Hospital acquired pneumonia and multimorbidity

Insight report
March 2024

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Introduction

Hospital acquired pneumonia (HAP) is a pneumonia that presents 48 hours or more after admission to hospital, or from the community in patients who were admitted to hospital in the previous 10 days [1,2]. A recent European point prevalence survey demonstrated that HAP is the most common type of healthcare associated infection (HCAI), accounting for 21.4% of all infections acquired in the hospital setting[3]. Looking specifically at England, HAP accounted for 27.8% of all HCAIs[3]. There is no national surveillance of HAP in the UK.

Previous work done in collaboration with the University of Liverpool has identified that in England there is considerable regional variation in HAP rates, which suggests there are opportunities for improvement in care[4,5].

Aqua, as part of their Advancing Quality (AQ) programme, have a North West-based quality improvement initiative for HAP. The AQ HAP programme gathers detailed care delivery data for clinically validated cases of HAP within participating NHS hospitals. Around 19% of coded cases are excluded from the dataset as not being 'true' incidences of HAP, largely due to radiological overdiagnosis. This validated data gives us an opportunity to understand, in more detail, the population at particular risk of developing HAP.

The purpose of this report is to present an analysis of HAP cases in our region in order to refine our understanding of who develops HAP. These insights will help us target quality improvement interventions such as education, audit and care bundles.

In this analysis, we explored the relationship between HAP and comorbidities and the incidence of HAP in patients having emergency and elective admissions.

HAP and multimorbidity

By definition, HAP is co-morbid with other conditions, in that it only occurs in patients who have been admitted to hospital for another reason. It is therefore a common adverse event suffered by a wide range of patients and it occurs on every ward in every hospital globally. For example, there are cases on stroke wards, trauma and respiratory wards, in non-acute hospitals specialising in cardiothoracic or neurological conditions, in women's hospitals and on paediatric units.

HAP and admissions

Although the majority of HAP cases occur in people who are admitted with an emergency into an acute hospital, our previous analysis of AQ data revealed that HAP also occurs in patients who are admitted for elective procedures and therefore not acutely unwell. This report describes new analysis which aims to determine if there is variation in HAP risk between types of emergency admission as well as for those undergoing specific categories of elective procedure, which could direct specific preventative interventions.

Methodology

Cases were selected from Secondary Uses Service (SuS) data. SuS is the single, comprehensive repository for healthcare data in England regarding a patient's time at hospital. In this dataset, a spell is an entire hospital admission. Spells are divided into episodes, each denoting a patient moving from ward to ward or under care of different consultants during a spell i.e. during the same admission.

SuS includes information about diagnosis and comorbidity, recorded using the International Classification of Diseases dictionary, tenth revision (ICD-10) and operative procedures, recorded using Office of Population Censuses and Surveys (OPCS) surgical procedure codes. The Admission Method field enables identification of elective and emergency admissions. The Patient Classification field distinguishes day cases from ordinary admissions.[6]

1 Population identification

The following criteria were used to identify HAP cases from SuS:

1. April 2022 - March 2023 discharges, inclusive, using final spell discharge date.
2. Ordinary admissions, excluding day cases.
3. Patients aged 18 years or older on admission.

Of 900,628 cases identified, 113,264 were admitted electively and 681,897 were emergency admissions.

Cases with a pneumonia ICD-10 code immediately followed by Y95.X, indicating a nosocomial condition, in any finished consultant episode (FCE) were classified as HAP.

2 Elective admissions

Analysis was restricted to patients with an OPCS code recorded. On this basis, 15,842 were excluded, leaving 97,422 cases which were analysed for number and rate of HAP per 1000 discharges as follows:

1. By OPCS category of primary procedure
2. By total number of ICD-10 codes recorded, indicating number of co-morbid diagnoses. Codes are counted distinctly: if the same code appears in multiple episodes, it is only counted once.
3. By OPCS procedure description for categories with the highest HAP rates.

3 Emergency admissions

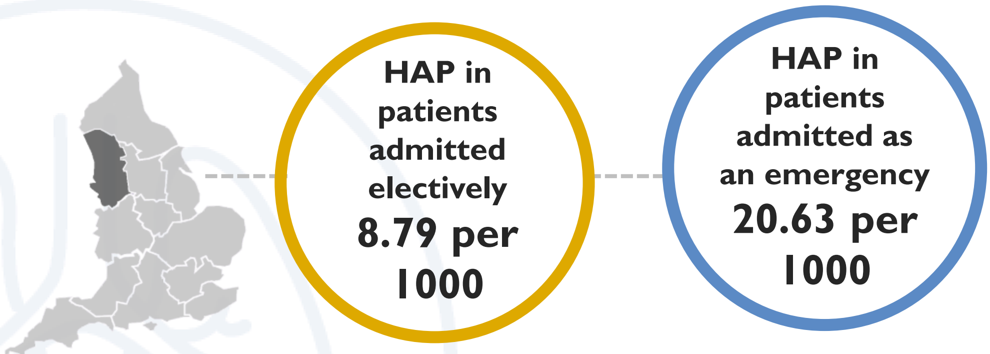
To better identify the initial cause of presentation to hospital, first episode primary diagnosis was used instead of spell primary diagnosis. Where this was not available, the earliest available primary diagnosis was used. 21,259 cases with no episode-level primary diagnosis present were excluded, leaving 660,432 cases which were analysed for number and rate of HAP per 1000 discharges as follows:

1. ICD-10 chapter of earliest available primary episode diagnosis code, all codes included
2. ICD-10 chapter of earliest available primary episode diagnosis code, primary diagnosis of pneumonia (n = 29,886) excluded.

Findings

HAP incidence

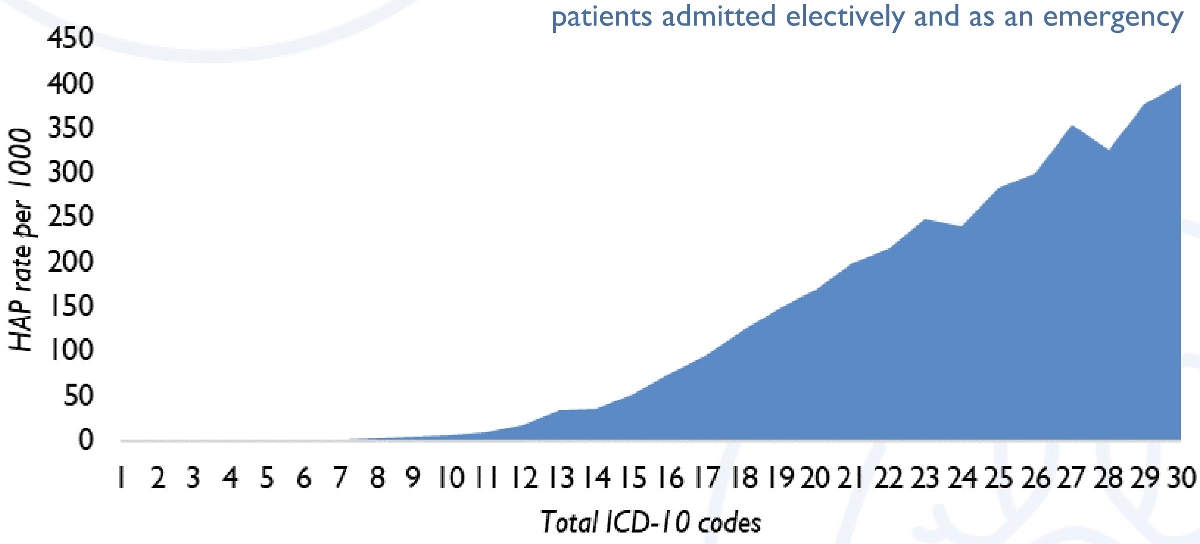
HAP was recorded in **996** of **113,264** patients admitted electively and in **14,070** of **681,897** patients admitted as an emergency.



HAP and multimorbidity

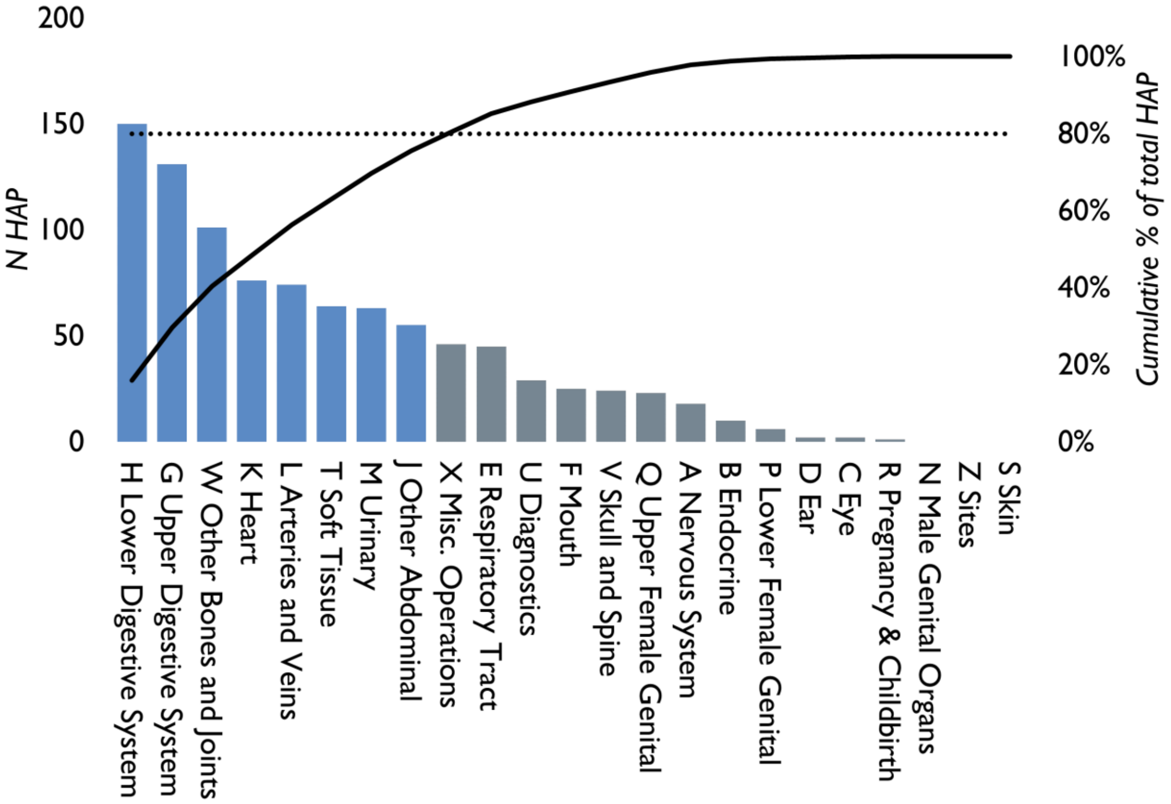
Our analysis shows a clear linear relationship between the number of coded co-morbidities patients have, and HAP incidence; the higher the number of co-morbidities, the higher the incidence risk of HAP, both in patients admitted electively and as an emergency.

April 2022 – March 2023 discharges, patients admitted electively and as an emergency



Elective procedures and HAP incidence

The incidence of HAP in elective admissions is considerably lower than that in the emergency hospital admission population in the North West. The Pareto chart below shows the categories of elective admission and associated HAP incidence in ranked order, along with a cumulative percentage; over 80% of elective HAP cases occur in the 8 procedure types with the greatest number of cases overall. Upper and lower digestive system procedures showed the highest amount of HAP.



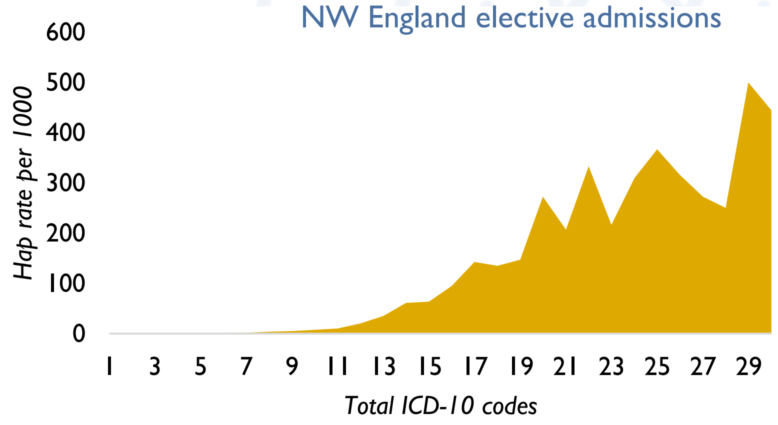
The x axis labels on this chart have been shortened for better display. A full list of OPCS categories is presented in appendix A.

The greatest number of HAP cases occurred in lower digestive system procedures, at **150** in total during the study period**.** Upper digestive system procedures had the highest HAP incidence of **34.5 per 1000** discharges, as shown in the table below.

Category of procedure	Total	HAP (n)	HAP per 1000
G Upper Digestive System	3793	131	34.5
H Lower Digestive System	6919	150	21.7
K Heart	3572	76	21.3
L Arteries and Veins	3484	74	21.2
F Mouth	1632	25	15.3
E Respiratory Tract	3341	45	13.5
T Soft Tissue	5745	64	11.1
V Bones and Joints of Skull and Spine	2158	24	11.1
A Nervous System	1679	18	10.7
J Other Abdominal Organs, Principally Digestive	5192	55	10.6
U Diagnostic Imaging, Testing and Rehabilitation	3126	29	9.3
X Miscellaneous Operations	6923	46	6.6
M Urinary	10860	63	5.8
W Other Bones and Joints	19106	101	5.3
P Lower Female Genital Tract	1142	6	5.3
D Ear	415	2	4.8
Q Upper Female Genital Tract	5577	23	4.1
B Endocrine System and Breast	4558	10	2.2
C Eye	1788	2	1.1
R Female Genital Tract Associated with Pregnancy, Childbirth and the Puerperium	3076	1	0.3
S Skin	1882	0	0.0
N Male Genital Organs	512	0	0.0

These figures show considerable variation in HAP incidence between procedure category; other bone and joint procedures have a considerably lower rate of HAP than heart for example, but a greater number of procedures are carried out.

When looking at comorbidities, elective admissions show a similar trend towards higher HAP incidence as diagnoses increase; however, there is wider variation.



Our analysis explored the breakdown of HAP cases in the three elective procedure groups with the highest incidence of HAP; upper and lower digestive and heart procedures. Care must be taken in interpreting these figures due to the small number of procedures in some categories; however there are considerable differences in HAP rates, with some commonly done procedures having no cases of HAP and others with much higher incidence. The tables below show a breakdown of rates for the most commonly performed procedures in each group.

Lower digestive system procedures (> 200 in the year)	**Total**	**HAP (n)**	**HAP per 1000**
H07.2 Right hemicolectomy and side to side anastomosis of ileum to transverse colon	570	25	43.9
H22.9 Unspecified diagnostic endoscopic examination of colon	537	0	0.0
H33.3 Anterior resection of rectum and anastomosis of colon to rectum using staples	457	20	43.8
H22.1 Diagnostic fibreoptic endoscopic examination of colon and biopsy of lesion of colon	387	0	0.0
H20.1 Fibreoptic endoscopic snare resection of lesion of colon	369	0	0.0
H33.6 Anterior resection of rectum and exteriorisation of bowel	252	10	39.7
H25.9 Unspecified diagnostic endoscopic examination of lower bowel using fibreoptic sigmoidoscope	244	0	0.0
H15.1 Loop colostomy	214	5	23.4
H33.1 Abdominoperineal excision of rectum and end colostomy	210	9	42.9
H20.7 Fibreoptic endoscopic mucosal resection of lesion of colon	201	0	0.0

Upper digestive system procedures (>100 in the year)	**Total**	**HAP (n)**	**HAP per 1000**
G45.1 Fibreoptic endoscopic examination of upper gastrointestinal tract and biopsy of lesion of upper gastrointestinal tract	757	1	1.3
G75.3 Closure of ileostomy	368	6	16.3
G45.9 Unspecified diagnostic fibreoptic endoscopic examination of upper gastrointestinal tract	349	2	5.7
G44.5 Fibreoptic endoscopic percutaneous insertion of gastrostomy	226	2	8.8
G23.4 Repair of diaphragmatic hernia using abdominal approach NEC	146	8	54.8
G24.3 Antireflux fundoplication using abdominal approach	142	0	0.0
G01.1 Oesophagogastrectomy and anastomosis of oesophagus to stomach	137	54	394.2
G34.2 Creation of temporary gastrostomy	129	2	15.5
G44.1 Fibreoptic endoscopic insertion of prosthesis into upper gastrointestinal tract	108	1	9.3

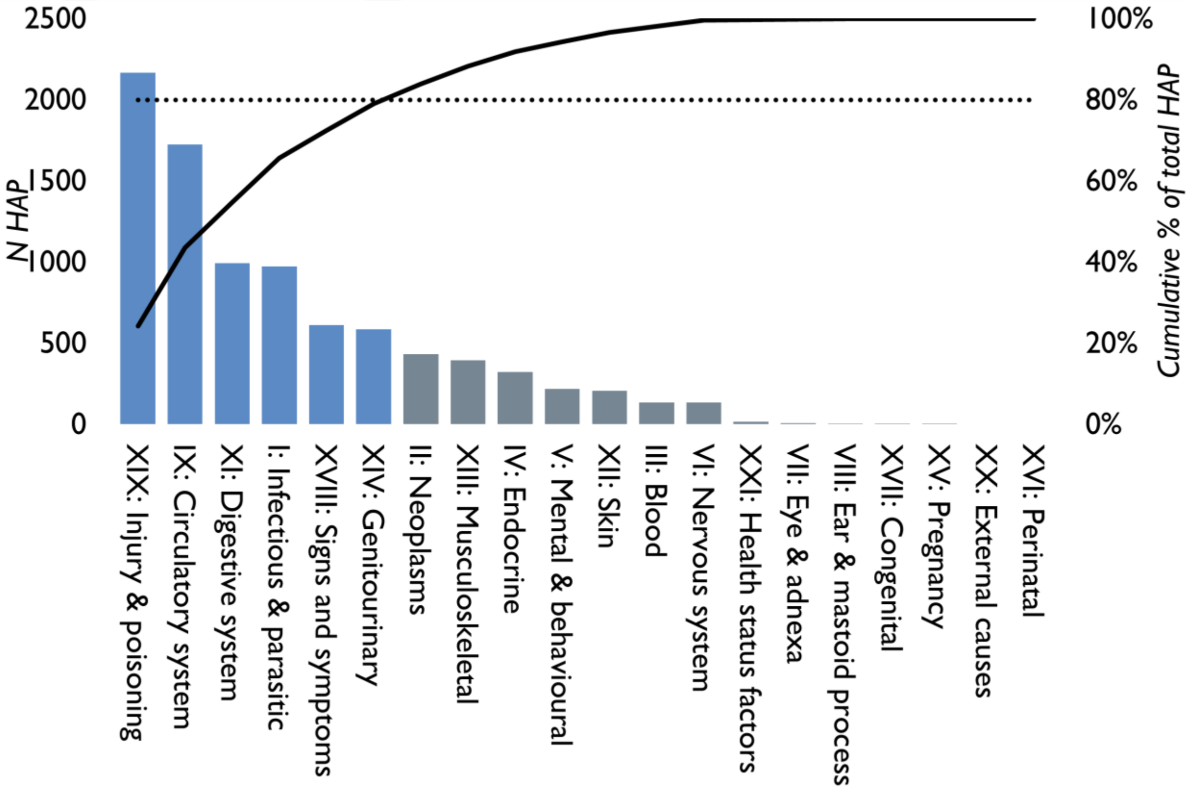
Heart procedures (>100 in the year)	**Total**	**HAP (n)**	**HAP per 1000**
K45.3 Anastomosis of mammary artery to left anterior descending coronary artery	556	31	55.8
K75.1 Percutaneous transluminal balloon angioplasty and insertion of 1-2 drug-eluting stents into coronary artery	472	0	0.0
K26.2 Xenograft replacement of aortic valve	424	17	40.1
K63.4 Coronary arteriography using two catheters	256	2	7.8
K62.1 Percutaneous transluminal ablation of pulmonary vein to left atrium conducting system	250	0	0.0
K60.6 Implantation of intravenous dual chamber cardiac pacemaker system	184	2	10.9
K57.4 Percutaneous transluminal ablation of accessory pathway	103	0	0.0

Emergency admissions and HAP incidence

A greater proportion of HAP cases develop in people admitted as an emergency compared to planned admissions, and again there is variation between HAP incidence and the primary diagnosis. In this analysis, the earliest primary diagnosis is a proxy for admission reason. The table below shows the greatest HAP incidence rate per 1000 discharges by ICD-10 chapter, in other words patients' main reason for hospital admission. Neoplasms showed the highest rate of HAP, at **34.6 per 1000** discharges, indicating patients acutely admitted for reasons related to cancer had the highest incidence of HAP.

Chapter of earliest primary diagnosis, i.e. admission reason	Total	HAP (n)	HAP per 1000
Neoplasms	12514	433	34.6
Certain infectious and parasitic diseases	31096	974	31.3
Injury, poisoning and certain other consequences of external causes	75919	2166	28.5
Diseases of the circulatory system	76494	1724	22.5
Diseases of the respiratory system	54998	979	17.8
Endocrine, nutritional and metabolic diseases	19112	322	16.8
Mental and behavioural disorders	13698	218	15.9
Diseases of the digestive system	67823	994	14.7
Congenital malformations, deformations and chromosomal abnormalities	282	4	14.2
Diseases of the genitourinary system	43015	584	13.6
Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	10832	135	12.5
Diseases of the musculoskeletal system and connective tissue	35696	394	11.0
Diseases of the skin and subcutaneous tissue	21887	206	9.4
Diseases of the nervous system	14241	133	9.3
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	114631	610	5.3
Factors influencing health status and contact with health services	4364	16	3.7
Diseases of the eye and adnexa	3157	8	2.5
Diseases of the ear and mastoid process	2931	5	1.7
Pregnancy, childbirth and the puerperium	18707	2	0.1

The Pareto chart below shows the categories of emergency admission and associated HAP incidence in ranked order, along with a cumulative percentage. As with elective admissions, over 80% of elective HAP cases occur in procedure types with the greatest number of cases overall; in this case, the first 6, with injury, poisoning and consequences of external causes having the highest incidence, closely followed by diseases of the circulatory system.



The x axis labels on this chart have been shortened for better display. A full list of ICD-10 chapters is presented in appendix B.

Conclusions

HAP and multimorbidity

Our analysis suggests that HAP is closely associated with increasing multimorbidity and this merits further exploration to derive methods of risk stratification. Preventative interventions could be targeted at higher risk, more co-morbid patients.

Elective admissions

We found wide variations in the incidence of HAP between different broad categories of surgical procedure. Patients admitted for urinary procedures had 6 times fewer episodes of HAP than those admitted for upper GI procedures. Furthermore, we found that within those broad elective admission categories there is further wide variation in the risk of HAP between procedures. For example, some lower GI operations account for two or three times as many cases of HAP as others. These insights could facilitate carefully targeted prevention and education strategies in areas where the most impact can be made, for example in right hemicolectomy operations or anterior resections of the rectum. For these frequently carried out procedures HAP incidence was disproportionately high, with respective incidences of 43.9 and 43.8 cases per 1000 discharges.

However, there are weaknesses to this analysis. The observed variation in HAP incidence between procedure category and between individual procedures merits further investigation to explore whether or not this could be due to variation in length of stay. Some procedures associated with high rates of HAP, for example heart and lower GI surgery, are those with long average lengths of hospital stay. In comparison, the lower incidence of HAP in hip or knee replacement, may be a result of relatively shorter lengths of stay; data from the AQ hip and knee replacement programme show that the average length of stay for these procedures is now 2 days. HAP is likely subject to time-dependent bias such that the longer a patient is in hospital the greater their risk of experiencing an episode of HAP. Our future work will seek to investigate this and adjust our estimates of HAP risk by taking into account time-dependent bias.

Emergency admissions

We observed the highest HAP incidence rates among patients admitted acutely as a result of cancer. Patients with cancer have varying degrees of immune suppression and other factors such as medication and mobility issues which may explain their particularly high risk. Understanding these factors may help inform improvements in models of care which could prevent some HAP episodes. Moreover, raising awareness of the risks associated with admission to hospital may be important for some patients and families when considering place of care.

Conditions associated with over 80% of all HAP cases in emergency admissions were injury and poisoning, diseases of the circulatory, digestive and genitourinary systems and infectious and parasitic diseases. This indicates a possible opportunity to design targeted prevention care bundles and quality improvement interventions at these specific patient groups. Further analysis is warranted of the specific diagnoses within these broad categories, in addition to identifying if there is variation within each category of primary diagnosis. A large proportion of cases also occurred in patients coded as having signs and symptoms not elsewhere classified. These codes are used when a diagnosis has not been assigned or a cause has not been found.

In addition to patient related factors such as comorbidities, there will likely be external factors which influence the risk of HAP; for example, the implementation of infection prevention and control procedures, single rooms versus shared bays, antibiotic policy and seasonal factors such winter flu epidemics. Future risk prediction tools and prevention strategies will need to take into account the dominant factors influencing risk and we plan to conduct the studies required to model these effects.

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Appendix A: OPCS categories

A Nervous System
B Endocrine System and Breast
C Eye
D Ear
E Respiratory Tract
F Mouth
G Upper Digestive System
H Lower Digestive System
J Other Abdominal Organs, Principally Digestive
K Heart
L Arteries and Veins
M Urinary
N Male Genital Organs
P Lower Female Genital Tract
Q Upper Female Genital Tract
R Female Genital Tract Associated with Pregnancy, Childbirth and the Puerperium
S Skin
T Soft Tissue
U Diagnostic Imaging, Testing and Rehabilitation
V Bones and Joints of Skull and Spine
W Other Bones and Joints
X Miscellaneous Operations
Y Subsidiary Classification of Methods of Operation
Z Subsidiary Classification of Sites of Operation.

Appendix B: ICD-10 chapters

I: Certain infectious and parasitic diseases
II: Neoplasms
III: Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism
IV: Endocrine, nutritional and metabolic diseases
IX: Diseases of the circulatory system
V: Mental and behavioural disorders
VI: Diseases of the nervous system
VII: Diseases of the eye and adnexa
VIII: Diseases of the ear and mastoid process
X: Diseases of the respiratory system
XI: Diseases of the digestive system
XII: Diseases of the skin and subcutaneous tissue
XIII: Diseases of the musculoskeletal system and connective tissue
XIV: Diseases of the genitourinary system
XIX: Injury, poisoning and certain other consequences of external causes
XV: Pregnancy, childbirth and the puerperium
XVI: Certain conditions originating in the perinatal period
XVII: Congenital malformations, deformations and chromosomal abnormalities
XVIII: Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified
XX: External causes of morbidity and mortality
XXI: Factors influencing health status and contact with health services
XXII: Codes for special purposes

Hospital acquired pneumonia and comorbidity

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