥69 mmol/mol	2.6 (289/11074)	2.2 (245/11131)	2.5 (259/10501)
> 75 mmol/mol	2.5 (188/7480)	2.1 (157/7317)	2.4 (162/6803)
> 80 mmol/ mol	2.7 (145/5459)	1.8 (96/5318)	2.3 (115/4982)

Figure 15 shows that children and young people with Type 1 diabetes living in more deprived areas were more likely to be admitted with hypoglycaemia than those in the least deprived areas.

Figure 15: Percentage of children and young people with Type 1 diabetes admitted for hypoglycaemia within each deprivation quintile, 2012-2015

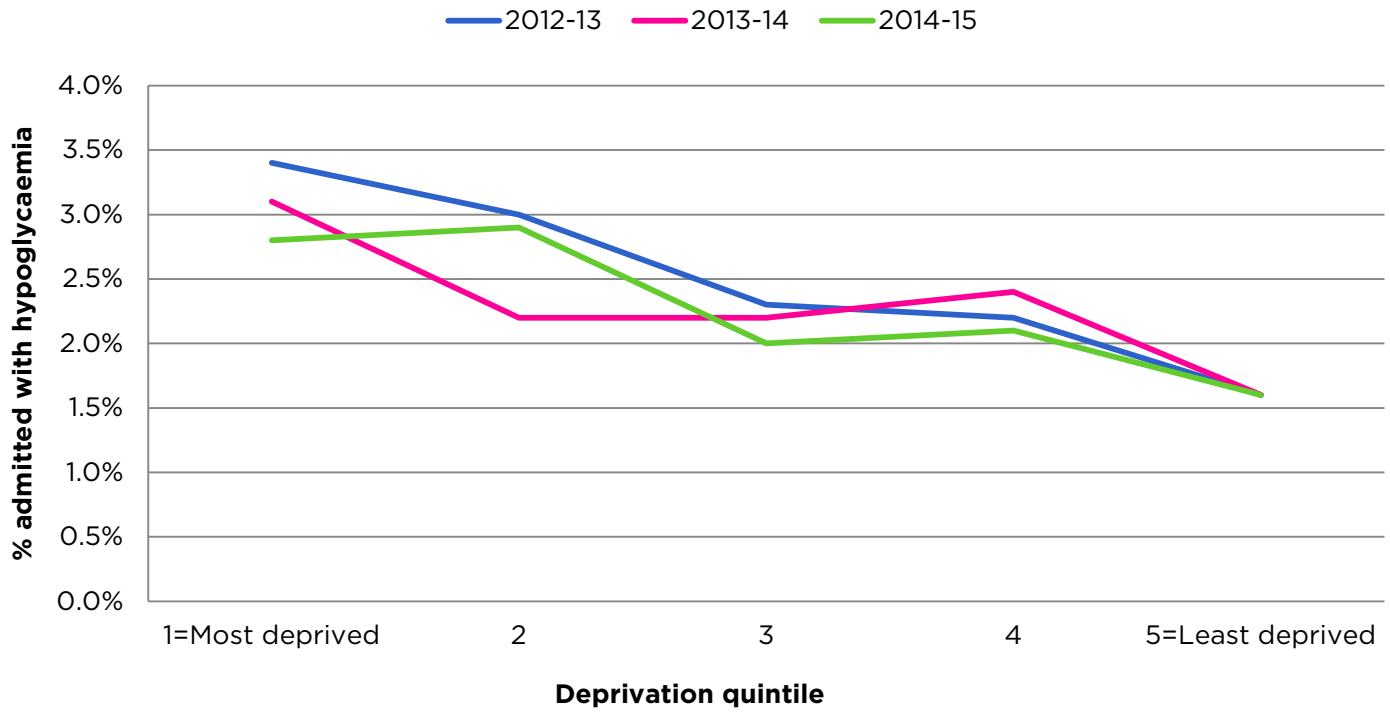


Figure 16 shows that risk of admission with hypoglycaemia decreased with age across all three audit years, with those aged 0-4 at greatest risk.

Figure 16: Percentage of children and young people with Type 1 diabetes admitted with hypoglycaemia within each age group, 2012-15

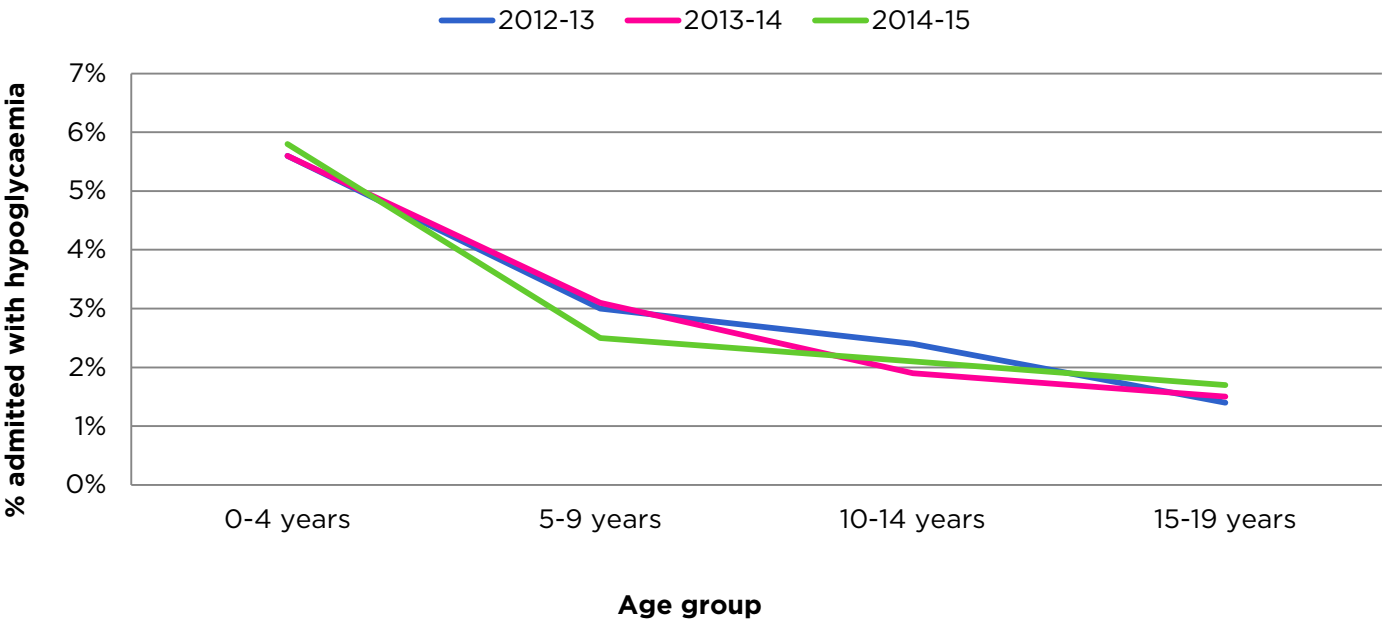
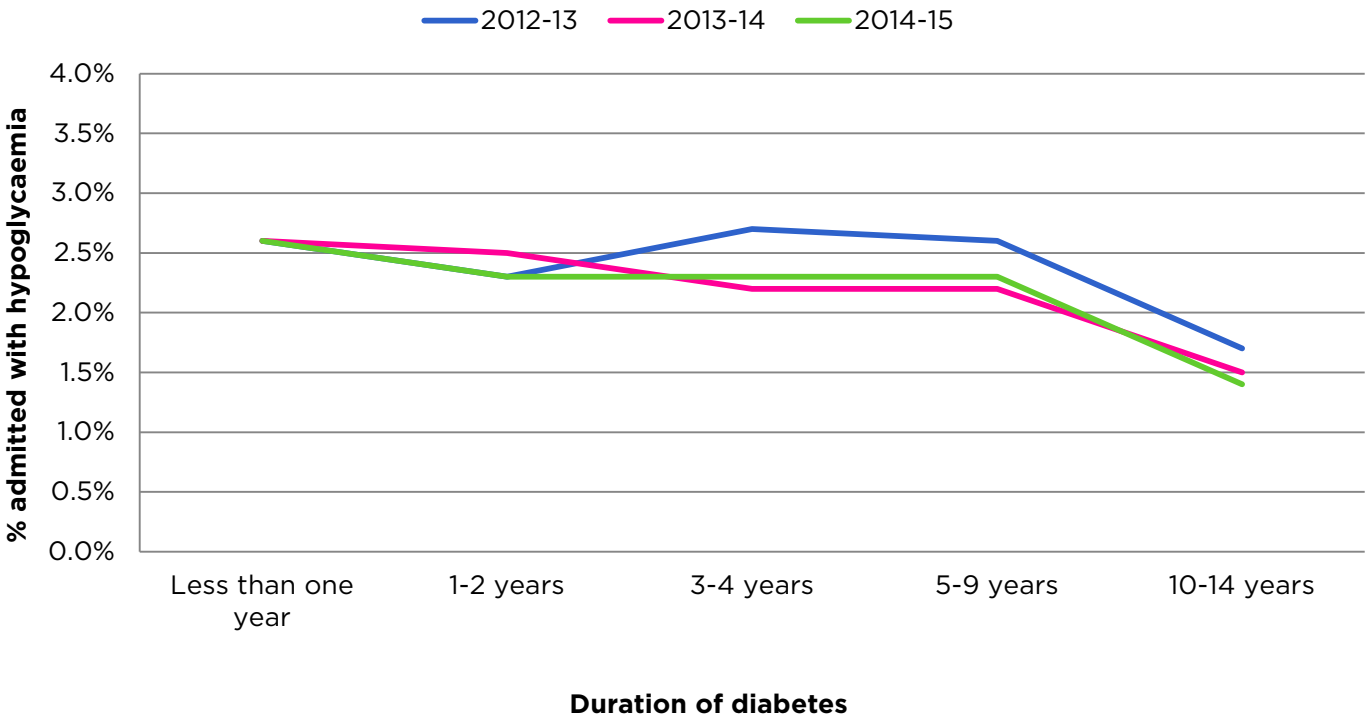


Figure 17 shows that the rate of admission for hypoglycaemia was similar for children and young people with Type 1 diabetes diagnosed less than ten years before the start of each audit year, but those diagnosed between 10-14 years after each audit year were less likely to be admitted with hypoglycaemia.

Figure 17: Proportion of children and young people with Type 1 diabetes admitted with hypoglycaemia by time since diabetes diagnosis, 2012-15



9.3 Socio-demographic and diabetes-related risk factors for hypoglycaemia admissions of children and young people with Type 1 diabetes

This patient-level analysis explored associations of socio-demographic and diabetes-related characteristics with admission for hypoglycaemia, combining data for all audit years. The analysis used Generalised Estimating Equations to adjust for within-PDU and within-patient effects in conjunction with logistic regression. The technical document explaining how the analysis was done, and the full results, can be found on the NPDA website.

Table 26 shows the association of each characteristic with DKA admission, after adjusting for the influence of all the other characteristics in the table. Although there are clear significant associations with some characteristics, NPDA and HES/PEDW data are cross-sectional and it is difficult to claim that one characteristic is *causing* the increased or decreased odds of admission. Table 25 therefore shows the strength of the *association* between DKA admission and each characteristic.

Table 26: Socio-demographic and diabetes-related risk factors associated with hypoglycaemia admission across three audit years

Characteristic	Risk effects	Magnitude of risk
Audit year	No risk	No risk
Age group	Lower risk for all age groups compared to the youngest (0-4 years).	• 55% reduced risk for patients 5-9 years • 68% reduced risk for patients 10-14 years • 78% reduced risk for patients 15-24 years
Sex	No risk	No risk
Ethnicity	Lower risk for patients with missing or 'Not Stated' ethnicity compared to White patients.	18% lower risk
Deprivation quintile: (1=most deprived, 5=least deprived)	Lowering risk with lowering deprivation	• 27% lower risk for middle quintile compared to first quintile • 23% lower risk for fourth quintile compared to first • 42% lower risk for fifth quintile compared to first quintile
Time since diabetes diagnosis on day 1 of the audit	Higher risk for patients diagnosed at 5-9 years before the audit started compared to those diagnosed less than 1 year before.	• 19% increased risk if diagnosed 5-9 years before the audit
HbA1c Median	Increasing risk with increasing HbA1c	• 33% increased risk if HbA1c is 58-80 mmol/mol compared to <58 mmol/mol • 32% increased risk if HbA1c is >80 mmol/mol compared to <58 mmol/mol
Regimen	No risk	No risk

9.4 Summary: Admissions of children and young people with Type 1 diabetes for hypoglycaemia

Hypoglycaemia was present in ~7% of admissions
This rate was stable between 2012-2015

~ 2% of all children and young people with Type 1 diabetes had an admission with hypoglycaemia in each audit year

Children aged 0-4, those living in a deprived areas and those with poorer diabetes control
Had higher rates of admission with hypoglycaemia

Risk factors for admission with hypoglycaemia

- Age <5 years old
- Longer duration of diabetes
- Deprivation
- Poor diabetes control

Please see pages 2-7 for a summary of recommendations.

10. Admission for 'other' Type 1 diabetes-related reasons

There are a large number of children and young people with Type 1 diabetes being admitted to hospital where the cause is unclear. HES and PEDW contain limited codes for paediatric diabetes which makes breakdown of other causes difficult. PDUs are also asked to submit data on hospital admissions as part of their annual NPDA submission. This contains a number of common causes for diabetes related admissions allowing an insight into possible causes of the HES/PEDW 'other admission' data.

10.1 Trends in diabetes-related admissions for other reasons

'Other' reasons for admission included the following:

- **From the NPDA** ketosis without acidosis, stabilisation of diabetes, surgical admissions, other reasons.
- **From HES/PEDW database** diabetes with: coma, renal complications, ophthalmic complications, neurological complications, peripheral circulatory complications, multiple complications, without complications, other complications (all of which are extremely rare in children and young people).

Table 27 shows that nearly two thirds of Type 1 diabetes-related admissions were due to 'other' reasons.

Table 27: Percentage and number of all Type 1 diabetes-related admissions for 'other' reasons, 2012-15 (denominator=all Type 1 diabetes-related admissions)

Statistic	2012-13	2013-14	2014-15
%	64.0	64.4	65.6
n/all diabetes related admissions	5886/9202	5975/9274	6522/9937

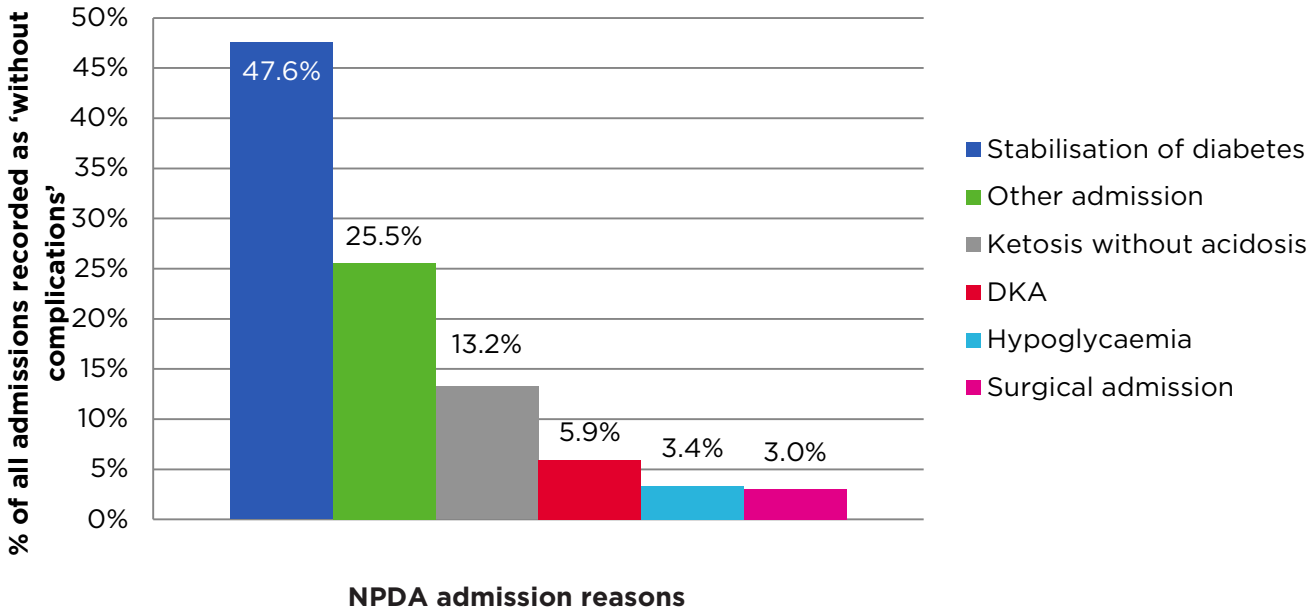
10.2 Admissions 'without complications'

This analysis aimed to break down the 'without complications' category given in HES/PEDW using NPDA data. Admission 'without complications' was the most commonly cited reason for admission of children and young people in the HES/PEDW dataset, with ~ 54% of all admissions uniquely identified within this dataset having this as a primary diagnostic code between 2012-2015.

There were 5043 admissions across the audit years where: 1) Type 1 admissions were present in both NPDA and HES/PEDW data files (i.e. they had an exact match on admission date and NHS number) and 2) HES/PEDW had recorded reason for admission as 'without complications'.

Figure 18 shows the reasons given in the NPDA dataset for the admissions 'without complications' cited in HES/PEDW. Note that the percentages do not add up to 100% because of missing NPDA data.

Figure 18: Percentage of different NPDA admission reasons for patients with Type 1 diabetes recorded as 'without complications' in HES/PEDW, 2012-15 (n=5043; denominator= patients with exact match on admission date)



Nearly half of all admissions recorded as 'without complications' in the HES/PEDW dataset were related to admissions for stabilisation of diabetes according to information submitted by PDUs.

Limitations to this exploratory subgroup analysis include the variation in quality of reporting by PDUs and that it only represents admissions with an exact match on admission date in both datasets.

10.3 'Other' admissions within the NPDA dataset

About one third of NPDA reported admissions were related to 'other' causes not attributable to DKA, hypoglycaemia, ketosis without acidosis, stabilisation of diabetes or surgery, with the most commonly cited reason being vomiting,

10.4 Incidence of 'other' admissions in children and young people with Type 1 diabetes, by socio-demographic and diabetes-related characteristics

Table 28 shows the percentage and numbers of admissions for causes other than DKA or hypoglycaemia amongst those with Type 1 diabetes broken down by socio-demographic factors. The denominator for this sub-section is all PDU patients with Type 1 diabetes; the numerator is the number of patients who were admitted for an 'other reason' during the audit period, broken down by socio-demographics, HbA1c group and time since diagnosis.

It shows that ~19% of all PDU patients had an admission for 'other' reasons within each audit year. There was a higher rate of admissions for 'other' reasons amongst those with better diabetes control. This is quite the reverse seen in DKA admissions. The NPDA data suggests that nearly half of these admissions may be for stabilisation of diabetes suggesting a possible association between admission for this cause and improved control. Further analysis is required to explore this possibly.

Table 28: Percentage and number of children and young people with Type 1 diabetes admitted to hospital for 'other' reasons at least once in different audit years by patient characteristic, 2012-15 (denominator = all PDU patients with Type 1 diabetes)

Patient characteristic	2012-13	2013-14	2014-15
	%(n) unless otherwise stated	%(n) unless otherwise stated	%(n) unless otherwise stated
Total	**18.8 (4443/23649)**	**18.4 (4617/25113)**	**18.9 (4950/26161)**
Country			
England	18.8 (4196/22271)	18.4 (4355/23703)	18.8 (4666/24773)
Wales	17.9 (247/1378)	18.6 (262/1410)	20.5 (284/1388)
Age			
0-4 years	37.9 (592/1563)	38.7 (607/1568)	38.9 (617/1585)
5-9 years	22.5 (1140/5065)	22.2 (1169/5276)	23.4 (1295/5537)
10-14 years	18.6 (1999/10737)	18.1 (1943/10742)	19.1 (2072/10820)
15-19 years	11.4 (708/6227)	11.9 (894/7491)	11.8 (960/8158)
20-24 years	7 (4/57)	11.1 (4/36)	9.8 (6/61)
Duration of diabetes			
Less than one year	42.7 (2307/5397)	42.5 (2332/5488)	43 (2457/5719)
1-2 years	13.5 (678/5024)	13 (684/5277)	13.1 (721/5519)
3-4 years	11.5 (490/4260)	12.4 (551/4443)	12.3 (560/4558)
5-9 years	11.4 (761/6659)	11.3 (820/7253)	11.9 (896/7515)
10-14 years	8.9 (190/2137)	8.9 (219/2454)	11.5 (302/2619)
15+ years	9.9 (17/172)	5.6 (11/198)	6.1 (14/231)
Treatment regimen			
1-2 insulin injections per day	15.6 (242/1548)	18.8 (299/1588)	15.9 (185/1167)
3 insulin injections per day	14.2 (137/963)	10.8 (85/788)	12.6 (100/794)
4 or more insulin injections per day	19.5 (2611/13397)	18.6 (2738/14754)	19.6 (3040/15515)
Insulin Pump therapy	17.9 (629/3521)	15.5 (792/5123)	15.7 (1000/6358)
Missing/invalid	19.5 (824/4220)	24.6 (703/2860)	26.6 (625/2327)
Deprivation quintile			
1=Most deprived	22.3 (1072/4812)	20.8 (1088/5222)	22.6 (1082/4778)
2	20.4 (927/4545)	20.4 (1002/4906)	19.6 (1043/5310)
3	18.1 (807/4468)	17.8 (866/4866)	18.5 (989/5341)
4	17 (769/4527)	17.2 (841/4892)	17.9 (951/5307)
5=Least deprived	15.9 (782/4915)	15.6 (803/5137)	16.1 (852/5277)
Sex			
Male	17.8 (2207/12402)	17.4 (2288/13153)	17.6 (2418/13707)
Female	19.9 (2230/11219)	19.5 (2326/11932)	20.3 (2519/12411)
Not known	21.4 (6/28)	10.7 (3/28)	30.2 (13/43)
Ethnicity			
White	22.9 (249/1089)	22.1 (269/1219)	21.1 (274/1301)
Asian	26.5 (104/392)	21.8 (92/422)	26.7 (129/484)
Black	21.6 (124/574)	19.5 (123/630)	21.8 (140/641)
Mixed	18.5 (61/330)	21.1 (75/356)	24.9 (105/422)
Other	15.1 (613/4054)	16 (696/4359)	13.8 (634/4586)
Not stated or missing	19.1 (3292/17210)	18.5 (3362/18127)	19.6 (3668/18727)
HbA1c median (groups)			
≤48 mmol/mol	30.8 (285/924)	28 (331/1184)	27.5 (385/1398)
≤53 mmol/mol	25.9 (520/2009)	23.1 (591/2554)	21.7 (681/3137)
<58 mmol/ mol	20.2 (801/3956)	19 (908/4783)	18.7 (1070/5713)
≥69 mmol/mol	16.3 (1807/11074)	16.2 (1803/11131)	17.4 (1828/10501)
> 75 mmol/mol	17.8 (1329/7480)	17.9 (1313/7317)	19.4 (1322/6803)
> 80 mmol/ mol	18.6 (1018/5459)	18.9 (1003/5318)	21.1 (1050/4982)
Median HbA1c of those admitted (n)	69.0 mmol/mol (3567)	68.0 mmol/mol (3764)	67.0 mmol/mol (4086)

Figure 19 shows there was a trend for higher rates of admission for 'other' reasons amongst children and young people in the most deprived areas, and that this trend was consistent across the three years.

Figure 19: Percentage of children and young people with Type 1 diabetes admitted for 'other' reasons within each deprivation quintile, 2012-15

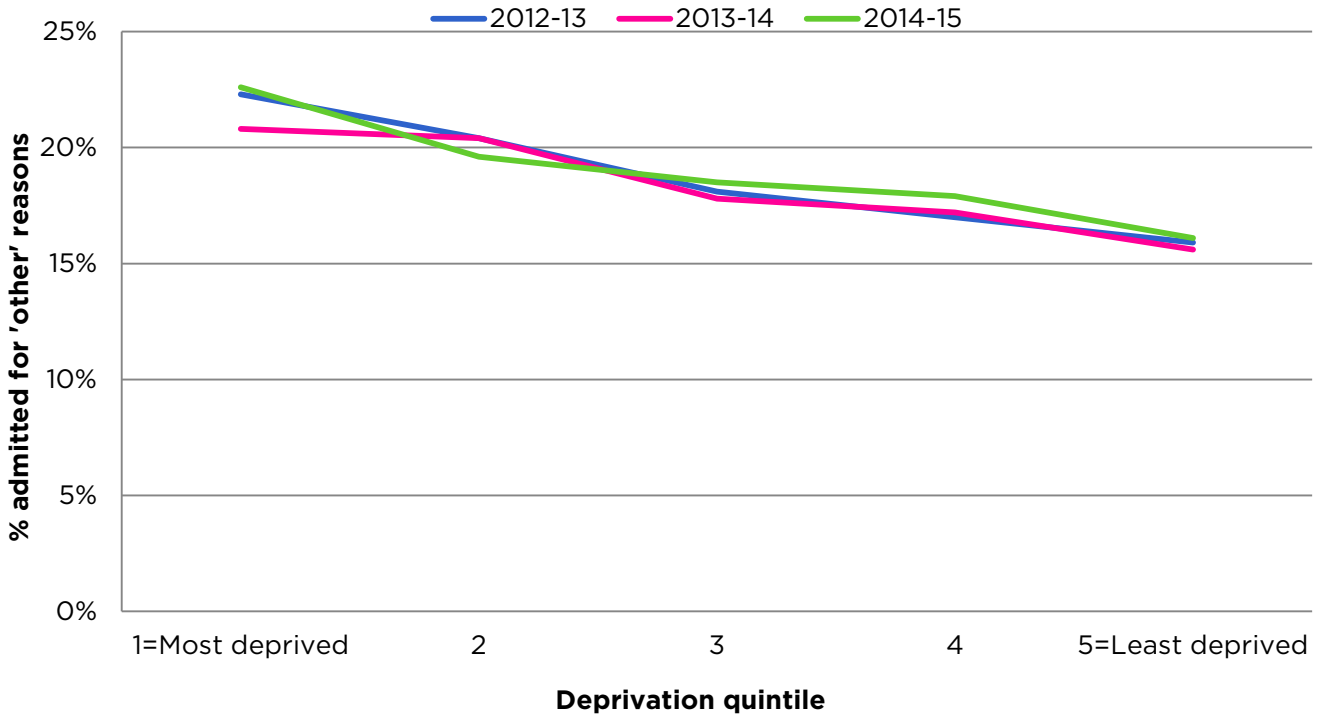


Figure 20 shows that admission rates for 'other' reasons amongst children and young people with Type 1 diabetes decreased with increasing age.

Figure 20: Percentage of children and young people with Type 1 diabetes admitted for 'other' reasons within each age group, 2012-15

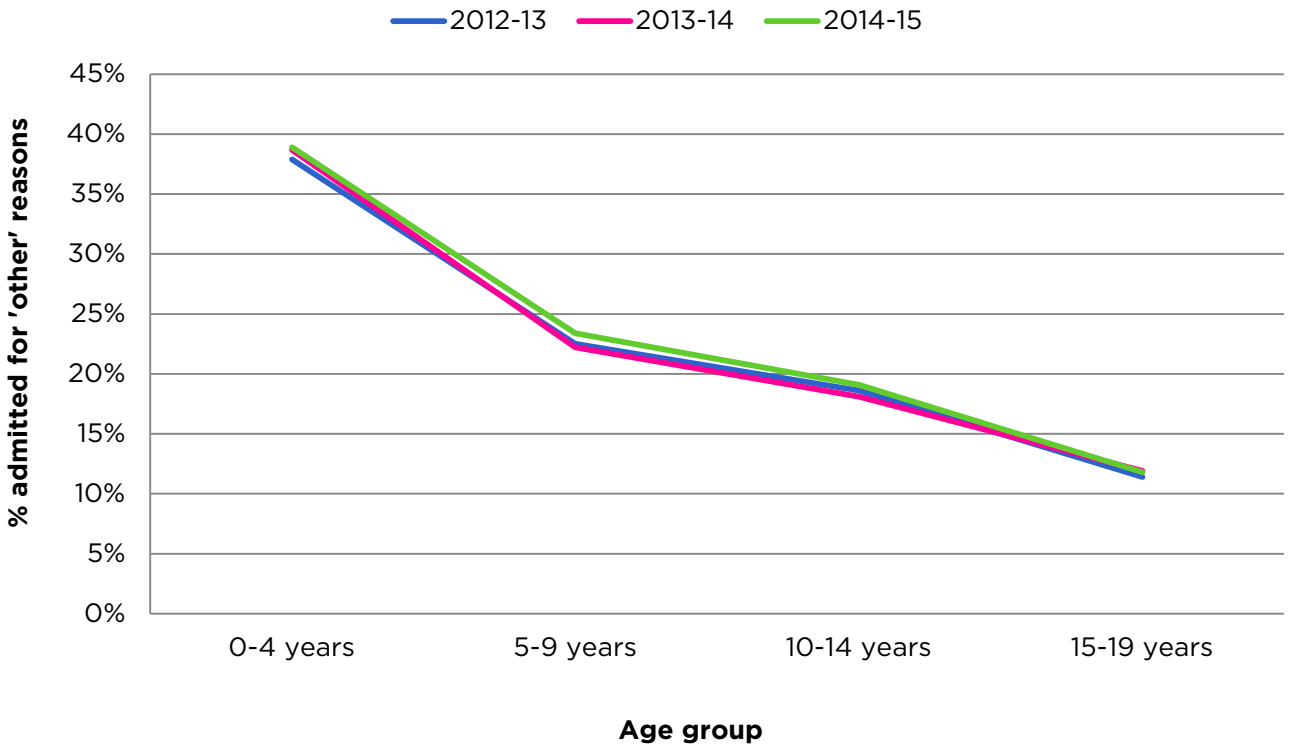
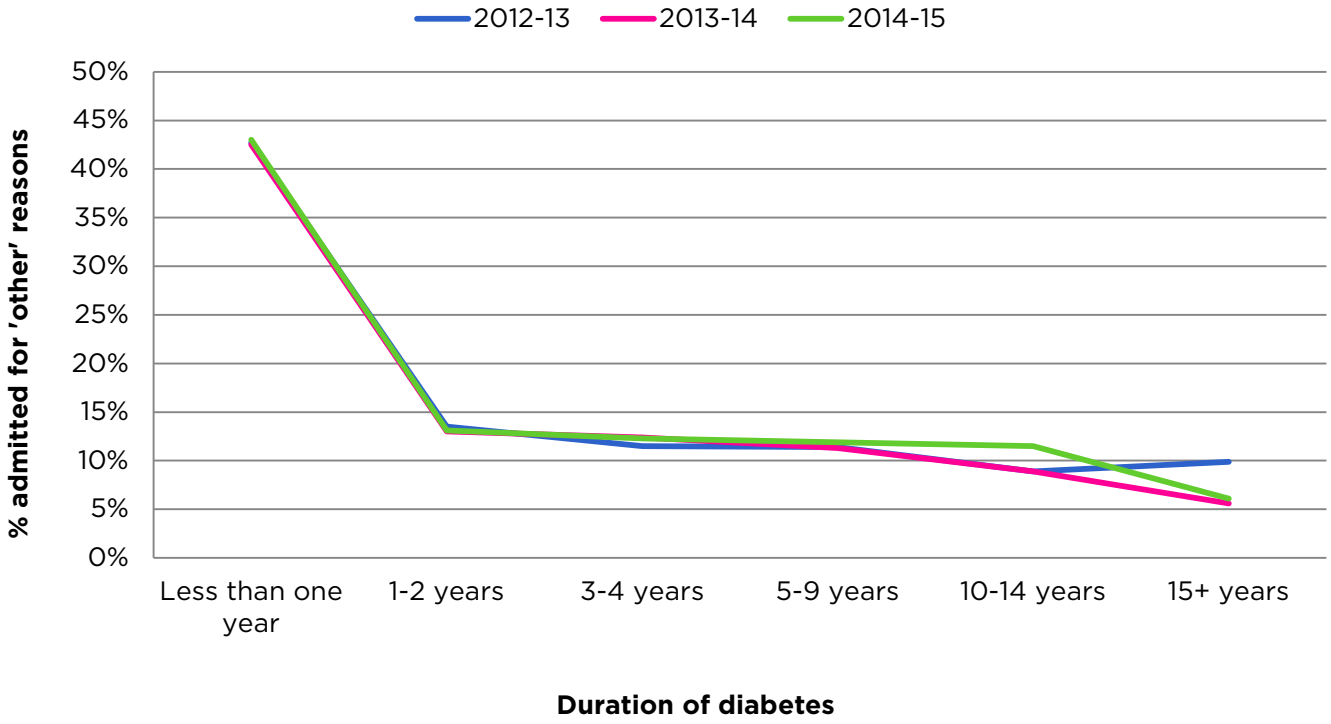


Figure 21 shows that there was a higher rate of admission for 'other' reasons amongst children and young people with Type 1 diabetes diagnosed less than a year before each audit period.

Figure 21: Proportion of children and young people with Type 1 diabetes admitted for 'other' reasons, by time since diabetes diagnosis, 2012-15



10.5 Socio-demographic and diabetes-related risk factors for 'other' admissions – Type 1 diabetes

This patient-level analysis explored associations of socio-demographic and diabetes-related characteristics with admission for causes other than DKA or hypoglycaemia, combining data for all audit years. The analysis used Generalised Estimating Equations to adjust for within-PDU and within-patient effects in conjunction with logistic regression. The technical document explaining how the analysis was done, and the full results, can be found on the NPDA website.

Table 28 shows the association of each characteristic with DKA admission, after adjusting for the influence of all the other characteristics in the table. Although there are clear significant associations with some characteristics, NPDA and HES/PEDW data are cross-sectional and it is difficult to claim that one characteristic is *causing* the increased or decreased odds of admission – reported is the strength of the *association* with each other.

The finding of a small increased risk of admission for other admissions (23%) over the three year audit period amongst children and young people with existing Type 1 diabetes on insulin pump therapy was surprising. This was after taking into account other confounding variables such as gender, age, duration, ethnicity, deprivation and HbA1c levels which also had influence on admission rates for other reasons. Awareness of this finding is important as more and more children and young people with Type 1 diabetes are opting for insulin pump therapy. The NPDA would recommend that this raised risk is discussed carefully with families at initiation of pump therapy and education with regards to DKA avoidance is paramount. This finding also requires further surveillance at local level and ongoing national audit monitoring to see if this is a continued trend.

This additional risk is surprising as it has not been demonstrated previously, and because admission rates of patients on insulin pumps were not found to be higher than patients on other regimens. The NPDA has found that children and young people in the least deprived areas are more likely to be using pump

therapy compared to those in the most deprived areas (RCPCH, 2016) whereas those in the most deprived areas are more likely to be admitted for diabetes-related reasons, which may have masked the increased risk identified when deprivation and other patient characteristics were controlled for. Awareness of this finding requires further surveillance at local level and ongoing audit surveillance to see if this is a continued trend.

Table 29: Socio-demographic and diabetes-related factors associated with admissions for 'other' causes in children and young people with Type 1 diabetes across three audit years

Characteristic	Risk effects	Magnitude of risk
Audit year	Lower risk of admission in 2013-14 audit year compared to 2012-13.	5% lower risk.
Age group	Lower risk for all age groups compared to the youngest (0-4 years).	• 32% reduced risk for patients 5-9 years • 36% reduced risk for patients 10-14 years • 53% reduced risk for patients 15-24 years
Sex	Females at a higher risk than males	25% higher risk
Ethnicity	Lower risk for patients with missing or 'Not Stated' ethnicity compared to White patients.	30% lower risk
Deprivation quintile: (1=most deprived, 5=least deprived)	Lowering risk with lowering deprivation.	• 12% lower risk for middle quintile compared to first quintile • 18% lower risk for fourth quintile compared to first • 26% lower risk for fifth quintile compared to first quintile
Time since diabetes diagnosis on day 1 of the audit	Lowering risk the longer the time since diagnosis compared to diagnosis less than 1 year before the audit.	• 73% decreased risk if diagnosed 1-2 years before the audit • 76% decreased risk if diagnosed 3-4 years before the audit • 77% decreased risk if diagnosed 5-9 years before the audit • 81% decreased risk if diagnosed 10+ years before the audit
HbA1c Median	Varying risk with increased HbA1c compared to HbA1c <58 mmol/mol	• 6% decreased risk if HbA1c is 58-80 mmol/mol compared to <58 mmol/mol • 90% increased risk if HbA1c is >80 mmol/mol compared to <58 mmol/mol
Regimen	Increased risk for insulin pumps compared to insulin injections	23% increased risk

10.6 Summary: Admissions of children and young people with Type 1 diabetes for 'other reasons'

~19% of all children and young people with Type 1 diabetes were admitted for 'other' reasons within each audit year

Using NPDA definitions for admission in this group, nearly half were related to stabilisation of diabetes

Younger children, those living in the most deprived areas, and those diagnosed less than one year before the each audit period
Had higher rates of admission

Risk factors for admission for 'other' reasons

- Age <4 years old
- Female gender
- Deprivation
- Duration of diabetes < 1 year
- Poor diabetes control
- Insulin pump usage

Please see pages 2-7 for a summary of recommendations.

11. Conclusions

Hospital admissions in children and young people with diabetes present a considerable burden on themselves, families and the NHS. This three year cumulative report triangulating hospital admission data both from HES and PEDW databases along with those reported by PDUs has shown little change in admission rates between 2012-15. However, it has highlighted variability across England and Wales and identified socio-demographic risk factors. Like many other healthcare related outcomes, living in a deprived area increased the risk of hospital admission as did poor diabetes control which is also related to deprivation index.

Reducing the risk of presenting with DKA at diagnosis appears to be a complex area. Public and healthcare professional awareness campaigns highlighting the early signs and symptoms of diabetes do not appear to have reduced the incidence of DKA at diagnosis over this three year audit period.

The increased risk of admission with DKA amongst children and young people with Type 1 diabetes on insulin pump therapy is surprising as this has not been demonstrated elsewhere. Awareness of this finding requires further surveillance at local level and ongoing audit surveillance to see if this is a continued trend.

Local centres providing diabetes care in children and young people need to monitor their hospital admissions and explore quality improvement initiatives that might be utilised to try and reduce the rate. This requires close collaboration between centres and networks and recognition of modifying factors that might influence admission rates such as diabetes control and treatment regimen.

A huge amount of work has been undertaken by healthcare teams, parents and patients to achieve better outcomes for children and young people in England and Wales over the last few years, which has been rewarded by continued improvements in national diabetes control. Similar energy and effort must now be directed towards reducing admission rates.

12. Glossary

Best Practice Tariff (for diabetes) – An annual payment from NHS England to paediatric diabetes units for each child or young person under their management whose care meets the best practice criteria.

Cerebral oedema - a swelling of the brain due to an accumulation of water that can happen as a complication of Diabetic Ketoacidosis (DKA). The brain compresses because of the swelling against the skull, which can lead to brain damage and death if not treated.

Diabetes mellitus (DM) is commonly referred to as diabetes. It is a condition where the blood glucose levels remain high because the body cannot use the glucose properly without treatment. If left untreated diabetes complications will occur, the common ones include eye and kidney damage, cardiovascular disease, strokes and foot damage.

Diabetic Ketoacidosis (DKA) - This happens when a severe lack of insulin means the body cannot use glucose for energy, and the body starts to break down other body tissue for energy instead. This produces ketones: poisonous chemicals which build up and will cause the body to become acidic if left untreated, which can be fatal.

Glucose - a simple sugar with a specific chemical formula and is classed as a monosaccharide. Glucose is the sugar that is found in blood and blood glucose acts as a major source of energy for the body.

HbA1c (Glycated haemoglobin) – a blood test that measures how much glucose binds to the red blood cells. It gives a measure of the average blood glucose level approximately 6 – 8 weeks before the test, and provides an indication of overall diabetes control.

Hypoglycaemia – Hypoglycaemia (or a "hypo") occurs when blood glucose levels fall below 4 mmol/L. Mild hypoglycaemia is relatively common and can be corrected by the child or young person or their parent/carer themselves, but severe hypoglycaemia must be treated with urgency in hospital to avoid potential coma and death.

Ketones – Poisonous chemicals produced when the body breaks down fat for energy instead of glucose due to a lack of insulin.

Logistic Regression - a statistical analysis method used to predict a data value based on prior observations of a data set by analysing the relationship between one or more existing independent variables.

Mean – a measure of the 'average' of set of numbers. Add up all the numbers, then divide by how many numbers there are in the sample.

Median – the median is the middle number of a list of numbers that are sorted from the smallest to the largest number.

NICE - The National Institute for Health and Care Excellence (NICE) provides national guidance and advice to improve health and social care.

Structured Patient Education Programme - a programme of self-management education, tailored to the child or young person's maturity and their family's needs. Specific education should be given at the initial diagnosis and on an on-going basis throughout the child's or young person's attendance at the diabetes clinic. This is a programme offered in addition to the education provided at routine outpatient consultations.

13. List of tables

14. List of figures

15. References

NICE (2015) *Diabetes (type 1 and type 2) in children and young people: diagnosis and management* (NG18). NICE, London. Available at: http://www.nice.or.uk/guidance/ng18

RCPCH (2014) *National Paediatric Diabetes Audit 2012-13 Report 1: Care Processes and Outcomes.* Royal College of Paediatrics and Child Health, London. Available at http://www.rcpch.ac.uk

RCPCH (2015) *National Paediatric Diabetes Audit 2013-14 Report 1: Care Processes and Outcomes.* Royal College of Paediatrics and Child Health, London. Available at http://www.rcpch.ac.uk/

RCPCH (2016) *National Paediatric Diabetes Audit 2014-15 Report 1: Care Processes and Outcomes.* Royal College of Paediatrics and Child Health, London. Available at http://www.rcpch.ac.uk

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