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Avoidable Hospital Admissions; Using hospital data for Ambulatory Care Sensitive Conditions (ACSC) to identify priorities for primary care investment in Ireland

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Abstract:

Objective

In 2016 The Irish acute hospital system operated well above the internationally recommended target of 85% occupancy level. Many admissions are avoidable in a health system with a robust primary care health service. The objective of this study was to measure the impact of ACSCs on acute hospital capacity in the Irish public system and identify specific care areas for enhanced primary care provision.

Design

National HIPE data was used to calculate 2011-2016 standardised bed day rates for selected ACSC conditions. A prioritisation exercise was then undertaken to identify the most significant contributors to bed days within our hospital system. Poisson regression analysis was used to determine any change over time using Incidence Rate Ratios (IRR) .(1)

Results

In 2016 ACSCs accounted for almost 20% of acute public hospital beds (n= 853,361 bed days; (18,297/100.00) with adults 65 years and over representing 69.1% (n=602,392) of these. Vaccine preventable conditions represented 39.1% of ACSCs. Influenza and pneumonia was responsible for 99.8% of these, and increased by 8.2% (IRR: 1.02; 95%CI 1.02-1.03) from 2011 to 2016. Pyelonephritis was the largest contributor to acute ACSCs representing 47.6% of acute ACSC bed days, increasing by 46.5% (IRR: 1.07; 95%CI 1.06-1.08) over the 5 years examined.

Conclusions

Prioritisation for targeted investment in robust integrated care programmes is enabled through analysis of ACSC's in terms of acute hospital bed days. This analysis demonstrates that efficiency gains in acute hospitals in Ireland are possible with ambulatory respiratory conditions in adults 65 years and over representing the greatest impact on hospital bed days in 2011-2016.

Article Summary

The impact of ACSCs on hospital capacity is best reflected by their contribution to bed days and this data can be used to determine priority areas for investment in primary care to reduce these potentially avoidable admissions. Ireland has had increasing difficulties in meeting demand for acute inpatient services in recent years reflected in a bed occupancy rate of 94% and a significant number of patients waiting on trolleys in Emergency Departments for admission. This analysis demonstrates that in Ireland, approximately one fifth of acute publicly funded bed days in 2016 were taken up by ACSC conditions. The majority of these (69%) were in those 65 and over. Three ACSC conditions, Influenza and pneumonia, COPD and pyelonephritis accounted for two thirds of these bed days. Evidence based approaches to the management of these conditions exist but are not available universally within the community in Ireland. Analysis of ACSCs using bed days and bed day rates can identify priority areas for investment in primary care.

Strengths and Limitations of this study:

- The study examines ambulatory care sensitive conditions (ACSCs) using national level data extracted from the national Hospital In-patient Enquiry System
- It considers the impact of ACSCs on the acute publicly funded hospital system using bed days and age-standardised bed day rates
- National bed day rates are standardised to the EU population; three age-specific bed days rates are analysed (children 0-15, adults 15-64 and persons 65 and older)
- All 19 ACSCs identified are included in the prioritisation exercise which identifies the top 5 contributors to ACSC bed days for the total population as well as for each age cohort examined
- Trend analysis over the 5 year period 2011-2016 is examined using Poisson regression techniques.

Introduction:

Ambulatory care sensitive conditions (ACSCs) are acute or episodic conditions where appropriate and timely community care can prevent disease and/or hospital admissions.(2) While there is variability in relation to the conditions considered ACSCs, they can be broadly classified into vaccine preventable, acute and chronic conditions. ACSCs are commonly used as an indicator of avoidable hospital admissions as well as quality of and access to primary care.(3, 4)

The current acute hospital bed occupancy rate of 94.2% is significantly higher than the internationally recognised target of 85%. Occupancy rates at this level are associated with adverse patient and staff outcomes as well as restricting efficiency in terms of patient flow.(5) To achieve international standards of bed occupancy would require the immediate introduction of 1,260 inpatient beds.(5) Ireland is experiencing an ageing demographic shift with an expected annual increase of almost 20,000 in the population 65 years and over. This population cohort currently occupy 54% of total acute bed days.(6) Moreover the demand for acute hospital beds is projected to increase significantly unless there is a shift in the model of care from acute hospital care to primary care.(6) The hospital centric nature of the Irish system continues to fuel an ever increasing demand for acute hospitals to deliver care and services which would be better provided in the community. However Primary Care services in Ireland remain under resourced.(7) As recognised within Slaintecare, the 10 year cross political vision for the future of Irish healthcare services, improvement and sustainability of the Irish Health system is dependant on a shift of care from acute hospitals to primary care.(7)

In the literature, ACSC analyses to date recognises the impact on emergency departments and admissions. Drivers of these admissions have been examined highlighting the association with levels of primary care provision, as well as higher levels of deprivation.(1, 8-10) However, the use of ACSC analysis to identify and prioritise areas for improved primary care resources and programmes of care remains unexamined. The purpose of this paper is to examine ACSCs in relation to their overall impact on acute hospital capacity in Ireland in terms of bed days and bed day rates and to assist prioritisation of targeted investment in primary care supporting robust integrated care programmes. This novel approach to the evaluation of ACSCs supports the left shift to primary care called for by Slaintecare and international policy.

Methods:

The international literature in relation to 'definition and coding' of ACSCs was reviewed and a list of 19 commonly cited ACSCs was identified for inclusion (appendix 1). Definition notes for ICD codes including primary and secondary diagnoses were examined and the definition notes most

appropriate to the Irish setting and reflective of bed utilisation were chosen. Data for these codes was extracted from the National Hospital In-patient Enquiry System (HIPE) to calculate 2011-2016 age-standardised bed day rates for selected ACSC conditions. Age specific analysis was carried out using the following categories; children (0-14 years), adults (15-64 years) and persons 65 years and over. A prioritisation exercise was then undertaken to identify the most significant contributors to bed days and bed day rates within our hospital system. Poisson regression analysis was used to distinguish a genuine change over time. Standardised Incidence Rate Ratios (IRR) with 95% Confidence Intervals and corresponding p values were reported.(1) Population rates are directly standardised to the European standard population.

Results:

ACSCs represented 18.5% (n=871,328; 18,297/100,000) of publicly funded bed days in Ireland in 2016 (table 1). An absolute increase in bed days of 111,726 bed days (IRR 1.03; p<0.01) attributable to ACSC conditions was observed over the 5 years examined 2011-2016 (table 2). Vaccine preventable conditions were the greatest contributor to ACSC bed days, representing 39.1% of bed days among ACSCs (10,170/100,000). There was an 8.2% (IRR 1.02; p<0.01) increase in bed days in this category from 2011-2016. This increase was particularly accelerated from 2014 onwards (table 2; figure 1). Influenza and pneumonia accounted for almost all of this category (99.8%), representing 7.2% (n= 339,613 (10,155/100,000) of total publicly funded bed days in Irish acute hospitals. In 2016 chronic ACSCs represented one third (31.9%) of all ACSC bed days. Bed days among chronic ACSCs reduced over the period 2011-2016 by approximately 10% (n=7,442; IRR 1.16; p<0.01). Chronic Obstructive Pulmonary Disease (COPD) accounted for 45% of this category (n= 126,336 bed days; 4,052/100,000), showing a slight increase in bed days over time (2011-2016) of 1.1% (IRR:1.16;p<0.001). A change to the ICD coding for diabetes in 2014 make direct comparison of rates over time difficult.

Acute ACSCs represent 29.0% of bed days attributable to ACSCs. Pyelonephritis represents almost half (51.2%; n=120,285 bed days; 3,681/100,000). Bed days for acute conditions increased by just under one fifth (19.7%) over the five years (IRR 1.05; p<0.01), representing a net increase of 56,773 bed days (figure 1; table 2).

Table 1 Impact of ACSCs on bed days in public acute hospitals in Ireland in 2016

ACSC		bed days	% ACSC bed days	% total bed days	standardised bed day rate per 100,000
Vaccine preventable	**total**	**340461**	**39.1**	**7.3**	**10170**
	influenza and pneumonia	339613	39.0	7.2	10155
	other vaccine preventable	848	0.1	0.0	81
Acute	**total**	**252698**	**29.0**	**5.4**	**7000**
	pyelonephritis	120285	13.8	2.6	3681
	cellulitis	46088	5.3	1.0	1307
	convulsions and epilepsy	36161	4.2	0.8	857
	dehydration & GII	7594	0.9	0.2	216
	dental	8422	1.0	0.2	162
	ENT infections	15443	1.8	0.3	282
	gangrene	11372	1.3	0.2	308
	perforated ulcer	5575	0.6	0.1	153
	PID	1758	0.2	0.0	37
Chronic	**total**	**278169**	**31.9**	**5.9**	**8226**
	COPD	126336	14.5	2.7	4052
	CHF	63560	7.3	1.3	2059
	diabetic complications	40241	4.6	0.9	1081
	angina	15179	1.7	0.3	430
	asthma	14519	1.7	0.3	318
	hypertension	5586	0.6	0.1	144
	iron deficiency anaemia	12523	1.4	0.3	357
	nutritional deficiencies	225	0.0	0.0	7
ACSC contribution to public bed days		**871328**	**100.0**	**18.5**	**18,297**

Table 2 Trend analysis of ACSC bed days in Irish publicly funded acute hospitals 2011-2016

ACSC		Absolute change in bed days	% change in standardised bed day rate	incidence rate ratio for trend	95% Confidence Interval
Vaccine preventable	**total**	**62395**	**8.2**	**1.02*** **	**1.017-1.027**
	influenza and pneumonia	62700	8.2	1.02***	1.018-1.027

	other vaccine preventable	-305	-25.4	0.90*	0.791-1.014
Acute	**total**	**56773**	**19.7**	**1.03*** **	**1.028-1.040**
	pyelonephritis	46554	46.5	1.07***	1.064-1.083
	cellulitis	13284	21.5	1.05***	1.035-1.063
	convulsions and epilepsy	3829	5.1	1.01	0.9905-1.023
	dehydration & GII	-4405	-44.9	0.94***	0.913-0.967
	dental	393	3.7	1.00	0.963-1.036
	ENT infections	250	5.5	1.00	0.973-1.029
	gangrene	-538	-22.1	0.98	0.955-1.01
	perforated ulcer	-2280	-38.2	0.93***	0.898-0.967
	PID	-314	-22.5	0.96	0.893-1.038
Chronic	**total**	**-7442**	**-10.7**	**0.97*** **	**0.969-0.979**
	COPD	18107	1.1	1.16***	1.157-1.171
	CHF	-1201	-11.4	0.97***	0.961-0.980
	diabetic complications	-11444	-34.1	0.91***	0.902-0.924
	angina	-8163	-43.8	0.90***	0.885-0.9195
	asthma	2877	17.6	1.03**	1.0073-1.0629
	hypertension	774	3.0	1.01	0.967-1.047
	iron deficiency anaemia	3916	40.5	1.05***	1.026-1.083
	nutritional deficiencies	174	633.7	1.08	0.838-1.38
ACSC contribution to public bed days		**111726**	**18.2**	1.03***	1.033-1.034

*P<0.1; ** p<0.05; ***P<0.01

Examination by Age Cohort

When age-specific bed day rates are examined significant variation becomes apparent (figure 2). Bed days increase sharply from age 45 years onwards and continue to rise with increasing age. ACSC conditions are concentrated in the older population, with those 65 and older representing 69.1% of ACSC bed days (n= 602,392 bed days; 94,483/100,000) in 2016 (table 3). The impact of ACSCs on total bed days also increases with age, with ACSC bed days representing one quarter of total bed days in this age cohort. Vaccine preventable conditions represented 39.0% of ACSC bed days among

this cohort of which 99% (n=248,524 bed days; 41,933/100,000) are due to influenza and pneumonia. COPD is the most significant chronic ACSC accounting for more than 100,000 bed days (16,749 /100,000) in 2016, pyelonephritis was the most significant acute ACSC in this cohort with 94,338 bed days (16,145/100,000). The bed day rate due to pyelonephritis has increased by 46.5% over the five years examined (IRR 1.07; p<0.01) (table 2).

In the child cohort (0-14 years), 13.8% of total acute hospital bed days were attributable to ACSCs, representing 80,927 bed days (4,650/100,000) in 2016 (table 3). Acute ACSCs represented 63.4% (n=29,155 bed days; 2,089/100,000**)** of these, with ENT infections the leading acute condition, representing 19.3% (n=8,871 bed days; 881/100,000) of ACSC bed days in 2016. Vaccine preventable ACSCs represented almost one quarter (24.2%) of ACSC bed days, with influenza and pneumonia being responsible for the majority of these.

Within the adult cohort (15-64 years), 11.0% (n= 364,809 bed days; 7,113/100,000) of total bed days were attributable to ACSCs (table 3). The most significant ACSCs condition among this age cohort was the vaccine preventable conditions influenza and pneumonia. Acute and chronic ACSCs contributed similar proportions to bed days at approximately one third each.

	0-14			15-64			65+			total		
	bed days	% total bed days	Age specific bed day rate	bed days	% total bed days	Age specific bed day rate	bed days	% total bed days	Age specific bed day rate	bed days	% total bed days	Stan bed
vaccine preventable	**11141**	**3.3**	**11141**	**80775**	**4.0**	**2826**	**248545**	**10.5**	**41933**	**340461**	**7.2**	
Influenza & pneumonia	10571	3.2	930	80518	4.0	2817	248524	10.5	41930	339613	7.2	
other vaccine preventable	570	0.2	76	257	0.0	81	21	0.0	3	848	0.0	
acute	**29155**	**8.7**	**2809**	**73371**	**3.6**	**2471**	**150172**	**6.4**	**25431**	**252698**	**5.4**	
pyelonephritis	6185	1.9	547	19762	1.0	680	94338	4.0	16145	120285	2.6	
cellulitis	2544	0.8	182	15403	0.8	5334	28141	1.2	4734	46088	1.0	
convulsions and epilepsy	6742	2.0	707	17426	0.9	5725	11993	0.5	1967	36161	0.8	
dehydration & GII	141	0.0	27	2713	0.1	911	4740	0.2	794	7594	0.2	
dental	4239	1.3	466	3374	0.2	110	809	0.0	126	8422	0.2	
ENT infections	8871	2.7	881	5401	0.3	1675	1171	0.0	193	15443	0.3	
gangrene	417	0.1	80	5128	0.3	1780	5827	0.2	956	11372	0.2	
perforated ulcer	9	0.0	29	2597	0.1	896	2969	0.1	487	5575	0.1	
PID	7	0.0	1	1567	0.1	485	184	0.0	29	1758	0.0	
chronic	**5704**	**1.7**	**562**	**68790**	**3.4**	**2448**	**203675**	**8.6**	**33631**	**278169**	**5.9**	
COPD	177	0.1	23	23500	1.2	5928	102659	4.4	16749	126336	2.7	
CHF	140	0.0	22	6425	0.3	2478	61904	2.6	9735	68469	1.5	
diabetic complications	1503	0.5	142	17259	0.9	5928	21479	0.9	3457	40241	0.9	
angina	13	0.0	1	5780	0.3	2125	9386	0.4	1499	15179	0.3	
asthma	3615	1.1	327	7889	0.4	2639	3015	0.1	471	14519	0.3	
hypertension	160	0.0	10	3158	0.2	1076	2268	0.1	371	5586	0.1	
iron deficiency anaemia	159	0.0	21	4449	0.2	1514	7915	0.3	1318	12523	0.3	
nutritional deficiencies	5	0.0	0	42	0.0	13	178	0.0	31	225	0.0	
ACSC contribution to total bed days in each cohort	**46,000**	**13.8**	**4,650**	**222,936**	**11.0**	**7,113**	**602392**	**25.5**	**94,483**	**871,328**	**18.5**	18,2

Table 3: ACSC contribution to national bed days by age cohort in 2016

Discussion

In Ireland the acute hospital system has been struggling to meet demand for some time, however, in the period 2011-2016 it has been increasingly difficult to achieve effectiveness and efficiency. In 2017 the bed occupancy rate was 94.5%, significantly higher than the internationally recognised target of 85%. This has created a care system that is struggling to maintain patient quality and safety at national and international standards. Significant numbers of patients wait for admission on trolleys in Emergency Departments.(11) In 2015, an average of almost 300 patients per day received their care on Emergency trollies in ED departments. This translates into 106,580 bed days in one year.(6) The 19 ACSCs identified for inclusion in this analysis accounted for almost 20% of the total publicly funded acute hospital bed days in 2016 or 853,361 bed days. When examined in relation to age specific cohorts, adults 65 years and over represent 69.1% of all ACSC bed days.

Just over half of ACSC bed days in 2016 were among respiratory conditions; influenza and pneumonia and COPD. Influenza and pneumonia was the single most important contributor to ACSC bed days across all age cohorts, increasing by 18% over the 5 years examined. The majority of these bed days (73.2%; n= 248,524 bed days) were among adults 65 years and over, a high risk group targeted by annual seasonal influenza and pneumococcal vaccination programmes in Ireland. Uptake of seasonal influenza vaccine among adults 65 years and over was estimated at 68% for the 2017/18 season, with uptake among healthcare workers estimated at just under 35%. Pneumococcal vaccine uptake among adults 65 years and over was estimated at 38% in 2013/14, with annual figures not routinely collected. Comparatively, in the UK, seasonal influenza vaccination rates consistently approach 70% among those over 65, with healthcare worker vaccination for the 2016/17 season reported as 63%.(12, 13) Pneumonia represents approximately 10% of ACSC admissions in the UK compared to approximately 30% in the Irish setting, supporting the case for routine monitoring of pneumococcal vaccination among those 65 and over as well as a catch up campaign.(1)

COPD represented 14.5%; n=126,336 of ACSC bed days in 2016. Adults 65 years and over were responsible for 81.3% of these bed days .Ireland consistently has one of the highest admission and re-admission rates for COPD in the OECD.(14, 15) COPD is also one of the most resource intensive DRGs in acute hospitals in Ireland. (6) Mortality rates in Ireland due to chronic lower respiratory diseases are 42% higher than the EU average.(6) Pulmonary rehabilitation is one of the most cost effective treatments available.(16) At a cost of 2-8k per QALY ,it is known to be effective at improving quality of life as well as reducing hospital admissions however this programme of care is not routinely available in Ireland.(17) While COPD patients are identified as a risk group for both

influenza and pneumococcal vaccination in Ireland, vaccination uptake among this group is not routinely measured or reported.(16) This paper provides evidence to support implementation of an integrated care programme for COPD focusing on primary care investment to reduce pressure on acute hospitals and improve quality of care for the patients close to home.

Pyeloneophritis was the next biggest contributor to bed days, representing 13.8% of ACSC bed days. Again, the relative contribution to bed days increases with increasing age, with adults 65 years and over representing 78.4% of these bed days. Over the five year period examined bed days due to pyelonephritis increased significantly (46.5%). This phenomena requires more exploration within the Irish context however it is consistent with trends in the UK.(11) Evidence demonstrates that with approrpirate primary care support in the form of diagnostics, treatment guidelines and preventive approaches, admissions can be reduced and quality of care provided closer to home.(18)

ACSCs are a high level indicator of potentially avoidable hospitalisation with admissions known to be correlated with primary care privosion as well as with deprivation.(1, 8, 10) The impact of ACSCs on acute hospital capacity is best measured using bed day rates. This analysis can be used to identify areas where efficiency gains within the acute sector may be possible. Identifying specific conditions by their impact on acute hospital capacity supports closer examination of integrated models of care for these conditions.(7, 19) This analysis not only supports the left shift to provision of care within the community called for in Slaintecare, but enables prioritisation of resources to primary care in the form of integrated care programmes.

ACSCs were responsible for almost one fifth of all acute hospital bed day usage in 2016 in Ireland. While the proportion of these admissions that represent truly avoidable admissions will require further exploration, an examination of the impact of these conditions in terms of bed days make a compelling argument for prioritising the development of integrated models of care with primary and community services, enabling the 'left shift' of care closer to home.

Author Contributions

Dr. Breda Smyth, Consultant in Public Health Medicine developed the study protocol and provided ongoing support to data analysis and interpretated. Dr. Geraldine McDarby, Specialist Registrar in Public Health Medicine, performed data extraction and analysis.

Competing interests statement

The authors report no competing interests.

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Patient and Public Involvement

Patients were not involved in the concept or design of this study.

Data sharing statement

Data will be made available to facility managers and policy maker upon request.

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Appendices

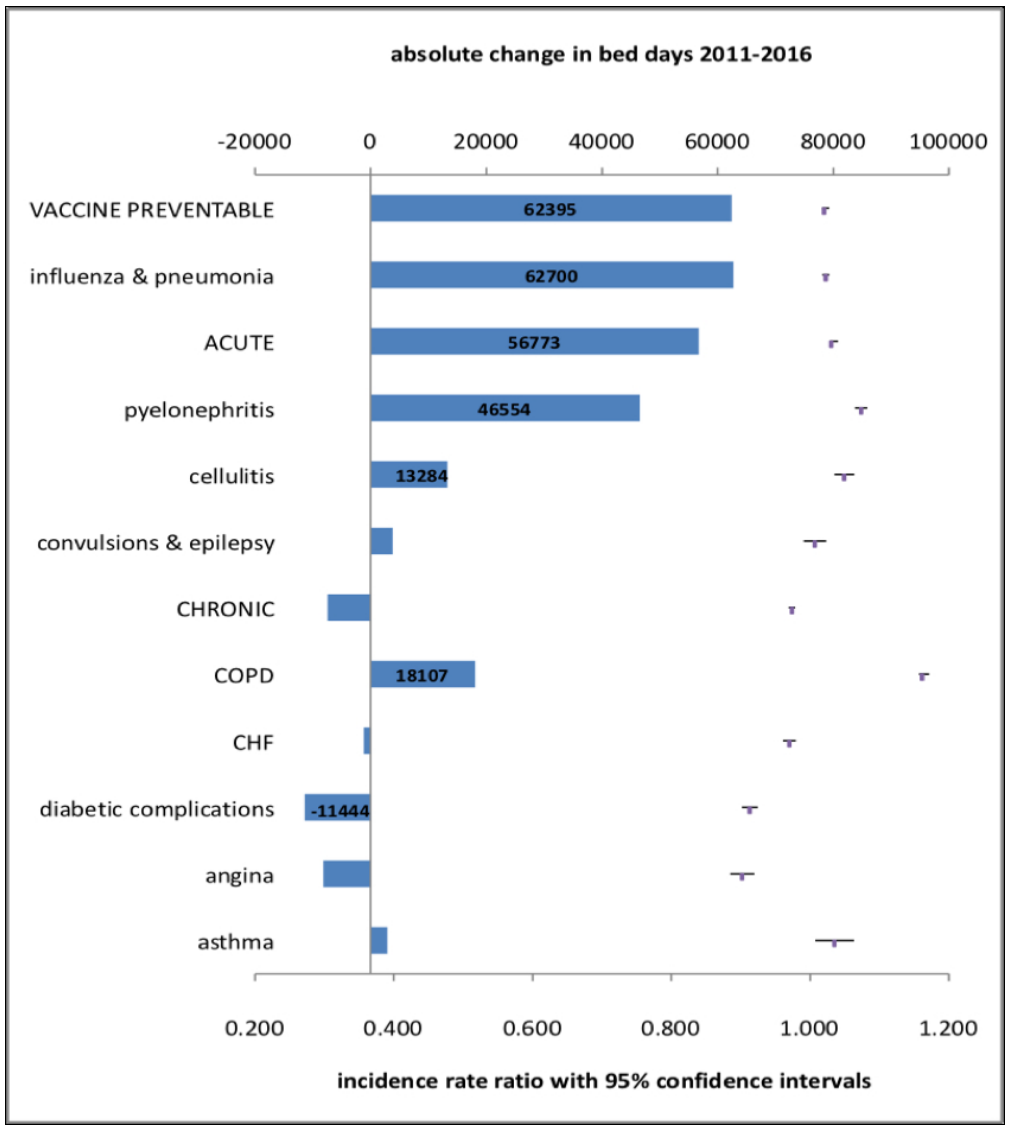
Sub category & Condition	OECD		NHS*		NSW		P4H	
Vaccine preventable	ICD 10 Code	Notes	ICD-10 Code	Notes	ICD10-AM Code	Notes	ICD-10	Notes
Influenza & pneumonia	-	-	J09, J10, J11, J13, J14, J15.3, J15.4, J15.7, J15.9, J16.8, J18.1, J18.8, J18.9	In any diagnosis field, excludes cases with secondary diagnosis of D57	J09, J10, J11, J13, J14, J15.3, J15.4, J15.7, J15.9, J16.8, J18.1, J18.8, J18.9	In any diagnosis field, excludes cases with secondary diagnosis of D57	J09, J10, J11, J13, J14, J15.3, J15.4, J15.7, J15.9, J16.8, J18.1, J18.8, J18.9	In any diagnosis field, excludes cases with secondary diagnosis of D57
Other vaccine preventable	-	-	A35, A36, A37, A80, B05, B06, B16.1, B16.9, B18.0, B18.1, B26, G00.0, M01.4	In any diagnosis field	A35, A36, A37, A80, B05, B06, B16.1, B16.9, B18.0, B18.1, B26, G00.0, M01.4	In any diagnosis field	A35, A36, A37, A80, B05, B06, B16.1, B16.9, B18.0, B18.1, B26, G00.0, M01.4	Principal diagnosis
Acute	ICD 10 Code	Notes	ICD-10 Code	Notes	ICD10-AM Code	Notes	ICD-10	Notes
Dehydration & Gastroenteritis	-	-	E86, K52.2, K52.8, K52.9	Principal diagnosis only	E86, K52.2, K52.8, K52.9	Principal diagnosis only	E86, K52.2, K52.8, K52.9	Principal diagnosis only
Convulsions & epilepsy	-	-	O15, G40, G41, R56	Principal diagnosis only	O15, G40, G41, R56	Principal diagnosis only	O15, G40, G41, R56	Principal diagnosis only
ENT infections	-	-	H66, H67, J02, J03, J06, J31.2	Principal diagnosis only	H66, H67, J02, J03, J06, J31.2	Principal diagnosis only	H66, H67, J02, J03, J06, J31.2	Principal diagnosis only
Dental conditions	-	-	K02-K06, K08, K09.8, K09.9, K12,	Principal diagnosis only	A69.0, K02-K06, K08, K09.8,	Principal diagnosis only	K02-K06, K08, K09.8, K09.9, K12,	Principal diagnosis only

			K13		K09.9, K12, K13		K13	
Perforated/bleding ulcer	-	-	K25.0, K25.1, K25.2, K25.4, K25.5, K25.6, K26.0, K26.1, K26.2, K26.4, K26.5, K26.6, K27.0, K27.1, K27.2, K27.4, K27.5, K27.6, K28.0, K28.1, K28.2, K28.4, K28.5, K28.6	Principal diagnosis only	K25.0-K25.2, K25.4-K25.6, K26.0-K26.2, K26.4-K26.6, K27.0-K27.2, K27.4-K27.6, K28.0-28.2, K28.4-K28.6	Principal diagnosis only	K25.0, K25.1, K25.2, K25.4, K25.5, K25.6, K26.0, K26.1, K26.2, K26.4, K26.5, K26.6, K27.0, K27.1, K27.2, K27.4, K27.5, K27.6, K28.0, K28.1, K28.2, K28.4, K28.5, K28.6	Principal diagnosis only
Ruptured appendix	-	-	-	-	K35.0	In any diagnosis field	-	-
Pyelonephritis	-	-	N10, N11, N12, N13.6, N39.0	Principal diagnosis only	N10, N11, N12, N13.6,	Principal diagnosis only	N10, N11, N12, N13.6, N39.0	Principal diagnosis only
PID	-	-	N70, N73, N74	Principal diagnosis only	N70, N73, N74	Principal diagnosis only	N70, N73, N74	Principal diagnosis only
Cellulitis	-	-	L03, L04, L08, L88, L98.0, L98.3	Principal diagnosis only, exclude cases with any procedure block except those in blocks 1820-2016 or procedure 30216-03, 30676-	L03, L04, L08.0, L08.8, L08.9, L88, L98.0, L98.3	Principal diagnosis AND no procedures OR procedures listed were only in blocks 1604, 1606, 1608, 1820-	L03, L04, L08, L88, L98.0, L98.3	Principal diagnosis only

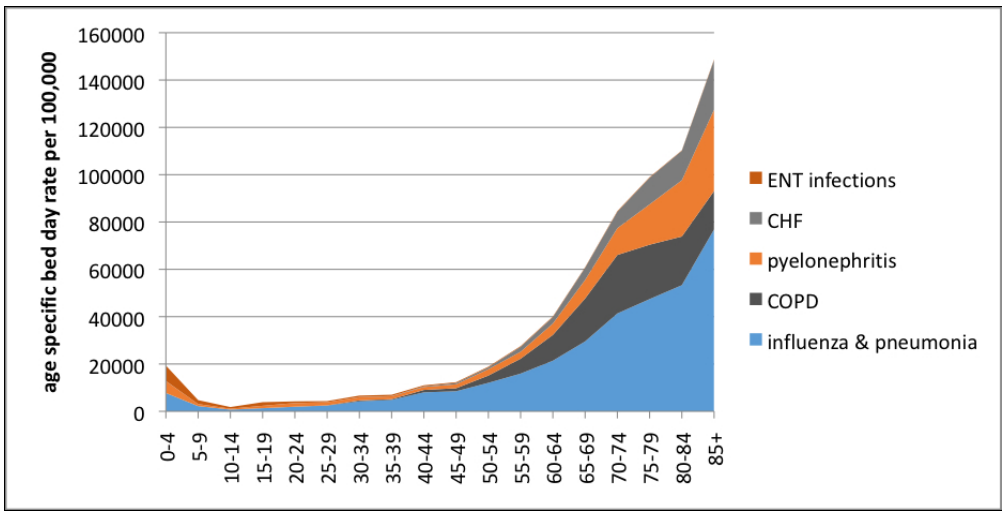
				00, 30223-02, 30064-00, 34527-01, 34527-00 or 90661-00		2016 or procedures 90660-00, 30207-00, 30676-00, 30679-00, 34530-01 and 47912-00 Additionally, check that the procedure is the only procedure when in the list: blocks 1604-1606, 1608, or the procedures are: 90660-00, 30207-00, 30676-00, 30679-00, 34530-01 and 47912-00]		
gangrene	-	-	R02	In any diagnosis field	R02	In any diagnosis field	R02	In any diagnosis field
Chronic	ICD 10 Code	Notes	ICD-10 Code	Notes	ICD10-AM Code	Notes	ICD-10	Notes
Asthma	J45, J46	Primary	J45, J46	Principal	J45, J46	Principal	J45, J46	Principal diagnosis

		diagnosis		diagnosis only		diagnosis only		only
COPD	J40-J44, J47 (J20)	Primary diagnosis (only with secondary diagnosis of J41-44, J47)	J40-J44, J47 (J20)	Primary diagnosis (only with secondary diagnosis of J41-44, J47)	J40-J44, J47 (J20)	Primary diagnosis (only with secondary diagnosis of J41-44, J47)	J40-J44, J47	Principal diagnosis only
CHF	I50, I11.0, J81	Primary diagnosis	I50, I11.0, J81	Principal diagnosis only			I50, I11.0, J81	Principal diagnosis only
Diabetic complications	-	-	E10.1-E10.8, E11.0-E11.8, E13.0-E13.8, E14.0-E14.8	In any diagnosis field	E10.1-E10.8, E11.0-E11.8, E13.0-E13.8, E14.0-E14.8	In any diagnosis field	E10.1-E10.8, E11.0-E11.8, E13.0-E13.8, E14.0-E14.8	Principal diagnosis only
Nutritional deficiencies	-	-	E40-E43, E55.0, E64.3	Principal diagnosis only	E40-E43, E55.0, E64.3	Principal diagnosis only	E40-E43, E55.0, E64.3	Principal diagnosis only
Iron deficiency anaemia	-	-	D50.1, D50.8, D50.9	Principal diagnosis only	D50.1, D50.8, D50.9	Principal diagnosis only	D50.1, D50.8, D50.9	Principal diagnosis only
Hypertension	-	-	I10, I11.9	Principal diagnosis only	I10, I11.9	Principal diagnosis only	I10, I11.9	Principal diagnosis only
Angina	-	-	I20, I24.0, I24.8, I24.9	Principal diagnosis only cases, excluding cases with procedure codes in blocks 1820-	I20, I24.0, I24.8, I24.9	Principal diagnosis only cases, excluding cases with procedure codes in blocks 1-1279	I20, I24.0, I24.8, I24.9	Principal diagnosis only cases, excluding cases with procedure codes in blocks 1820-2140

	IRR	SE	p	95%CI	LRchi2	p
Vaccine preventable	**1.02**	**0.0025**	**0.00**	**1.0174-1.0272**	**81.35**	**0.00**
influenza & pneumonia	1.02	0.0025	0.00	1.0176-1.0274	82.71	0.00
other vaccine preventable	0.90	0.0566	0.08	0.7913-1.0138	3.07	0.08
Acute	**1.03**	**0.0031**	**0.00**	**1.0282-1.0402**	**127.85**	**0.00**
pyelonephritis	1.07	0.0046	0.00	1.0643-1.0825	271.17	0.00
cellulitis	1.05	0.0073	0.00	1.0348-1.0633	47.80	0.00
convulsions & epilepsy	1.01	0.0083	0.42	0.99051-1.0231	0.65	0.42
dehydration & GII	0.94	0.0138	0.00	0.9127-0.9668	18.24	0.00
dental	1.00	0.0188	0.94	0.9625-1.0361	0.01	0.94
ENT infections	1.00	0.0144	0.95	0.9732-1.0294	0.00	0.95
gangrene	0.98	0.0136	0.16	0.9545-1.008	1.95	0.16
perforated ulcer	0.93	0.0177	0.00	0.8979-0.9673	13.85	0.00
PID	0.96	0.0371	0.32	0.8925-1.0379	0.99	0.32
Chronic	**0.97**	**0.0025**	**0.00**	**0.9690-0.9786**	**110.69**	**0.00**
COPD	1.16	0.0050	0.00	1.1570-1.1712	1250.71	0.00
CHF	0.97	0.0048	0.00	0.9606-0.9795	37.56	0.00
diabetic complications	0.91	0.0057	0.00	0.9018-0.9242	213.14	0.00
angina	0.90	0.0089	0.00	0.8847-0.91945	111.22	0.00
asthma	1.03	0.0142	0.01	1.0073-1.0629	6.20	0.01
hypertension	1.01	0.0203	0.76	0.9672-1.0469	0.10	0.76
Iron deficiency anaemia	1.05	0.0143	0.00	1.0263-1.0825	14.99	0.00
Nutritional deficiencies	1.08	0.1369	0.57	0.8384-1.381	0.33	0.56



Absolute change in bed days with IRR and 95% CI from 2011 to 2016



Bed day rate by 5 year age group for top 5 ACSCs by bed days 2016

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Identifying Priorities for Primary Care Investment in Ireland through Analysis of Avoidable Hospital Admissions for Ambulatory Care Sensitive Conditions (ACSC)

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Title: Identifying Priorities for Primary Care Investment in Ireland through Analysis of Avoidable Hospital Admissions for Ambulatory Care Sensitive Conditions (ACSC)

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Abstract:

Background

In 2016 the Irish acute hospital system operated well above internationally recommended occupancy targets . Investment in primary care can prevent hospital admissions of Ambulatory Care Sensitive Conditions (ACSCs).Objective

To measure the impact of ACSCs on acute hospital capacity in the Irish public system and identify specific care areas for enhanced primary care provision.

Design

National HIPE data was used to calculate 2011-2016 standardised bed day rates for selected ACSC conditions. A prioritisation exercise was undertaken to identify the most significant contributors to bed days within our hospital system. Poisson regression was used to determine change over time using Incidence Rate Ratios (IRR) .

Results

In 2016 ACSCs accounted for almost 20% of acute public hospital beds (n= 871,328 bed days) with adults over 65 representing 69.1% (n=602,392) of these. Vaccine preventable conditions represented 39.1% of ACSCs. Influenza and pneumonia was responsible for 99.8% of these, increasing by 8.2% (IRR: 1.02; 95%CI 1.02-1.03) from 2011 to 2016. Pyelonephritis represented 47.6% of acute ACSC bed days, increasing by 46.5% (IRR: 1.07; 95%CI 1.06-1.08) over the 5 years examined.

Conclusions

Prioritisation for targeted investment in integrated care programmes is enabled through analysis of ACSC's in terms of acute hospital bed days. This analysis demonstrates that primary care investment in integrated care programmes for respiratory ACSC's from prevention to rehabilitation at scale could assist with bed capacity in acute hospitals in Ireland. In adults 65 years and over, including COPD patients, the current analysis supports targeting community based pulmonary rehabilitation including pneumococcal and influenza vaccination programmes in order to reduce the burden of infection and hospitalisations. Further exploration of pyelonephritis is necessary in order to ascertain patient profile and appropriateness of admissions.

Strengths and Limitations of this study:

The study examines the impact of ambulatory care sensitive conditions (ACSCs) on the acute publicly funded hospital system using national level data extracted from the national Hospital In-patient Enquiry System in the form of bed days and bed day rates

- National bed day rates are standardised to the EU population; three age-specific bed days rates are analysed (children 0-15, adults 15-64 and persons 65 and older); Trend analysis over the 5 year period 2011-2016 is examined using Poisson regression techniques.
- All 19 ACSCs identified are included in the prioritisation exercise which identifies the top 5 contributors to ACSC bed days for the total population as well as for each age cohort examined
- Irish HIPE data is episodic, therefore admissions are not linked to patient details. This prevented further in-depth analysis of patient profiles. As the current analysis is concerned primarily with capacity and age cohort the integrity of the analysis remains robust.
- The categorisation of ACSCs remains poorly defined internationally in terms of the application of ICD coding at primary and secondary diagnosis level. This limits generalisability of all ACSC research and a refinement of coding would enhance specificity and generalisability of this area of research

Introduction:

Ambulatory care sensitive conditions (ACSCs) are acute or episodic conditions where appropriate and timely community care can prevent disease and/or hospital admissions.(1) While there is variability in relation to the conditions considered ACSCs, they can be broadly classified into vaccine preventable, acute and chronic conditions. ACSCs are commonly used as an indicator of avoidable hospital admissions as well as quality of and access to primary care.(2,3)

The current acute hospital bed occupancy rate of 94.2% is significantly higher than the internationally recognised target of 85%. Occupancy rates at this level are associated with adverse patient and staff outcomes as well as restricting efficiency in terms of patient flow.(4) To achieve international standards of bed occupancy would require the immediate introduction of 1,260 inpatient beds.(5) Ireland is experiencing an ageing demographic shift with an expected annual increase of almost 20,000 in the population 65 years and over. This population cohort currently occupy 54% of total acute bed days.(6) Moreover the

demand for acute hospital beds is projected to increase significantly unless there is a shift in the model of care from acute hospital care to primary care.(6) The hospital centric nature of the Irish system continues to fuel an ever increasing demand for acute hospitals to deliver care and services which would be better provided in the community. However Primary Care services in Ireland remain under resourced.(7) As recognised within Slaintecare, the 10 year cross political vision for the future of Irish healthcare services, improvement and sustainability of the Irish Health system is dependent on a shift of care from acute hospitals to primary care.(7)

In the literature, ACSC analyses to date recognises the impact on emergency departments and admissions. Drivers of these admissions have been examined highlighting the association with levels of primary care provision, as well as higher levels of deprivation.(1, 8-10) However, the use of ACSC analysis to identify and prioritise areas for improved primary care resources and programmes of care remains unexamined. The purpose of this paper is to examine ACSCs in relation to their overall impact on acute hospital capacity in Ireland in terms of bed days and bed day rates and to assist prioritisation of targeted investment in primary care supporting robust integrated care programmes. This novel approach to the evaluation of ACSCs supports the left shift to primary care called for by Slaintecare and international policy.

Methods:

The international literature in relation to 'definition and coding' of ACSCs was reviewed and a list of 19 commonly cited ACSCs was identified for inclusion (appendix 1). Definition notes for ICD codes including primary and secondary diagnoses were examined and the definition notes most appropriate to the Irish setting and reflective of bed utilisation were chosen. Data for these codes was extracted from the National Hospital In-patient Enquiry System (HIPE) to calculate 2011-2016 age-standardised bed day rates for selected ACSC conditions. Age specific analysis was carried out using the following categories; children (0-14 years), adults (15-64 years) and persons 65 years and over. A prioritisation exercise in which all 19 conditions were ranked in terms of their contribution to total and age specific bed days and bed day rates in 2017 was undertaken to identify the most significant contributors within our hospital system (figure 1). Poisson regression analysis was used to distinguish a genuine change over time. Standardised Incidence Rate Ratios (IRR) with 95% Confidence Intervals and corresponding p values were reported.(10) Population rates are directly standardised to

the European standard population. As the analysis represents a secondary analysis of an anonymised data set, ethical approval was not required.

Results:

ACSCs represented 18.5% (n=871,328) of publicly funded bed days in Ireland in 2016 with an 18.2% (IRR 1.03; p<0.01) increase over the 5-year time period examined The most significant contributors to ACSC bed days included influenza and pneumonia, COPD and pyelonephritis. Influenza and pneumonia accounted for 39.0% of total ACSC bed days (n=339,613), with the proportion of ACSC bed days increasing with increasing age across the three age cohorts examined (table 1; figure 1). The bed day rate increased by 8.2% (IRR 1.02; p<0.01) from 2011-2016 (table 2). Chronic Obstructive Pulmonary Disease (COPD) accounted for almost half of chronic ACSC bed days in 2016 and 14.5% of total ACSC bed days (n= 126,336 bed days; 3,831/100,000). The COPD bed day rate increased (2011-2016) by 1.1% (IRR:1.16; p<0.01) on a background of a 10.7% reduction in the chronic ACSC bed day rate over the five-year period examined.

Table 1 ACSC contribution to national bed days by age cohort in 2016

	total				0-14			
ACSCs	bed days	% ACSC bed days	% total bed days	Standardised bed day rate*	bed days	% ACSC bed days	Age specific bed day rate	bed
vaccine preventable	**340461**	**39.1**	**7.2**	**10170**	**11276**	**24.1**	**11141**	**8**
Influenza & pneumonia	339613	39	7.2	10155	10704	22.9	930	8
other vaccine preventable	848	0.1	0	14	572	1.2	76	
acute	**252698**	**29**	**5.4**	**7002**	**29822**	**63.7**	**2809**	**7**
pyelonephritis	120285	13.8	2.6	3681	6282	13.4	547	1
cellulitis	46088	5.3	1	1307	2512	5.4	182	1
convulsions and epilepsy	36161	4.2	0.8	857	7026	15.0	707	1
dehydration & GII	7594	0.9	0.2	216	149	0.3	27	
dental	8422	1	0.2	162	4308	9.2	466	
ENT infections	15443	1.8	0.3	282	9090	19.4	881	
gangrene	11372	1.3	0.2	308	417	0.9	80	
perforated ulcer	5575	0.6	0.1	153	10	0.0	29	
PID	1758	0.2	0	37	28	0.1	1	
chronic	**278169**	**31.9**	**5.9**	**8227**	**5704**	**12.2**	**562**	**6**
COPD	126336	14.5	2.7	3831	140	0.3	23	2
CHF	68469	7.3	1.5	2059	141	0.3	22	
diabetic complications	40241	4.6	0.9	1081	1656	3.5	142	1

angina	15179	1.7	0.3	430	13	0.0	1	
asthma	14519	1.7	0.3	318	3703	7.9	327	
hypertension	5586	0.6	0.1	144	177	0.4	10	
iron deficiency anaemia	12523	1.4	0.3	357	180	0.4	21	
nutritional deficiencies	225	0	0	7	5	0.0	0	
ACSC contribution to total bed days in each cohort	**871,328**	**100**	**18.5**	**18,297**	**46,802**		**4,650**	**222**

Pyelonephritis represented almost half (51.2%; n=120,285 bed days; 3,681/100,000) of acute ACSC bed days in 2016 and 13.8% of total ACSC bed days. The bed day rate for pyelonephritis increased by 46.5% over the five years examined.

Table 2 Trend analysis of ACSC bed days in Irish acute public hospitals 2011-2016

ACSC		Absolute change in bed days	% change in standardised bed day rate	incidence rate ratio for trend	95% Confidence Interval
Vaccine preventable	**total**	**62395**	**8.2**	**1.02*** **	**1.017-1.027**
	influenza and pneumonia	62700	8.2	1.02***	1.018-1.027
	other vaccine preventable	-305	-25.4	0.90*	0.791-1.014
Acute	**total**	**56773**	**19.7**	**1.03*** **	**1.028-1.040**
	pyelonephritis	46554	46.5	1.07***	1.064-1.083
	cellulitis	13284	21.5	1.05***	1.035-1.063
	convulsions and epilepsy	3829	5.1	1.01	0.9905-1.023
	dehydration & GII	-4405	-44.9	0.94***	0.913-0.967
	dental	393	3.7	1.00	0.963-1.036
	ENT infections	250	5.5	1.00	0.973-1.029
	gangrene	-538	-22.1	0.98	0.955-1.01
	perforated ulcer	-2280	-38.2	0.93***	0.898-0.967
	PID	-314	-22.5	0.96	0.893-1.038
Chronic	**total**	**-7442**	**-10.7**	**0.97*** **	**0.969-0.979**
	COPD	18107	1.1	1.16***	1.157-1.171
	CHF	-1201	-11.4	0.97***	0.961-0.980
	diabetic complications	-11444	-34.1	0.91***	0.902-0.924

	angina	-8163	-43.8	0.90*** 0.885-0.9195
	asthma	2877	17.6	1.03** 1.0073-1.0629
	hypertension	774	3.0	1.01 0.967-1.047
	iron deficiency anaemia	3916	40.5	1.05*** 1.026-1.083
	nutritional deficiencies	174	633.7	1.08 0.838-1.38
ACSC contribution to public bed days		**111726**	**18.2**	1.03*** 1.033-1.034

Examination by Age Cohort

When age-specific bed day rates are examined significant variation becomes apparent (figure 2). ACSC conditions were concentrated in the older population, with adults 65 and older representing 69.1% of ACSC bed days (n= 602,392 bed days; 94,483/100,000) in 2016. The impact of ACSCs on total bed days also increased with age, with ACSC bed days representing one quarter of total bed days in this age cohort. Vaccine preventable conditions represented 41.3% of ACSC bed days among this cohort of which 99% (n=248,524 bed days; 41,933/100,000) were due to influenza and pneumonia. COPD was the most significant chronic ACSC among this age cohort accounting for more than 100,000 bed days (16,749 /100,000). In 2016, pyelonephritis was the most significant acute ACSC in this cohort with 94,338 bed days (16,145/100,000). The bed day rate due to pyelonephritis has increased by 46.5% over the five years examined (IRR 1.07; p<0.01) (table 2).

In the child cohort (0-14 years), 13.8% of total acute hospital bed days were attributable to ACSCs, representing 46,802 bed days in 2016 (table 2). Acute ACSCs represented 63.4% (n=29,822 bed days; 2,089/100,000**)**, with ENT infections the leading acute condition, representing 19.4% (n=9,090 bed days; 881/100,000) of ACSC bed days in 2016. Vaccine preventable ACSCs represented almost one quarter (24.1%) of ACSC bed days, with influenza and pneumonia being responsible for the majority of these.

Within the adult cohort (15-64 years), 11.0% (n= 222,936 bed days; 7,113/100,000) of total bed days were attributable to ACSCs (table 1). The most significant ACSCs condition among this age cohort was the vaccine preventable category influenza and pneumonia. Acute and chronic ACSCs contributed similar proportions to bed days at approximately one third each.

Discussion

The 19 ACSCs identified for inclusion in this analysis accounted for almost 20% of the total publicly funded acute hospital bed days in 2016 or 871,328 bed days. When examined in relation to age specific cohorts, adults 65 years and over represent 69.1% of all ACSC bed days. Just over half of ACSC bed days in 2016 were among respiratory conditions; influenza and pneumonia and COPD. Influenza and pneumonia was the single most important contributor to ACSC bed days across all age cohorts, increasing by 8.2% over the 5 years examined. The majority of these bed days (73.2%; n= 248,524 bed days) were among adults 65 years and over. COPD represented 14.5% (n=126,336) of ACSC bed days in 2016, with 81.3% of these in adults 65 years and over. Pyelonephritis was the next biggest contributor to bed days, representing 13.8% of ACSC bed days. Again, the relative contribution to bed days increased with age, with adults 65 years and over representing 78.4%. Over the five-year period examined bed days due to pyelonephritis increased significantly (46.5%).

Evidenced based models of care for influenza and pneumonia include integrated care programmes which include prevention. Seasonal influenza and pneumococcal vaccination remain the mainstay of preventing mortality and morbidity associated with influenza and pneumonia in Ireland as well as internationally. Seasonal influenza vaccination is recommended for disease specific risk groups including COPD, adults 65 years and over and healthcare workers (HCWs). Pneumococcal vaccination is recommended for those 65 and over and those with COPD. While the absolute impact of seasonal influenza and pneumococcal vaccination remains difficult to quantify, recent studies confirm their effectiveness at reducing the risk of pneumococcal pneumonia as well as hospitalisation from respiratory illness among adults 65 and over.(12,13) Despite this, uptake of seasonal influenza vaccine in Ireland consistently lags behind our closest neighbour the UK, while rates of uptake of pneumococcal vaccination are not routinely collected. In Ireland, uptake of seasonal influenza vaccine among adults 65 and over was 56.9% for the 2012/2013 season, with uptake among HCWs at just 17.6%. Pneumococcal vaccine uptake was estimated at 36%.(14,15,16) Comparatively, in the UK, seasonal influenza vaccination rates consistently approach or exceed 70% among adults over 65, with HCW vaccination rates consistently above Irish estimates (table 3).(17,18) For the 2012/2013 season, for which comparative data is available, pneumonia represented approximately 10% of ACSC admissions in the UK compared to approximately 30% in the Irish setting.(1) These estimates support the continued emphasis on seasonal influenza and pneumococcal

vaccination for HCWs and adults 65 and over as well as the regular monitoring of pneumococcal vaccination uptake rates in Ireland.

Table 2 Comparative vaccination uptake figures 2012/13 & 2017/18

	2012/2013				2017/2018		
	Seasonal Influenza vaccine uptake 65+	Seasonal influenza vaccine uptake HCW*	IPV uptake 65+	Pneumonia (% ACSC admissions)	Seasonal Influenza vaccine uptake 65+	Seasonal influenza vaccine uptake HCW	IPV uptake 65+
Ireland	56.9%	17.6%	38%	29%-35%**	68%	44.8%	38%
UK	74%	45.6%	69.1%	15%	70.5%	68.7%	69.5%

Ireland consistently has one of the highest admission and re-admission rates for COPD in the OECD.(19,20) COPD is also one of the most resource intensive DRGs in acute hospitals in Ireland.(6) Mortality rates in Ireland due to chronic lower respiratory diseases are 42% higher than the EU average.(6) Pulmonary rehabilitation is one of the most cost effective treatments available.(21) At a cost of 2-8k per QALY, it is known to be effective at improving quality of life as well as reducing hospital admissions. Despite being recognised as the standard of care, this programme is not routinely available in Ireland.(22) While COPD patients are identified as a risk group for both influenza and pneumococcal vaccination in Ireland, vaccination uptake among this group is not routinely measured or reported.(21) This paper provides evidence to support implementation of an integrated care programme for COPD focusing on primary care investment to reduce pressure on acute hospitals and improve quality of care for the patients close to home.(23)

The impact and increase observed for pyelonephritis is surprising, though a similar trend has been observed in the UK.(11) Further exploration of this phenomenon is necessary in order to ascertain patient profile and appropriateness of admissions. Available evidence demonstrates that with appropriate primary care support in the form of diagnostics, treatment guidelines and preventive approaches, admissions can be reduced and quality of care provided closer to home.(18)

ACSCs are a high level indicator of potentially avoidable hospitalisation with admissions known to be correlated with primary care provision as well as with deprivation.(1, 8, 10) The impact of ACSCs on acute hospital capacity is best measured using bed day rates. This analysis can be used to identify conditions that would benefit from investment in primary and community care. Identifying specific conditions by their impact on acute hospital

capacity supports closer examination of integrated models of care for these conditions.(7, 19) This analysis not only supports the left shift to provision of care within the community called for in Slaintecare, but enables prioritisation of resources to primary care.

ACSCs were responsible for almost one fifth of all acute hospital bed day usage in 2016 in Ireland. While the proportion of these admissions that represent truly avoidable admissions will require further exploration, an examination of the impact of these conditions in terms of bed days make a compelling argument for prioritising the development of integrated models of care with primary and community services, enabling the 'left shift' of care closer to home.

Figure & table legend:

Figure 1 Impact of ACSCs on bed days in public acute hospitals in Ireland in 2016 by age cohort

Table 1 ACSC contribution to national bed days by age cohort in 2016

Table 2 Trend analysis of ACSC bed days in public acute hospitals in Ireland 20

Figure 1 Bed day rate by five year age bands for top three ACSCs among total population

Table 3 Comparative vaccination uptake figures 2012/13 & 2017/18

Author Contributions

Dr. Breda Smyth, Consultant in Public Health Medicine developed the study protocol and provided ongoing support to data analysis and interpreted. Dr. Geraldine McDarby, Specialist Registrar in Public Health Medicine, performed data extraction and analysis. Both authors have given final approval for publication and are accountable for all aspects of the work.

Competing interests' statement

The authors report no competing interests

Funding Statement

This study received no specific funding from any funding agency in the public, commercial or not-for-profit sector.

Patient and Public Involvement

Patients were not involved in the concept or design of this study.

Data sharing statement

Data will be made available to facility managers and policy maker upon request.

Licence

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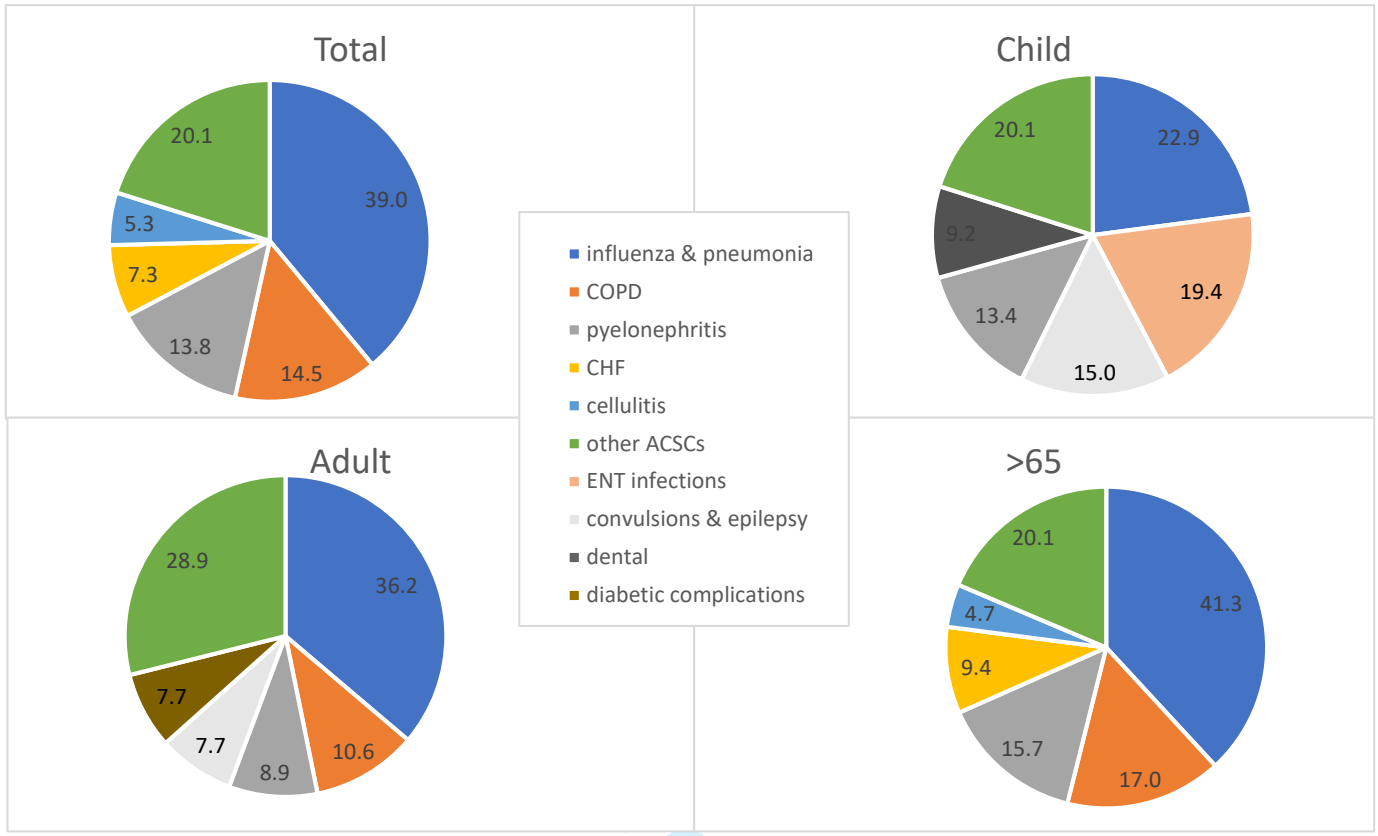
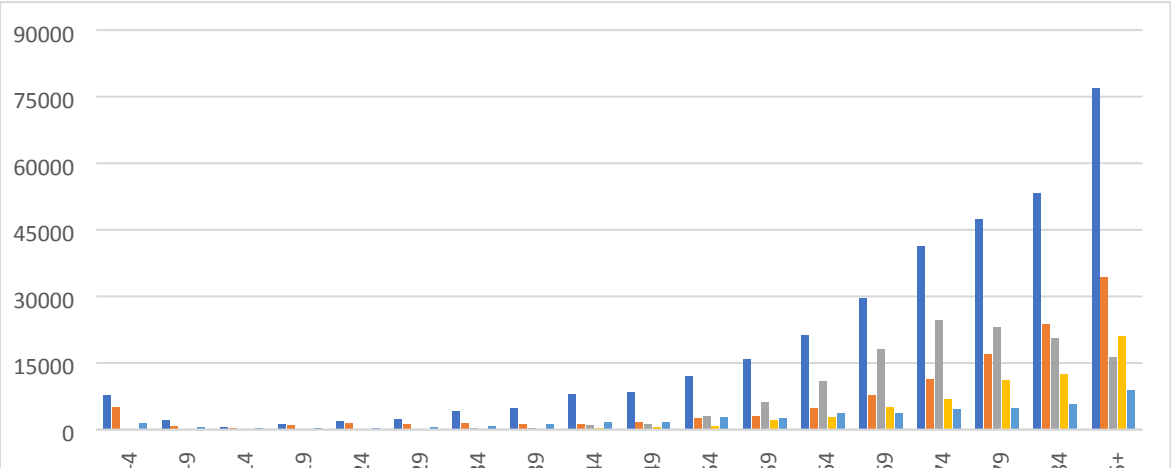

Total
39.0
14.5
13.8
7.3
5.3
20.1
Child
22.9
19.4
15.0
13.4
9.2
20.1
Adult
36.2
10.6
8.9
7.7
7.7
28.9
>65
41.3
17.0
15.7
9.4
4.7
20.1
influenza & pneumonia
COPD
pyelonephritis
CHF
cellulitis
other ACSCs
ENT infections
convulsions & epilepsy
dental
diabetic complications



Vaccine preventable	ICD 10 Code	Notes	ICD-10 Code	Notes	ICD10-AM Code	Notes	ICD-10	Notes
Influenza & pneumonia	-	-	J09, J10, J11, J13, J14, J15.3, J15.4, J15.7, J15.9, J16.8, J18.1, J18.8, J18.9	In any diagnosis field, excludes cases with secondary diagnosis of D57	J09, J10, J11, J13, J14, J15.3, J15.4, J15.7, J15.9, J16.8, J18.1, J18.8, J18.9	In any diagnosis field, excludes cases with secondary diagnosis of D57	J09, J10, J11, J13, J14, J15.3, J15.4, J15.7, J15.9, J16.8, J18.1, J18.8, J18.9	In any diagnosis field, excludes cases with secondary diagnosis of D57
Other vaccine preventable	-	-	A35, A36, A37, A80, B05, B06, B16.1, B16.9, B18.0, B18.1, B26, G00.0, M01.4	In any diagnosis field	A35, A36, A37, A80, B05, B06, B16.1, B16.9, B18.0, B18.1, B26, G00.0, M01.4	In any diagnosis field	A35, A36, A37, A80, B05, B06, B16.1, B16.9, B18.0, B18.1, B26, G00.0, M01.4	Principal diagnosis
Acute	ICD 10 Code	Notes	ICD-10 Code	Notes	ICD10-AM Code	Notes	ICD-10	Notes
Dehydration & Gastroenteritis	-	-	E86, K52.2, K52.8, K52.9	Principal diagnosis only	E86, K52.2, K52.8, K52.9	Principal diagnosis only	E86, K52.2, K52.8, K52.9	Principal diagnosis only
Convulsions & epilepsy	-	-	O15, G40, G41, R56	Principal diagnosis only	O15, G40, G41, R56	Principal diagnosis only	O15, G40, G41, R56	Principal diagnosis only
ENT infections	-	-	H66, H67, J02, J03, J06, J31.2	Principal diagnosis only	H66, H67, J02, J03, J06, J31.2	Principal diagnosis only	H66, H67, J02, J03, J06, J31.2	Principal diagnosis only
Dental conditions	-	-	K02-K06, K08, K09.8, K09.9, K12, K13	Principal diagnosis only	A69.0, K02-K06, K08, K09.8, K09.9, K12, K13	Principal diagnosis only	K02-K06, K08, K09.8, K09.9, K12, K13	Principal diagnosis only
Perforated/ bleding ulcer	-	-	K25.0, K25.1, K25.2, K25.4, K25.5, K25.6, K26.0, K26.1, K26.2, K26.4, K26.5, K26.6, K27.0, K27.1, K27.2, K27.4, K27.5, K27.6, K28.0, K28.1, K28.2, K28.4, K28.5, K28.6	Principal diagnosis only	K25.0-K25.2, K25.4-K25.6, K26.0-K26.2, K26.4-K26.6, K27.0-K27.2, K27.4-K27.6, K28.0-28.2, K28.4-K28.6	Principal diagnosis only	K25.0, K25.1, K25.2, K25.4, K25.5, K25.6, K26.0, K26.1, K26.2, K26.4, K26.5, K26.6, K27.0, K27.1, K27.2, K27.4, K27.5, K27.6, K28.0, K28.1, K28.2, K28.4, K28.5, K28.6	Principal diagnosis only

Ruptured appendix	-	-	-	-	K35.0	In any diagnosis field	-	-
Pyelonephritis	-	-	N10, N11, N12, N13.6, N39.0	Principal diagnosis only	N10, N11, N12, N13.6,	Principal diagnosis only	N10, N11, N12, N13.6, N39.0	Principal diagnosis only
PID	-	-	N70, N73, N74	Principal diagnosis only	N70, N73, N74	Principal diagnosis only	N70, N73, N74	Principal diagnosis only
Cellulitis	-	-	L03, L04, L08, L88, L98.0, L98.3	Principal diagnosis only, exclude cases with any procedure block except those in blocks 1820-2016 or procedure 30216-03, 30676-00, 30223-02, 30064-00, 34527-01, 34527-00 or 90661-00	L03, L04, L08.0, L08.8, L08.9, L88, L98.0, L98.3	Principal diagnosis AND no procedures OR procedures listed were only in blocks 1604-1606, 1608, 1820-2016 or procedures 90660-00, 30207-00, 30676-00, 30679-00, 34530-01 and 47912-00 Additionally check that the procedure is the only procedure when in the list: blocks 1604-1606, 1608, or the procedures are: 90660-00, 30207-00, 30676-00, 30679-00, 34530-01 and 47912-00]	L03, L04, L08, L88, L98.0, L98.3	Principal diagnosis only
gangrene	-	-	R02	In any diagnosis field	R02	In any diagnosis field	R02	In any diagnosis field
Chronic	ICD 10 Code	Notes	ICD-10 Code	Notes	ICD10-AM Code	Notes	ICD-10	Notes

Asthma	J45, J46	Primary diagnosis	J45, J46	Principal diagnosis only	J45, J46	Principal diagnosis only	J45, J46	Principal diagnosis only
COPD	J40-J44, J47 (J20)	Primary diagnosis (only with secondary diagnosis of J41-44, J47)	J40-J44, J47 (J20)	Primary diagnosis (only with secondary diagnosis of J41-44, J47)	J40-J44, J47 (J20)	Primary diagnosis (only with secondary diagnosis of J41-44, J47)	J40-J44, J47	Principal diagnosis only
CHF	I50, I11.0, J81	Primary diagnosis	I50, I11.0, J81	Principal diagnosis only			I50, I11.0, J81	Principal diagnosis only
Diabetic complications	-	-	E10.1-E10.8, E11.0-E11.8, E13.0-E13.8, E14.0-E14.8	In any diagnosis field	E10.1-E10.8, E11.0-E11.8, E13.0-E13.8, E14.0-E14.8	In any diagnosis field	E10.1-E10.8, E11.0-E11.8, E13.0-E13.8, E14.0-E14.8	Principal diagnosis only
Nutritional deficiencies	-	-	E40-E43, E55.0, E64.3	Principal diagnosis only	E40-E43, E55.0, E64.3	Principal diagnosis only	E40-E43, E55.0, E64.3	Principal diagnosis only
Iron deficiency anaemia	-	-	D50.1, D50.8, D50.9	Principal diagnosis only	D50.1, D50.8, D50.9	Principal diagnosis only	D50.1, D50.8, D50.9	Principal diagnosis only
Hypertension	-	-	I10, I11.9	Principal diagnosis only	I10, I11.9	Principal diagnosis only	I10, I11.9	Principal diagnosis only
Angina	-	-	I20, I24.0, I24.8, I24.9	Principal diagnosis only cases, excluding cases with procedure codes in blocks 1820-2140	I20, I24.0, I24.8, I24.9	Principal diagnosis only cases, excluding cases with procedure codes in blocks 1-1779	I20, I24.0, I24.8, I24.9	Principal diagnosis only cases, excluding cases with procedure codes in blocks 1820-2140

STROBE Statement

Checklist of items that should be included in reports of observational studies

Section/Topic	Item No	Recommendation	Reported on Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	n/a
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	3
Bias	9	Describe any efforts to address potential sources of bias	n/a
Study size	10	Explain how the study size was arrived at	n/a
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	2-3
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	3
		(*b*) Describe any methods used to examine subgroups and interactions	n/a
		(*c*) Explain how missing data were addressed	n/a
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	n/a
		(*e*) Describe any sensitivity analyses	n/a

Section/Topic	Item No	Recommendation	Reported on Page No
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	n/a
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	n/a
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	4-5
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	4-5
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	18	Summarise key results with reference to study objectives	5-6
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	3
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	5-7
Generalisability	21	Discuss the generalisability (external validity) of the study results	7
Other Information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	n/a

**Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.*

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Identifying Priorities for Primary Care Investment in Ireland through a Population Based Analysis of Avoidable Hospital Admissions for Ambulatory Care Sensitive Conditions (ACSC)

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Primary Subject Heading:	Health services research
Secondary Subject Heading:	Health policy, Health services research, Public health
Keywords:	Ambulatory care sensitive conditions, resource allocation, primary healthcare, prioritisation, avoidable admissions, integrated care planning

Title page:

Title: Identifying Priorities for Primary Care Investment in Ireland through a Population Based Analysis of Avoidable Hospital Admissions for Ambulatory Care Sensitive Conditions (ACSC)

Authors: McDarby, G.[1], and Smyth B.[2]

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Word Count: 2005

Keywords: Ambulatory Care Sensitive Conditions, Avoidable Admissions, Prioritization, Resource Allocation, Integrated Care Planning

Abstract:

Background

In 2016 the Irish acute hospital system operated well above internationally recommended occupancy targets . Investment in primary care can prevent hospital admissions of Ambulatory Care Sensitive Conditions (ACSCs).

Objective

To measure the impact of ACSCs on acute hospital capacity in the Irish public system and identify specific care areas for enhanced primary care provision.

Design

National HIPE data was used to calculate 2011-2016 standardised bed day rates for selected ACSC conditions. A prioritisation exercise was undertaken to identify the most significant contributors to bed days within our hospital system. Poisson regression was used to determine change over time using Incidence Rate Ratios (IRR) .

Results

In 2016 ACSCs accounted for almost 20% of acute public hospital beds (n= 871,328 bed days) with adults over 65 representing 69.1% (n=602,392) of these. Vaccine preventable conditions represented 39.1% of ACSCs. Influenza and pneumonia was responsible for 99.8% of these, increasing by 8.2% (IRR: 1.02; 95%CI 1.02-1.03) from 2011 to 2016. Pyelonephritis represented 47.6% of acute ACSC bed days, increasing by 46.5% (IRR: 1.07; 95%CI 1.06-1.08) over the 5 years examined.

Conclusions

Prioritisation for targeted investment in integrated care programmes is enabled through analysis of ACSC's in terms of acute hospital bed days. This analysis demonstrates that primary care investment in integrated care programmes for respiratory ACSC's from prevention to rehabilitation at scale could assist with bed capacity in acute hospitals in Ireland. In adults 65 years and over, including COPD patients, the current analysis supports targeting community based pulmonary rehabilitation including pneumococcal and influenza vaccination programmes in order to reduce the burden of infection and hospitalisations. Further exploration of pyelonephritis is necessary in order to ascertain patient profile and appropriateness of admissions.

Strengths and Limitations of this study:

- The study examines the impact of ambulatory care sensitive conditions (ACSCs) on the acute publicly funded hospital system using national level data extracted from the national Hospital In-patient Enquiry System in the form of bed days and bed day rates
- National bed day rates are standardised to the EU population with three age-specific cohorts analysed (children 0-15, adults 15-64 and persons 65 and older) as well as trend analysis over the 5 year period 2011-2016 using Poisson regression techniques.
- All 19 ACSCs identified are included in the prioritisation exercise which identifies the top 5 contributors to ACSC bed days for the total population as well as for each age cohort examined
- While the current analysis of capacity and age cohorts remains robust, further in-depth analysis of patient profiles was limited by the episodic nature of Irish HIPE data , where admissions are not linked to patient details.
- The generalizability of all ACSC research is limited by poorly defined categorisation of ACSCs internationally , and a refinement of coding would enhance specificity and generalisability of this area of research

Introduction:

Ambulatory care sensitive conditions (ACSCs) are acute or episodic conditions where appropriate and timely community care can prevent disease and/or hospital admissions.(1) While there is variability in relation to the conditions considered ACSCs, they can be broadly classified into vaccine preventable, acute and chronic conditions. ACSCs are commonly used as an indicator of avoidable hospital admissions as well as quality of and access to primary care.(2,3)

The current acute hospital bed occupancy rate of 94.2% is significantly higher than the internationally recognised target of 85%. Occupancy rates at this level are associated with adverse patient and staff outcomes as well as restricting efficiency in terms of patient flow.(4) To achieve international standards of bed occupancy would require the immediate introduction of 1,260 inpatient beds.(5) Ireland is experiencing an ageing demographic shift with an expected annual increase of almost 20,000 in the population 65 years and over. This population cohort currently occupy 54% of total acute bed days.(6) Moreover the

demand for acute hospital beds is projected to increase significantly unless there is a shift in the model of care from acute hospital care to primary care.(6) The hospital centric nature of the Irish system continues to fuel an ever increasing demand for acute hospitals to deliver care and services which would be better provided in the community. However Primary Care services in Ireland remain under resourced.(7) As recognised within Slaintecare, the 10 year cross political vision for the future of Irish healthcare services, improvement and sustainability of the Irish Health system is dependent on a shift of care from acute hospitals to primary care.(7)

In the literature, ACSC analyses to date recognises the impact on emergency departments and admissions. Drivers of these admissions have been examined highlighting the association with levels of primary care provision, as well as higher levels of deprivation.(1, 8-10) However, the use of ACSC analysis to identify and prioritise areas for improved primary care resources and programmes of care remains unexamined. The purpose of this paper is to examine ACSCs in relation to their overall impact on acute hospital capacity in Ireland in terms of bed days and bed day rates and to assist prioritisation of targeted investment in primary care supporting robust integrated care programmes. This novel approach to the evaluation of ACSCs supports the left shift to primary care called for by Slaintecare and international policy.

Methods:

The international literature in relation to 'definition and coding' of ACSCs was reviewed and a list of 19 commonly cited ACSCs was identified for inclusion (appendix 1). Definition notes for ICD codes including primary and secondary diagnoses were examined and the definition notes most appropriate to the Irish setting and reflective of bed utilisation were chosen. Data for these codes was extracted from the National Hospital In-patient Enquiry System (HIPE) to calculate 2011-2016 age-standardised bed day rates for selected ACSC conditions. Age specific analysis was carried out using the following categories; children (0-14 years), adults (15-64 years) and persons 65 years and over. A prioritisation exercise in which all 19 conditions were ranked in terms of their contribution to total and age specific bed days and bed day rates in 2017 was undertaken to identify the most significant contributors within our hospital system (figure 1). Poisson regression analysis was used to distinguish a genuine change over time. Standardised Incidence Rate Ratios (IRR) with 95% Confidence Intervals and corresponding p values were reported.(10) Population rates are directly standardised to

the European standard population. As the analysis represents a secondary analysis of an anonymised data set, ethical approval was not required.

Patient and Public Involvement

Patients were not involved in the concept or design of this study.

Results:

ACSCs represented 18.5% (n=871,328) of publicly funded bed days in Ireland in 2016 with an 18.2% (IRR 1.03; p<0.01) increase over the 5-year time period examined The most significant contributors to ACSC bed days included influenza and pneumonia, COPD and pyelonephritis. Influenza and pneumonia accounted for 39.0% of total ACSC bed days (n=339,613), with the proportion of ACSC bed days increasing with increasing age across the three age cohorts examined (table 1; figure 1). The bed day rate increased by 8.2% (IRR 1.02; p<0.01) from 2011-2016 (table 2). Chronic Obstructive Pulmonary Disease (COPD) accounted for almost half of chronic ACSC bed days in 2016 and 14.5% of total ACSC bed days (n= 126,336 bed days; 3,831/100,000). The COPD bed day rate increased (2011-2016) by 1.1% (IRR:1.16; p<0.01) on a background of a 10.7% reduction in the chronic ACSC bed day rate over the five-year period examined.

Table 1 ACSC contribution to national bed days by age cohort in 2016

	total				0-14			15-64			65+		
ACSCs	bed days	% ACSC bed days	% total bed days	Standardised bed day rate*	bed days	% ACSC bed days	Age specific bed day rate	bed days	% ACSC bed days	Age specific bed day rate	bed days	% ACSC bed days	Age specific bed day rate
vaccine preventable	**340,461**	**39.1**	**7.2**	**10,170**	**11,276**	**24.1**	**11,141**	**80,775**	**36.4**	**2,826**	**248,545**	**41.3**	**41,933**
Influenza & pneumonia	339,613	39.0	7.2	10,155	10,704	22.9	930	80,518	36.2	2,817	248,524	41.3	41,930
other vaccine preventable	848	0.1	0.0	14	572	1.2	76	257	0.1	81	21	0.0	3
acute	**252,698**	**29.0**	**5.4**	**7,002**	**29,822**	**63.7**	**2,809**	**73,371**	**32.8**	**2,471**	**150,172**	**24.9**	**25,431**
pyelonephritis	120,285	13.8	2.6	3,681	6,282	13.4	547	19,762	8.9	680	94,338	15.7	16,145
cellulitis	46,088	5.3	1.0	1,307	2,512	5.4	182	15,403	6.9	5,334	28,141	4.7	4,734
convulsions and epilepsy	36,161	4.2	0.8	857	7,026	15.0	707	17,426	7.7	5,725	11,993	2.0	1,967
dehydration & GII	7,594	0.9	0.2	216	149	0.3	27	2,713	1.2	911	4,740	0.8	794
dental	8,422	1.0	0.2	162	4,308	9.2	466	3,374	1.5	110	809	0.1	126
ENT infections	15,443	1.8	0.3	282	9,090	19.4	881	5,401	2.3	1,675	1,171	0.2	193
gangrene	11,372	1.3	0.2	308	417	0.9	80	5,128	2.3	1,780	5,827	1.0	956
perforated ulcer	5,575	0.6	0.1	153	10	0.0	29	2,597	1.2	896	2,969	0.5	487
PID	1,758	0.2	0.0	37	28	0.1	1	1,567	0.7	485	184	0.0	29
chronic	**278,169**	**31.9**	**5.9**	**8,227**	**5,704**	**12.2**	**562**	**68,790**	**30.9**	**2,448**	**203,675**	**33.8**	**33,631**
COPD	126,336	14.5	2.7	3,831	140	0.3	23	23,500	10.6	5,928	102,659	17.0	16,749
CHF	68,469	7.3	1.5	2,059	141	0.3	22	6425	3.0	2,478	61,904	9.4	9,735
diabetic complications	40,241	4.6	0.9	1,081	1,656	3.5	142	17,259	7.7	5,928	21,479	3.6	3,457
angina	15,179	1.7	0.3	430	13	0.0	1	5780	2.6	2,125	9,386	1.6	1,499
asthma	14,519	1.7	0.3	318	3,703	7.9	327	7,889	3.5	2,639	3,015	0.5	471
hypertension	5,586	0.6	0.1	144	177	0.4	10	3,158	1.4	1,076	2,268	0.4	371
iron deficiency anaemia	12,523	1.4	0.3	357	180	0.4	21	4,449	2.0	1,514	7,915	1.3	1,318
nutritional deficiencies	225	0	0.0	7	5	0.0	0	42	0.0	13	178	0.0	31
ACSC contribution to total bed days in each cohort	**871,328**	**100**	**18.5**	**18,297**	**46,802**		**4,650**	**222,936**		**7,113**	**602,392**		**94,483**

Pyelonephritis represented almost half (51.2%; n=120,285 bed days; 3,681/100,000) of acute ACSC bed days in 2016 and 13.8% of total ACSC bed days. The bed day rate for pyelonephritis increased by 46.5% over the five years examined.

Table 2 Trend analysis of ACSC bed days in Irish acute public hospitals 2011-2016

ACSC		Absolute change in bed days	% change in standardised bed day rate	incidence rate ratio for trend	95% Confidence Interval
Vaccine preventable	**total**	**62,395**	**8.2**	**1.02*** **	**1.017-1.027**
	influenza and pneumonia	62,700	8.2	1.02***	1.018-1.027
	other vaccine preventable	-305	-25.4	0.90*	0.791-1.014
Acute	**total**	**56,773**	**19.7**	**1.03*** **	**1.028-1.040**
	pyelonephritis	46,554	46.5	1.07***	1.064-1.083
	cellulitis	13,284	21.5	1.05***	1.035-1.063
	convulsions and epilepsy	3,829	5.1	1.01	0.9905-1.023
	dehydration & GII	-4,405	-44.9	0.94***	0.913-0.967
	dental	393	3.7	1.00	0.963-1.036
	ENT infections	250	5.5	1.00	0.973-1.029
	gangrene	-538	-22.1	0.98	0.955-1.010
	perforated ulcer	-2,280	-38.2	0.93***	0.898-0.967
	PID	-314	-22.5	0.96	0.893-1.038
Chronic	**total**	**-7,442**	**-10.7**	**0.97*** **	**0.969-0.979**
	COPD	18,107	1.1	1.16***	1.157-1.171
	CHF	-1,201	-11.4	0.97***	0.961-0.980
	diabetic complications	-11,444	-34.1	0.91***	0.902-0.924
	angina	-8,163	-43.8	0.90***	0.885-0.9195
	asthma	2,877	17.6	1.03**	1.007-1.063
	hypertension	774	3.0	1.01	0.967-1.047
	iron deficiency anaemia	3,916	40.5	1.05***	1.026-1.083
	nutritional deficiencies	174	633.7	1.08	0.838-1.380

ACSC contribution to public bed days	**111,726**	**18.2**	1.03***	1.033-1.034

Examination by Age Cohort

When age-specific bed day rates are examined significant variation becomes apparent (figure 2). ACSC conditions were concentrated in the older population, with adults 65 and older representing 69.1% of ACSC bed days (n= 602,392 bed days; 94,483/100,000) in 2016. The impact of ACSCs on total bed days also increased with age, with ACSC bed days representing one quarter of total bed days in this age cohort. Vaccine preventable conditions represented 41.3% of ACSC bed days among this cohort of which 99% (n=248,524 bed days; 41,933/100,000) were due to influenza and pneumonia. COPD was the most significant chronic ACSC among this age cohort accounting for more than 100,000 bed days (16,749 /100,000). In 2016, pyelonephritis was the most significant acute ACSC in this cohort with 94,338 bed days (16,145/100,000). The bed day rate due to pyelonephritis has increased by 46.5% over the five years examined (IRR 1.07; p<0.01) (table 2).

In the child cohort (0-14 years), 13.8% of total acute hospital bed days were attributable to ACSCs, representing 46,802 bed days in 2016 (table 2). Acute ACSCs represented 63.4% (n=29,822 bed days; 2,089/100,000**)**, with ENT infections the leading acute condition, representing 19.4% (n=9,090 bed days; 881/100,000) of ACSC bed days in 2016. Vaccine preventable ACSCs represented almost one quarter (24.1%) of ACSC bed days, with influenza and pneumonia being responsible for the majority of these.

Within the adult cohort (15-64 years), 11.0% (n= 222,936 bed days; 7,113/100,000) of total bed days were attributable to ACSCs (table 1). The most significant ACSC condition among this age cohort was the vaccine preventable category influenza and pneumonia. Acute and chronic ACSCs contributed similar proportions to bed days at approximately one third each.

Discussion

The 19 ACSCs identified for inclusion in this analysis accounted for almost 20% of the total publicly funded acute hospital bed days in 2016 or 871,328 bed days. When examined in relation to age specific cohorts, adults 65 years and over represented 69.1% of all ACSC bed days. Just over half of ACSC bed days in 2016 were among respiratory conditions; influenza and pneumonia and COPD. Influenza and pneumonia was the single most important contributor to ACSC bed days across all age cohorts, increasing by 8.2% over the 5 years examined. The majority of these bed days (73.2%; n= 248,524 bed days) were among adults

65 years and over. COPD represented 14.5% (n=126,336) of ACSC bed days in 2016, with 81.3% of these in adults 65 years and over. Pyelonephritis was the next biggest contributor to bed days, representing 13.8% of ACSC bed days. Again, the relative contribution to bed days increased with age, with adults 65 years and over representing 78.4%. Over the five-year period examined bed days due to pyelonephritis increased significantly (46.5%).

Evidenced based models of care for influenza and pneumonia include integrated care programmes which include prevention. Seasonal influenza and pneumococcal vaccination remain the mainstay of preventing mortality and morbidity associated with influenza and pneumonia in Ireland as well as internationally. Seasonal influenza vaccination is recommended for disease specific risk groups including COPD, adults 65 years and over and healthcare workers (HCWs). Pneumococcal vaccination is recommended for those 65 and over and those with COPD. While the absolute impact of seasonal influenza and pneumococcal vaccination remains difficult to quantify, recent studies confirm their effectiveness at reducing the risk of pneumococcal pneumonia as well as hospitalisation from respiratory illness among adults 65 and over.(11,12) Despite this, uptake of seasonal influenza vaccine in Ireland consistently lags behind our closest neighbour the UK, while rates of uptake of pneumococcal vaccination are not routinely collected. In Ireland, uptake of seasonal influenza vaccine among adults 65 and over was 56.9% for the 2012/2013 season, with uptake among HCWs at just 17.6%. Pneumococcal vaccine uptake was estimated at 36%.(13,14,15) Comparatively, in the UK, seasonal influenza vaccination rates consistently approach or exceed 70% among adults over 65, with HCW vaccination rates consistently above Irish estimates (table 3).(16,17) For the 2012/2013 season, for which comparative data is available, pneumonia represented approximately 10% of ACSC admissions in the UK compared to approximately 30% in the Irish setting.(1) These estimates support the continued emphasis on seasonal influenza and pneumococcal vaccination for HCWs and adults 65 and over as well as the regular monitoring of pneumococcal vaccination uptake rates in Ireland.

Table 3 Comparative vaccination uptake figures 2012/13 & 2017/18

	2012/2013				2017/2018		
	Seasonal Influenza vaccine uptake 65+	Seasonal influenza vaccine uptake HCW*	IPV uptake 65+	Pneumonia (% ACSC admissions)	Seasonal Influenza vaccine uptake 65+	Seasonal influenza vaccine uptake HCW	IPV uptake 65+
Ireland	56.9%	17.6%	38.0%	29.0%-35.0%**	68.0%	44.8%	38.0%

UK	74.0%	45.6%	69.1%	15.0%	70.5%	68.7%	69.5%

Ireland consistently has one of the highest admission and re-admission rates for COPD in the OECD.(18,19) COPD is also one of the most resource intensive DRGs in acute hospitals in Ireland.(6) Mortality rates in Ireland due to chronic lower respiratory diseases are 42% higher than the EU average.(6) Pulmonary rehabilitation is one of the most cost effective treatments available.(20) At a cost of 2-8k per QALY, it is known to be effective at improving quality of life as well as reducing hospital admissions. Despite being recognised as the standard of care, this programme is not routinely available in Ireland.(21) While COPD patients are identified as a risk group for both influenza and pneumococcal vaccination in Ireland, vaccination uptake among this group is not routinely measured or reported.(18) This paper provides evidence to support implementation of an integrated care programme for COPD focusing on primary care investment to reduce pressure on acute hospitals and improve quality of care for the patients closer to home.

The impact and increase observed for pyelonephritis is surprising, though a similar trend has been observed in the UK.(10) Further exploration of this phenomenon is necessary in order to ascertain patient profile and appropriateness of admissions. Available evidence demonstrates that with appropriate primary care support in the form of diagnostics, treatment guidelines and preventive approaches, admissions can be reduced and quality of care provided closer to home.(22)

Conclusion

ACSCs are a high level indicator of potentially avoidable hospitalisation with admissions known to be correlated with primary care provision as well as with deprivation.(1, 8, 10) The impact of ACSCs on acute hospital capacity is best measured using bed day rates. This analysis can be used to identify conditions that would benefit from investment in primary and community care. Identifying specific conditions by their impact on acute hospital capacity supports closer examination of integrated models of care for these conditions.(7, 20) This analysis not only supports the left shift to provision of care within the community called for in Slaintecare, but enables prioritisation of resources to primary care.(6)

ACSCs were responsible for almost one fifth of all acute hospital bed day usage in 2016 in Ireland. While the proportion of these admissions that represent truly avoidable admissions will require further exploration, an examination of the impact of these conditions in terms of

bed days make a compelling argument for prioritising the development of integrated models of care with primary and community services, enabling the 'left shift' of care closer to home envisioned within government policy.(6,23)

Figure & table legend:

Figure 1 Impact of ACSCs on bed days in public acute hospitals in Ireland in 2016 by age cohort

Table 1 ACSC contribution to national bed days by age cohort in 2016

Table 2 Trend analysis of ACSC bed days in public acute hospitals in Ireland 20

Figure 1 Impact of ACSCs on bed days in public acute hospitals in Ireland in 2016 by age cohort

Figure 2 Bed day rate by five year age bands for top three ACSCs among total population

Table 3 Comparative vaccination uptake figures 2012/13 & 2017/18

Author Contributions

Dr. Breda Smyth, Consultant in Public Health Medicine developed the study protocol and provided ongoing support to data analysis and interpreted. Dr. Geraldine McDarby, Specialist Registrar in Public Health Medicine, performed data extraction and analysis. Both authors have given final approval for publication and are accountable for all aspects of the work. This work was conducted within the work programme of the Planning for Health Group.

Competing interests' statement

None Declared

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Data sharing statement

Data will be made available to facility managers and policy maker upon request.

Licence

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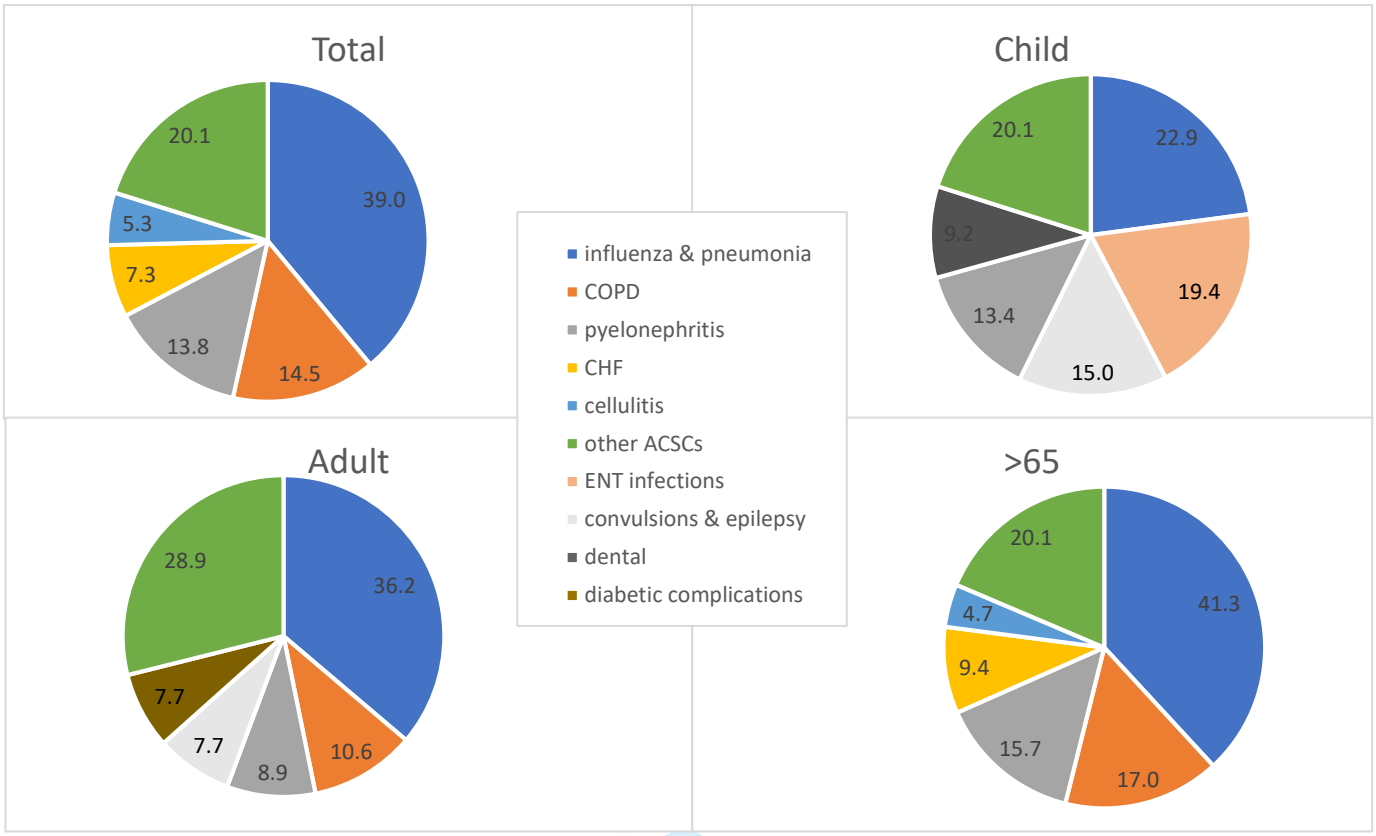
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5.3
7.3
13.8
14.5
Child
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22.9
9.2
19.4
13.4
15.0
Adult
28.9
36.2
7.7
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8.9
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>65
20.1
41.3
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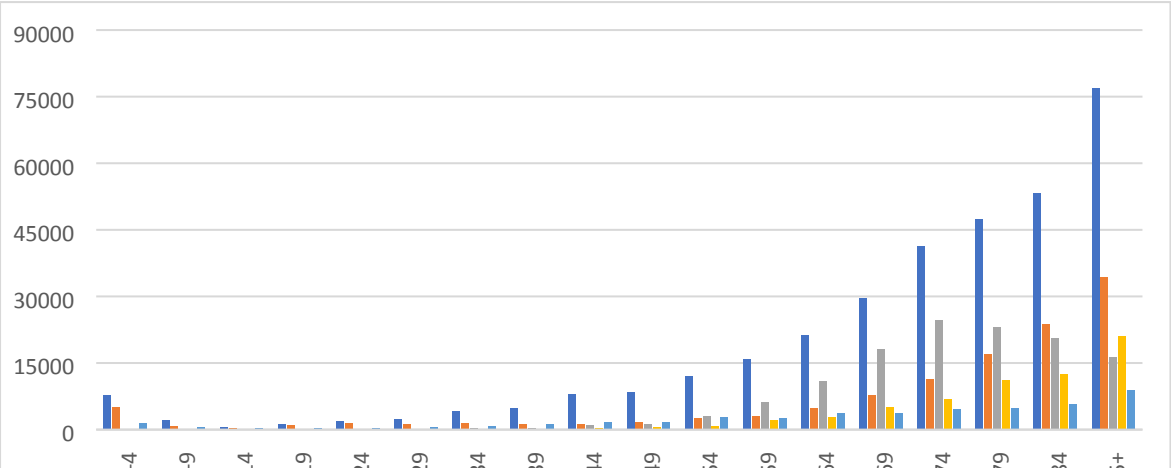
CHF
cellulitis
other ACSCs
ENT infections
convulsions & epilepsy
dental
diabetic complications



Vaccine preventable	ICD 10 Code	Notes	ICD-10 Code	Notes	ICD10-AM Code	Notes	ICD-10	Notes
Influenza & pneumonia	-	-	J09, J10, J11, J13, J14, J15.3, J15.4, J15.7, J15.9, J16.8, J18.1, J18.8, J18.9	In any diagnosis field, excludes cases with secondary diagnosis of D57	J09, J10, J11, J13, J14, J15.3, J15.4, J15.7, J15.9, J16.8, J18.1, J18.8, J18.9	In any diagnosis field, excludes cases with secondary diagnosis of D57	J09, J10, J11, J13, J14, J15.3, J15.4, J15.7, J15.9, J16.8, J18.1, J18.8, J18.9	In any diagnosis field, excludes cases with secondary diagnosis of D57
Other vaccine preventable	-	-	A35, A36, A37, A80, B05, B06, B16.1, B16.9, B18.0, B18.1, B26, G00.0, M01.4	In any diagnosis field	A35, A36, A37, A80, B05, B06, B16.1, B16.9, B18.0, B18.1, B26, G00.0, M01.4	In any diagnosis field	A35, A36, A37, A80, B05, B06, B16.1, B16.9, B18.0, B18.1, B26, G00.0, M01.4	Principal diagnosis
Acute	ICD 10 Code	Notes	ICD-10 Code	Notes	ICD10-AM Code	Notes	ICD-10	Notes
Dehydration & Gastroenteritis	-	-	E86, K52.2, K52.8, K52.9	Principal diagnosis only	E86, K52.2, K52.8, K52.9	Principal diagnosis only	E86, K52.2, K52.8, K52.9	Principal diagnosis only
Convulsions & epilepsy	-	-	O15, G40, G41, R56	Principal diagnosis only	O15, G40, G41, R56	Principal diagnosis only	O15, G40, G41, R56	Principal diagnosis only
ENT infections	-	-	H66, H67, J02, J03, J06, J31.2	Principal diagnosis only	H66, H67, J02, J03, J06, J31.2	Principal diagnosis only	H66, H67, J02, J03, J06, J31.2	Principal diagnosis only
Dental conditions	-	-	K02-K06, K08, K09.8, K09.9, K12, K13	Principal diagnosis only	A69.0, K02-K06, K08, K09.8, K09.9, K12, K13	Principal diagnosis only	K02-K06, K08, K09.8, K09.9, K12, K13	Principal diagnosis only
Perforated/ bleding ulcer	-	-	K25.0, K25.1, K25.2, K25.4, K25.5, K25.6, K26.0, K26.1, K26.2, K26.4, K26.5, K26.6, K27.0, K27.1, K27.2, K27.4, K27.5, K27.6, K28.0, K28.1, K28.2, K28.4, K28.5, K28.6	Principal diagnosis only	K25.0-K25.2, K25.4-K25.6, K26.0-K26.2, K26.4-K26.6, K27.0-K27.2, K27.4-K27.6, K28.0-28.2, K28.4-K28.6	Principal diagnosis only	K25.0, K25.1, K25.2, K25.4, K25.5, K25.6, K26.0, K26.1, K26.2, K26.4, K26.5, K26.6, K27.0, K27.1, K27.2, K27.4, K27.5, K27.6, K28.0, K28.1, K28.2, K28.4, K28.5, K28.6	Principal diagnosis only

Ruptured appendix	-	-	-	-	K35.0	In any diagnosis field	-	-
Pyelonephritis	-	-	N10, N11, N12, N13.6, N39.0	Principal diagnosis only	N10, N11, N12, N13.6,	Principal diagnosis only	N10, N11, N12, N13.6, N39.0	Principal diagnosis only
PID	-	-	N70, N73, N74	Principal diagnosis only	N70, N73, N74	Principal diagnosis only	N70, N73, N74	Principal diagnosis only
Cellulitis	-	-	L03, L04, L08, L88, L98.0, L98.3	Principal diagnosis only, exclude cases with any procedure block except those in blocks 1820-2016 or procedure 30216-03, 30676-00, 30223-02, 30064-00, 34527-01, 34527-00 or 90661-00	L03, L04, L08.0, L08.8, L08.9, L88, L98.0, L98.3	Principal diagnosis AND no procedures OR procedures listed were only in blocks 1604-1606, 1608, 1820-2016 or procedures 90660-00, 30207-00, 30676-00, 30679-00, 34530-01 and 47912-00 Additionally check that the procedure is the only procedure when in the list: blocks 1604-1606, 1608, or the procedures are: 90660-00, 30207-00, 30676-00, 30679-00, 34530-01 and 47912-00]	L03, L04, L08, L88, L98.0, L98.3	Principal diagnosis only
gangrene	-	-	R02	In any diagnosis field	R02	In any diagnosis field	R02	In any diagnosis field
Chronic	ICD 10 Code	Notes	ICD-10 Code	Notes	ICD10-AM Code	Notes	ICD-10	Notes

Asthma	J45, J46	Primary diagnosis	J45, J46	Principal diagnosis only	J45, J46	Principal diagnosis only	J45, J46	Principal diagnosis only
COPD	J40-J44, J47 (J20)	Primary diagnosis (only with secondary diagnosis of J41-44, J47)	J40-J44, J47 (J20)	Primary diagnosis (only with secondary diagnosis of J41-44, J47)	J40-J44, J47 (J20)	Primary diagnosis (only with secondary diagnosis of J41-44, J47)	J40-J44, J47	Principal diagnosis only
CHF	I50, I11.0, J81	Primary diagnosis	I50, I11.0, J81	Principal diagnosis only			I50, I11.0, J81	Principal diagnosis only
Diabetic complications	-	-	E10.1-E10.8, E11.0-E11.8, E13.0-E13.8, E14.0-E14.8	In any diagnosis field	E10.1-E10.8, E11.0-E11.8, E13.0-E13.8, E14.0-E14.8	In any diagnosis field	E10.1-E10.8, E11.0-E11.8, E13.0-E13.8, E14.0-E14.8	Principal diagnosis only
Nutritional deficiencies	-	-	E40-E43, E55.0, E64.3	Principal diagnosis only	E40-E43, E55.0, E64.3	Principal diagnosis only	E40-E43, E55.0, E64.3	Principal diagnosis only
Iron deficiency anaemia	-	-	D50.1, D50.8, D50.9	Principal diagnosis only	D50.1, D50.8, D50.9	Principal diagnosis only	D50.1, D50.8, D50.9	Principal diagnosis only
Hypertension	-	-	I10, I11.9	Principal diagnosis only	I10, I11.9	Principal diagnosis only	I10, I11.9	Principal diagnosis only
Angina	-	-	I20, I24.0, I24.8, I24.9	Principal diagnosis only cases, excluding cases with procedure codes in blocks 1820-2140	I20, I24.0, I24.8, I24.9	Principal diagnosis only cases, excluding cases with procedure codes in blocks 1-1779	I20, I24.0, I24.8, I24.9	Principal diagnosis only cases, excluding cases with procedure codes in blocks 1820-2140

STROBE Statement

Checklist of items that should be included in reports of observational studies

Section/Topic	Item No	Recommendation	Reported on Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	n/a
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	3
Bias	9	Describe any efforts to address potential sources of bias	n/a
Study size	10	Explain how the study size was arrived at	n/a
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	2-3
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	3
		(*b*) Describe any methods used to examine subgroups and interactions	n/a
		(*c*) Explain how missing data were addressed	n/a
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	n/a
		(*e*) Describe any sensitivity analyses	n/a

Section/Topic	Item No	Recommendation	Reported on Page No
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	n/a
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	n/a
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	4-5
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	4-5
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	18	Summarise key results with reference to study objectives	5-6
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	3
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	5-7
Generalisability	21	Discuss the generalisability (external validity) of the study results	7
Other Information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	n/a

**Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.*

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.