Royal College of Physicians | NACAP

National Asthma and Chronic Obstructive Pulmonary Disease Audit Programme (NACAP)

Outcomes of patients included in the 2017/18 COPD clinical audit

(patients with COPD exacerbations discharged from acute hospitals in England and Wales between September 2017 and September 2018)

Audit report

Published July 2020

In association with:

ARNS

asthma UK and British Lung Foundation Partnership

British Thoracic Society

Imperial College London

PCRS

RCGP Royal College of General Practitioners

Commissioned by:

HQIP Healthcare Quality Improvement Partnership

The Royal College of Physicians

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National Asthma and Chronic Obstructive Pulmonary Disease (COPD) Audit Programme

NACAP is a programme of work that aims to improve the quality of care, services and clinical outcomes for patients with asthma and COPD in England, Scotland and Wales. Spanning the entire patient care pathway, NACAP includes strong collaboration with asthma and COPD patients, as well as healthcare professionals, and aspires to set out a vision for a service which puts patient needs first. To find out more about the NACAP visit: www.rcplondon.ac.uk/nacap.

COPD: Outcomes of patients included in the 2017/18 COPD clinical audit

This report was prepared by the following people, on behalf of the COPD advisory group (the full list of members can be found on the NACAP resources page here: www.rcplondon.ac.uk/nacap-resources.

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Document purpose

Document purpose	To disseminate the outcomes of patients included in the clinical audit of COPD exacerbations discharged from acute hospitals in England and Wales between 14 September 2017 and 30 September 2018. To contribute to the overarching quality improvement (QI) objectives of the NACAP and to empower stakeholders to use audit data to facilitate improvements in the quality of care.
Title	Outcomes of patients included in the 2017/18 COPD clinical audit.
Authors	Hurst J, Shanahan L, Imoedemhe E, Andrews R, Moussaif M, Adamson A, Quint J, Roberts CM. National Asthma and Chronic Obstructive Pulmonary Disease Audit Programme (NACAP), Royal College of Physicians
Publication date	June 2020
Audience	Healthcare professionals; NHS managers, chief executives and board members; service commissioners; policymakers and voluntary organisations.
Description	This outcomes report describes findings from linkage of the 2017/18 audit patient cohort (patients discharged from hospital between 14 September 2017 and 30 September 2018) with the following datasets: Hospital Episode Statistics (HES) for Admitted Patient Care (APC), NHS Wales Informatics Service (NWIS) Patient Episode Database for Wales (PEDW) and Office for National Statistics (ONS). This has allowed derivation of 30- and 90-day readmission and mortality rates. It is intended to be read as an addendum to the clinical report, *COPD clinical audit 2017/18*, published in May 2019, which is available at www.rcplondon.ac.uk/copd-2017-18. Together, these reports provide a comprehensive picture of the care provided to patients admitted to hospital for an exacerbation of COPD during this time and what happened after they were discharged. The report is designed to provide readers with a basis for identifying areas that need change and to facilitate the development of improvement programmes that are relevant not only to secondary care providers but also to commissioners and policymakers. There is no scheduled review date for the report.
Supersedes	Hurst J, Stone RA, McMillan V, Mortier K, Shanahan L, Moussaif M, Stone P, Quint J, Roberts CM. *National Asthma and Chronic Obstructive Pulmonary Disease Audit Programme (NACAP). Outcomes of patients included in the 2017 COPD clinical audit (patients with COPD exacerbations discharged from acute hospitals in England and Wales between February and September 2017).* Audit report. London: RCP, 2019.
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Report at a glance

Mortality

Mortality within **30 days** of index admission was

Mortality within **90 days** of index admission was

The most common cause of mortality within both 30 and 90 days was **COPD**.

Readmissions

of patients were readmitted **at least once within 30 days**

of patients were readmitted **at least once within 90 days**

Although COPD was the most common cause for readmission, it **accounted for less than half of all readmissions**

COPD Pneumonia

Foreword by John Hurst, COPD audit clinical lead

It is a pleasure to introduce this report examining 30- and 90-day outcomes for the cohort of people admitted to hospital with a COPD exacerbation and audited between September 2017 and September 2018. It should be read in conjunction with the clinical audit 2017/18 report, published in May 2019, which reported in-hospital care and outcomes[7]. While the NACAP COPD secondary care audit focuses on care delivered in hospital for the acute event, what happens after people go home from hospital is of utmost importance to patients. The report is based on data from over 53,000 index admissions. Dividing the number of cases entered by the number coded in Hospital Episode Statistics (HES) and Patient Episode Database for Wales (PEDW) suggests the audit examines the outcomes for just over 54% of patients admitted. This is a large sample, though we cannot know if the results are representative of the whole cohort.

Mortality at 30 and 90 days, running at 6.3% and 12% nationally (England and Wales), are similar to the previous reporting period. As are national 30- and 90-day readmission rates at 23.9% and 43.2% respectively. Older people, men, those of highest socio-economic status, those with multimorbidity, those admitted for longer and those requiring non-invasive ventilation (NIV) during admission were all at higher risk of death. These factors will be challenging to modify. Similar outcomes were seen in relation to risk of re-admission, although here the relationship with deprivation is reversed such that greater deprivation was associated with greater risk of re-admission. The utility of this report is in benchmarking mortality and admission rates between units because, within these average figures, there remains significant and often unexplained variation in outcomes. What can you do locally to facilitate better outcomes? Are your services sufficiently joined up across secondary, community and primary care providers? Are services holistic in optimisation of the comorbidities which drive many of the readmissions?

Only through holistic, person-centred joined-up care can we hope to improve outcomes, bringing the poorest performing units closer to the best, while encouraging the best to be better still. It's all our responsibility. Our patients deserve it.

Recommendations

For providers of exacerbation care

1. Embed the COPD audit into everyday practice and use real-time data feedback to implement local QI initiatives to address readmission rates.
2. Apply evidence-based interventions to treat and prevent COPD exacerbations in a timely manner in order to impact positively on outcomes.[a]
3. Record all comorbid conditions in people admitted with an exacerbation of COPD and ensure the management plan optimises treatment not just of COPD but of all other relevant conditions.

For commissioners/health boards/sustainability and transformation partnerships (STPs) and integrated care systems (ICSs)

1. Ensure every hospital has a regular multidisciplinary meeting between the inpatient respiratory team and those providing COPD services in the community to ensure seamless care in the transition from hospital to home.

For primary care

1. Recognise that the time following discharge from hospital following an exacerbation of COPD is one of high risk for readmission. Therefore, ensure review of patients within 2 weeks post-discharge period to identify risks for readmissions.[10]
2. Ensure annual review templates include documentation of prior exacerbation history which is the best guide to future exacerbation risk, and a focus on multimorbidity.

[a] To avoid duplication, this recommendation only appears once. However, it is particularly relevant across the spectrum of providers and commissioners, including STPs, ICSs and primary care. We feel that commissioners, STPs and ICSs are best placed to plan systems that support organisations to work together to support patients with multimorbidity.

Section 1:
Mortality after index admission

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Key findings

Please note that the key findings below relate to national results (combined England and Wales data). Tables in section 1.1 provide results for England and Wales specifically.

- Mortality within 30 days of index admission was 6.3%.
- Mortality within 90 days of index admission was 12.0%.
- The most common cause of mortality within both 30 and 90 days of the index admission was J44[b]: Other chronic obstructive pulmonary disease (30 days: 65.6%; 90 days: 60.2%).

Demographics

- Females were 11% less likely to die within 30 days of admission (AOR[c]: 0.89 [95% CI[d]: 0.82 – 0.95]) and 15% less likely to die within 90 days of admission (AOR: 0.85 [95% CI: 0.81 – 0.90]).
- Older patients were more likely to die within both 30 and 90 days of admission.
  - Patients aged 85 or older were nearly two and a half times more likely to die within 30 days (AOR: 2.40 [95% CI: 2.16 – 2.67]) and just over twice as likely to die within 90 days (AOR: 2.22 [95% CI: 2.05 – 2.41]) of admission than those aged 65–74.
- The relationship between socioeconomic status and mortality is unclear, with confidence intervals for adjusted odds ratios containing 1 for 30-day and/or 90-day mortality for IMD quintiles 2-4. However, patients in the highest (5th) economic quintile, and therefore the least deprived, were more likely to die within 30 days and 90 days of index admission than those patients in the lowest (1st) quintile (AOR for 30-day mortality: 1.19 [95% CI: 1.05 – 1.35], AOR for 90-day mortality: 1.12 [95% CI: 1.01 – 1.23]).

Comorbidities

- Patients with more comorbidities were more likely to die within both 30 and 90 days of admission.
  - Patients with a Charlson comorbidity index (CCI)[11] of 7 or more were just over five times more likely to die within both 30 and 90 days of admission than a patient with no comorbidities (AOR: 5.07 [95% CI: 4.26 – 6.04] and AOR: 5.91 [95% CI: 5.11 – 6.83] respectively).

Length of stay

- Patients admitted to hospital for longer than 4 days (the median length of stay) were 41% more likely to die within 30 days of admission (AOR: 1.41 [95% CI: 1.30 – 1.52]) and 73% more likely to die within 90 days of admission (AOR: 1.73 [95% CI: 1.63 – 1.83]) than those admitted for 4 days or less.

Non-invasive ventilation

- Patients who received NIV during admission were just over three and a half times more likely to die within 30 days (AOR: 3.55 [95% CI: 3.23 – 3.90]) and more than two and a half times more likely to die within 90 days of admission (AOR: 2.68 [95% CI: 2.48 – 2.90]) than those who did not receive NIV.

[b] International Classification of Diseases, tenth revision (ICD-10) code
[c] Adjusted odds ratio
[d] Confidence interval

1.1 Mortality within 30/90 days of index admission

1.1.1 Mortality within 30/90 days: percentage mortality historical comparison

	2017/18			2017
Mortality	England (N=51,352)	Wales (N=2,013)	All (N=53,365)	All (N=30,294)
Within 30 days of index admission	3,249 (6.3%)	130 (6.5%)	3,379 (6.3%)	1,832 (6.1%)
Within 90 days of index admission	6,148 (12.0%)	241 (12.0%)	6,389 (12.0%)	3,426 (11.3%)

1.1.2 Mortality within 30 days of index admission: by top five causes

2017/18 (N=53,365)					
Mortality <30 days of index admission Top five causes of mortality (ICD-10 code)					
	England (N=3,249)		Wales (N=130)		All (N=3,379)
J44	2,131 (65.6%)	J44	87 (66.9%)	J44	2,218 (65.6%)
C34	215 (6.6%)	C34	5 (3.8%)	C34	220 (6.5%)
I25	92 (2.8%)	I25	4 (3.1%)	I25	96 (2.8%)
J18	59 (1.8%)	I21	3 (2.3%)	I21	61 (1.8%)
I21	58 (1.8%)	K56	3 (2.3%)	J18	61 (1.8%)

J44: Other chronic obstructive pulmonary disease; C34: Malignant neoplasm of bronchus and lung; I25: Chronic ischaemic heart disease; I21: Acute myocardial infarction; J18: Pneumonia, unspecified organism; K56: Paralytic ileus and intestinal obstruction without hernia

1.1.3 Mortality within 90 days of index admission: by top five causes

2017/18 (N=53,365)					
Mortality <90 days of index admission Top five causes of mortality (ICD-10 code)					
	England (N=6,148)		Wales (N=241)		All (N=6,389)
J44	3,697 (60.1%)	J44	87 (66.9%)	J44	3,846 (60.2%)
C34	462 (7.5%)	C34	5 (3.8%)	C34	480 (7.5%)
I25	230 (3.7%)	I25	4 (3.1%)	I25	243 (3.8%)
I21	118 (1.9%)	J18	3 (2.3%)	I21	122 (1.9%)
J18	100 (1.6%)	K56	3 (2.3%)	J18	106 (1.7%)

J44: Other chronic obstructive pulmonary disease; C34: Malignant neoplasm of bronchus and lung; I25: Chronic ischaemic heart disease; I21: Acute myocardial infarction; J18: Pneumonia, unspecified organism; K56: Paralytic ileus and intestinal obstruction without hernia

1.2 Mortality within 30 days: by variable

An odds ratio (OR) is a measure of association between an exposure and an outcome. The OR represents the odds that an outcome will occur given a particular exposure, compared with the odds of the outcome occurring in the absence of that exposure. For example, an odds ratio of 0.75 means that in that particular group the outcome is 25% less likely to occur. An odds ratio of 1.33 means that in that particular group the outcome is 33% more likely to occur.

An adjusted odds ratio takes into account the effect due to other variables included in the analysis; ie it helps to account for confounding.

Odds ratios have not been broken down by England and Wales specifically, as with the other tables in this report. Small numbers, particularly for Wales, mean that these would be accompanied by a high degree of uncertainty and that inaccurate messages could potentially be drawn from them. It was additionally felt that enough could be gleaned from the national (All) odds ratios data, from a national and country specific level, to warrant this exclusion.

1.2.1 Mortality within 30 days: by variable (England and Wales)

	2017/18			
Variable	**Odds ratio (OR)**	**95% confidence interval (CI)**	**Adjusted odds ratio (AOR)[e]**	**95% confidence interval (CI)**
Gender				
Female	0.87	0.82 to 0.94	0.89	0.82 to 0.95
Quintile of Index of Multiple Deprivation, England (IMD)[1]/ Welsh Index of Multiple Deprivation (WIMD)[2]				
1 (most deprived)	**1**	-	**1**	-
2	1.15	1.04 to 1.27	1.06	0.96 to 1.18
3	1.30	1.16 to 1.44	1.12	1.00 to 1.25
4	1.23	1.10 to 1.38	1.04	0.92 to 1.17
5 (least deprived)	1.45	1.28 to 1.65	1.19	1.05 to 1.35
Age				
35–44	0.33	0.16 to 0.66	0.40	0.20 to 0.80
45–54	0.35	0.26 to 0.46	0.40	0.30 to 0.54
55–64	0.67	0.59 to 0.76	0.69	0.61 to 0.80
65–74	**1**	-	**1**	-
75–84	1.50	1.38 to 1.64	1.46	1.33 to 1.60
85+	2.45	2.21 to 2.70	2.40	2.16 to 2.67
Charlson comorbidity index (CCI)				
0-1	**1**	-	**1**	-
2	1.49	1.36 to 1.64	1.31	1.19 to 1.44
3	1.76	1.58 to 1.96	1.43	1.29 to 1.60
4	2.12	1.87 to 2.40	1.61	1.42 to 1.84
5	2.56	2.18 to 3.00	1.89	1.60 to 2.23
6	2.74	2.17 to 3.47	1.95	1.52 to 2.49
7+	5.85	4.95 to 6.91	5.07	4.26 to 6.04
Length of stay				
>4 days	1.96	1.83 to 2.11	1.41	1.30 to 1.52
Non-invasive ventilation (NIV)				
Patient received NIV	3.35	3.07 to 3.66	3.55	3.23 to 3.90

[e] Mutually adjusted for all variables shown in table.

1.3 Mortality within 90 days: by variable (England and Wales)

	2017/18			
Variable	**Odds ratio (OR)**	**95% confidence interval (CI)**	**Adjusted odds ratio (AOR)[f]**	**95% confidence interval (CI)**
Gender				
Female	0.85	0.80 to 0.89	0.85	0.81 to 0.90
Quintile of Index of Multiple Deprivation, England (IMD)[3]/ Welsh Index of Multiple Deprivation (WIMD)[4]				
1 (most deprived)	**1**	-	**1**	-
2	1.13	1.05 to 1.21	1.04	0.96 to 1.12
3	1.22	1.13 to 1.32	1.05	0.97 to 1.15
4	1.20	1.10 to 1.30	1.00	0.92 to 1.10
5 (least deprived)	1.37	1.25 to 1.50	1.12	1.01 to 1.23
Age				
35–44	0.32	0.19 to 0.52	0.39	0.23 to 0.65
45–54	0.35	0.29 to 0.43	0.42	0.35 to 0.51
55–64	0.62	0.56 to 0.68	0.64	0.58 to 0.71
65–74	**1**	-	**1**	-
75–84	1.48	1.39 to 1.58	1.42	1.33 to 1.52
85+	2.34	2.17 to 2.53	2.22	2.05 to 2.41
Charlson comorbidity index (CCI)				
0-1	**1**	-	**1**	-
2	1.47	1.38 to 1.58	1.28	1.20 to 1.38
3	1.85	1.71 to 2.01	1.49	1.37 to 1.62
4	2.25	2.05 to 2.48	1.69	1.53 to 1.86
5	2.57	2.27 to 2.91	1.84	1.62 to 2.09
6	2.74	2.28 to 3.30	1.89	1.55 to 2.29
7+	6.87	5.98 to 7.89	5.91	5.11 to 6.83
Length of stay				
>4 days	2.24	2.12 to 2.36	1.73	1.63 to 1.83
Non-invasive ventilation (NIV)				
Patient received NIV	2.68	2.50 to 2.89	2.68	2.48 to 2.90

[f] Mutually adjusted for all variables shown in table.

Section 2:
Readmissions after index discharge

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Key findings

Please note that the key findings below relate to national results (combined England and Wales data). Tables 2.1.1 – 2.1.4 provide results for England and Wales specifically.

- 23.9% of patients were readmitted at least once within 30 days and 43.2% of patients were readmitted at least once within 90 days of index discharge date.
- Although J44 (Other chronic obstructive pulmonary disease) was the most common cause for readmission, it accounted for less than half of all the readmissions within 30 days (39.5%) and 90 days (46.8%) of index discharge date.

Demographics

- The least deprived patients (5th quintile) were 11% less likely to be readmitted at both 30 and 90 days than the most deprived patients (1st quintile) (AOR: 0.89 [95% CI: 0.83 – 0.96] and AOR: 0.89 [95% CI: 0.83 – 0.95] respectively).

Comorbidities

- Patients with comorbidities were more likely to be readmitted within both 30 and 90 days of index discharge.
- Patients with a CCI of 7 or more were twice as likely to be readmitted within both 30 and 90 days of index discharge than a patient with no comorbidities (AOR: 1.97 [95% CI: 1.71 – 2.29] and AOR: 2.03 [95% CI: 1.77 – 2.34] respectively).

Length of stay

- Patients who were admitted to hospital for longer than 4 days (the median length of stay) were 20% more likely to be readmitted within both 30 and 90 days of index discharge (AOR: 1.21 [95% CI: 1.16 – 1.26] and AOR: 1.22 [95% CI: 1.17 – 1.27] respectively).

NIV

- After adjustment, patients who received NIV were 11% more likely to be readmitted within 30 days and 7% more likely to be readmitted within 90 days (AOR: 1.11 [95% CI: 1.03 – 1.19] and AOR: 1.07 [95% CI: 1.01 – 1.15] respectively).

2.1 Readmission within 30/90 days of index discharge date[g]

2.1.1 Number of admissions with readmissions within 30 days of index discharge date

	2017/18			2017
Number of readmissions within 30 days of index discharge	England (N=49,413)	Wales (N=1,937)	All (N=51,350)	All (N=30,294)
None	37,501 (75.9%)	1,560 (80.5%)	39,061 (76.1%)	22,786 (75.2%)
One	9,623 (19.5%)	321 (16.6%)	9,944 (19.4%)	5,926 (19.6%)
Two	1,893 (3.8%)	51 (2.6%)	1,944 (3.8%)	1,246 (4.1%)
Three or more	396 (0.8%)	5 (0.3%)	401 (0.8%)	336 (1.1%)

2.1.2 Top five reasons for all readmissions within 30 days of index discharge date

2017/18					
Top five reasons for readmissions within 30 days of index discharge (ICD-10 code)					
	England (N=15,187)		Wales (N=442)		All (N=15,629)
J44	5,971 (39.3%)	J44	202 (45.7%)	J44	6,173 (39.5%)
J18	2,039 (13.4%)	J18	68 (15.4%)	J18	2,107 (13.5%)
N18	406 (2.7%)	A41	11 (2.5%)	N18	406 (2.6%)
A41	296 (1.9%)	R06	9 (2.0%)	A41	307 (2.0%)
I50	269 (1.8%)	N17	8(1.8%)	I50	277 (1.8%)

J44: Other chronic obstructive pulmonary disease; J18: Pneumonia, unspecified organism; N18: Chronic kidney disease; A41: Other sepsis; I50: Heart failure; R06: Acute respiratory distress; N17: Acute kidney failure

2.1.3 Number of admissions with readmissions with 90 days of index discharge date

	2017/18			2017
Number of readmissions within 30 days of index discharge	England (N=49,413)	Wales (N=1,937)	All (N=51,350)	All (N=30,294)
None	27,881 (56.4%)	1,272 (65.7%)	29,153 (56.8%)	17,241 (56.9%)
One	12,644 (25.6%)	436 (22.5%)	13,080 (25.5%)	7,447 (24.6%)
Two	5,198 (10.5%)	154 (8.0%)	5,352 (10.4%)	3,140 (10.4%)
Three or more	3,690 (7.5%)	75 (3.9%)	3,765 (7.3%)	2,466 (8.1%)

[g] Only including patients that were alive at discharge. Same day readmissions have been excluded from the analysis.

2.1.4 Top five reasons for all readmissions within 90 days of index discharge date

2017/18					
Top five reasons for readmissions within 90 days of index discharge (ICD-10 code)					
	England (N=38,542)		Wales (N=1,016)		All (N=51,350)
J44	14,190 (36.8%)	**J44**	202 (45.7%)	**J44**	475 (46.8%)
J18	4,580 (11.9%)	**J18**	68 (15.4%)	**J18**	138 (13.6%)
N18	1,283 (3.3%)	**A41**	11 (2.5%)	**A41**	22 (2.2%)
I50	733 (1.9%)	**R06**	9 (2.0%)	**R06**	18 (1.8%)
A41	722 (1.9%)	**N17**	8(1.8%)	**I50**	17 (1.7%)

J44: Other chronic obstructive pulmonary disease; J18: Pneumonia, unspecified organism; N18: Chronic kidney disease; I50: Heart failure; A41: Other sepsis; R06: Acute respiratory distress

Fig 1. Kaplan-Meier: Time to first readmission – All

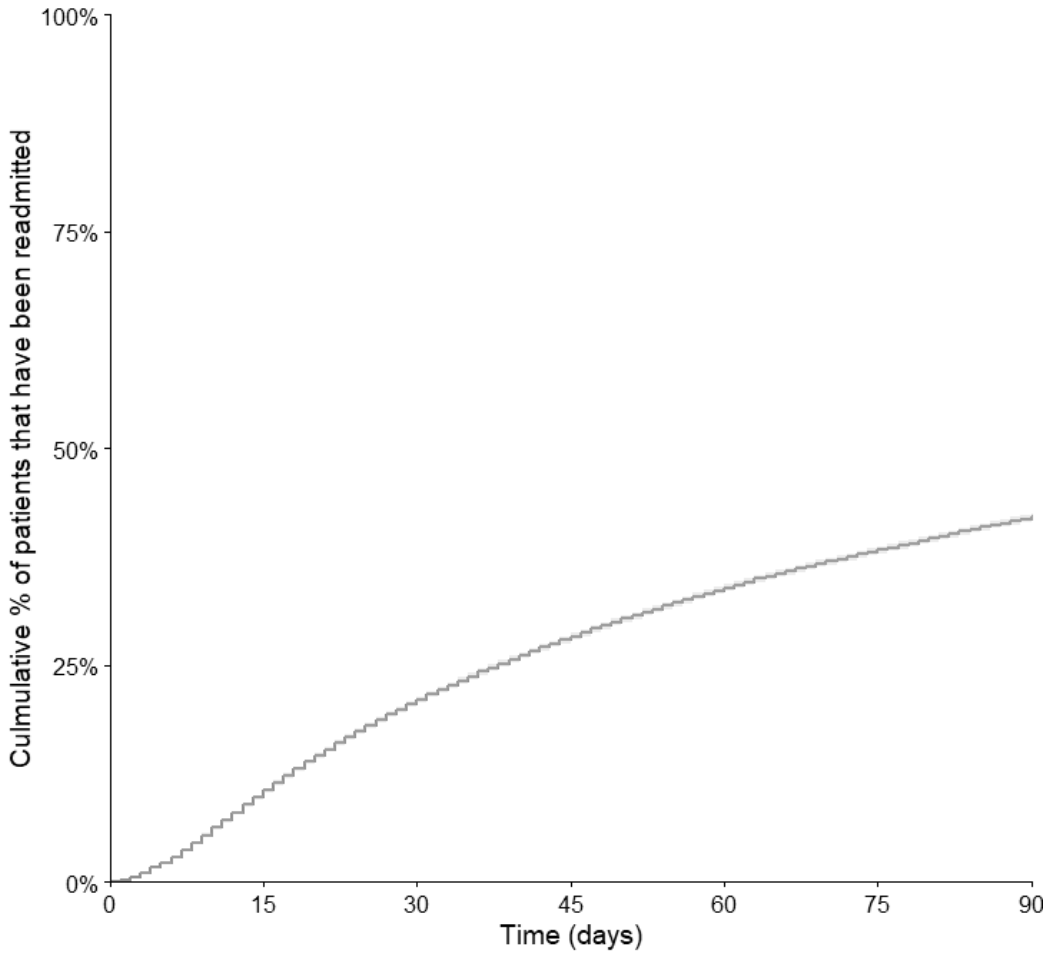

Figure 1. The Kaplan-Meier curve shows the proportion of the audit sample readmitted at 10-day intervals after their index admission discharge date. At 30 days after discharge, approximately 24.4% of the index admissions in the audit sample who were discharged alive had been readmitted to hospital. At 90 days after discharge, approximately 43.4% of the audit sample had been readmitted. It should be noted that median time to readmission cannot be established from this graph as not all patients will be readmitted.

2.1.5 Readmission within 30 days of discharge: by variable (England and Wales)

	2017/18			
Variable	**Odds ratio (OR)**	**95% confidence interval (CI)**	**Adjusted odds ratio (AOR)[h]**	**95% confidence interval (CI)**
Gender				
Female	0.91	0.87 to 0.95	0.93	0.90 to 0.97
Quintile of Index of Multiple Deprivation, England (IMD)[5]/ Welsh Index of Multiple Deprivation (WIMD)[6]				
1 (most deprived)	**1**	-	**1**	-
2	0.99	0.93 to 1.04	0.96	0.91 to 1.02
3	1.01	0.95 to 1.07	0.97	0.91 to 1.03
4	0.97	0.91 to 1.04	0.93	0.87 to 0.99
5 (least deprived)	0.94	0.87 to 1.01	0.89	0.83 to 0.96
Age				
35–44	0.83	0.66 to 1.04	0.90	0.71 to 1.13
45–54	0.77	0.70 to 0.85	0.84	0.76 to 0.93
55–64	0.84	0.78 to 0.89	0.87	0.82 to 0.93
65–74	**1**	-	**1**	-
75–84	1.07	1.02 to 1.13	1.03	0.97 to 1.08
85+	1.17	1.10 to 1.25	1.08	1.00 to 1.15
Charlson comorbidity index (CCI)				
0-1	**1**	-	**1**	-
2	1.23	1.17 to 1.29	1.18	1.12 to 1.25
3	1.51	1.42 to 1.60	1.42	1.34 to 1.52
4	1.59	1.47 to 1.72	1.48	1.36 to 1.60
5	1.81	1.63 to 2.01	1.65	1.48 to 1.84
6	2.06	1.76 to 2.42	1.88	1.60 to 2.22
7+	2.09	1.81 to 2.42	1.97	1.71 to 2.29
Length of stay				
>4 days	1.29	1.24 to 1.34	1.21	1.16 to 1.26
Non-invasive ventilation (NIV)				
Patient received NIV	1.15	1.07 to 1.24	1.11	1.03 to 1.19

[h] Mutually adjusted for all variables shown in table.

2.1.6 Readmission within 90 days of discharge: by variable (England and Wales)

	2017/18			
Variable	**Odds ratio (OR)**	**95% confidence interval (CI)**	**Adjusted odds ratio (AOR)[i]**	**95% confidence interval (CI)**
Gender				
Female	0.92	0.88 to 0.95	0.94	0.91 to 0.98
1 (most deprived)	**1**	-	**1**	-
2	0.96	0.92 to 1.01	0.94	0.89 to 0.99
3	0.99	0.94 to 1.04	0.95	0.90 to 1.00
4	0.94	0.89 to 1.00	0.90	0.85 to 0.95
5 (least deprived)	0.94	0.88 to 1.00	0.89	0.83 to 0.95
Age				
35–44	0.86	0.71 to 1.03	0.94	0.78 to 1.14
45–54	0.73	0.67 to 0.79	0.78	0.72 to 0.85
55–64	0.85	0.81 to 0.90	0.88	0.84 to 0.93
65–74	**1**	-	**1**	-
75–84	1.13	1.08 to 1.17	1.07	1.03 to 1.12
85+	1.16	1.09 to 1.23	1.05	0.99 to 1.12
Charlson comorbidity index (CCI)				
0-1	**1**	-	**1**	-
2	1.27	1.22 to 1.33	1.22	1.17 to 1.28
3	1.58	1.50 to 1.67	1.49	1.41 to 1.58
4	1.71	1.59 to 1.83	1.59	1.48 to 1.71
5	1.84	1.67 to 2.03	1.68	1.52 to 1.86
6	2.28	1.96 to 2.67	2.10	1.79 to 2.45
7+	2.16	1.88 to 2.48	2.03	1.77 to 2.34
Length of stay				
>4 days	1.29	1.25 to 1.34	1.22	1.17 to 1.27
Non-invasive ventilation (NIV)				
Patient received NIV	1.12	1.06 to 1.20	1.07	1.01 to 1.15

[i] Mutually adjusted for all variables shown in table.

Section 3: Case ascertainment

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Case ascertainment rates were calculated based on the number of records entered to the audit compared with data obtained from the Hospital Episode Statistics (HES) Admitted Patient Care (APC) dataset for England and the NHS Wales Informatics Service (NWIS) Patient Episode Database for Wales (PEDW). To see the latest figures and find out more about case ascertainment please visit: www.rcplondon.ac.uk/COPD-CA.

The total number of patients discharged from English and Welsh hospitals recorded by HES APC and NWIS PEDW datasets between 14 September 2017 and 30 September 2018 was 149,607. The total number of records submitted to the audit by English and Welsh hospitals during the same period was 72,933. The median case ascertainment rate for this period was 54% with an interquartile range of 33 – 68%. In England, the median case ascertainment rate for the period of 14 September 2017 and 30 September 2018 was 55% with an interquartile range of 35 – 68%. For Wales, the median case ascertainment rate for this period was 43% with an interquartile range of 16 – 67%.
Possible reasons why this figure is lower than may be expected include:

- Patients with COPD tend to be admitted across the hospital, rather than solely to respiratory wards. This can make local case identification challenging.
- The relatively short length of stay for these patients (4 days[7]) compounds challenges in case identification.
- The volume of admitted cases (over 140,000 per annum[8]) is high, which poses a considerable administrative and resource challenge for local teams to enter into the audit, assuming all cases could be identified locally.
- Local coding procedures, which can make retrospective case identification difficult, such as potential over-coding of COPD admissions (falsely reducing case ascertainment) due to the frequent overlap between respiratory tract infections (eg pneumonia) and COPD exacerbations.

All data presented in this report should be reviewed taking into account that 54% of cases reported by HES and PEDW have not been included in the audit. However, notwithstanding this, the large number of records included provide sufficient statistical power to ensure confidence in the data presented. There is also no evidence of any link between geography (areas of England and Wales) and low case ascertainment.

Appendix A: Methodology

Methodology of audit creation and setup

NACAP's COPD secondary care continuous clinical audit is built upon the learning from the 2014 snapshot clinical audit.[9] The structure of the dataset is similar to that used in 2014. However, it has been considerably streamlined to account for the change in methodology from snapshot (in 2014) to continuous audit, which commenced in February 2017. The first annual report since the start of continuous data collection presented the results of the cohort of patients discharged between 1 February and 13 September 2017. This can be found at: www.rcplondon.ac.uk/working-together. All hospitals in England and Wales that admit patients with exacerbations of COPD were eligible to participate in the audit (N=192). 182 hospitals (95%) participated in the period outlined above. A full list of participating hospitals can be found in the national report at: www.rcplondon.ac.uk/working-together.

Information governance (IG) and data storage, security and transfer

The audit operates under Section 251 approval from the Confidentiality Advisory Group (CAG) of the Health Research Authority (HRA). The reference number is CAG-8-06(b)/2013. This approval also grants the RCP permission to link audit data to externally held sources of data (using patient identifiable data items) for derivation of longer-term outcomes of the patient cohort. A record of the approval can be found at: www.hra.nhs.uk/about-the-hra/our-committees/section-251/cag-advice-and-approval-decisions (April 2013 onwards; non research).

To find out more about the audit's information governance, legal basis, or data storage, security and transfer arrangements please refer to the fair processing document, IG frequently asked questions (FAQs) and data flow diagram, all of which can be found on the audit resources page: www.rcplondon.ac.uk/nacap-copd-resources. In addition, a patient leaflet and poster are available to download from the same page.

Recruitment

The recruitment process for the continuous audit started in 2016. For further details of the recruitment methodology employed, please refer to appendix C of the data analysis and methodology component of the 2017 clinical audit report, which can be found at: www.rcplondon.ac.uk/working-together.

Audit question development and pilot

The audit dataset was based on the snapshot 2014 dataset. It was developed in 2016 iteratively by the audit programme team and clinical lead, in consultation with the workstream group. For further information on the piloting of the audit please refer to appendix C of the data analysis and methodology component of the 2017 clinical audit report at: www.rcplondon.ac.uk/working-together.

Data entry

Hospitals are required to enter data via the audit programme's bespoke web-tool, created by Crown Informatics Ltd (available at www.nacap.org.uk).

Guidance documentation to support participation in the audit such as the dataset with help notes, data collection sheets, audit technical guidance and frequently asked questions are available to download from both the web tool (www.nacap.org.uk) and the COPD audit resources webpage on the RCP website (www.rcplondon.ac.uk/nacap-copd-resources).

Data entry to the audit is regularly reviewed by the NACAP team. Where few records are entered (eg fewer than 50–100 a year, depending on the size of the hospital) or where there is a notable change in participation rates (eg a hospital that has entered 50% fewer records in the current 6 months than in the 6 months prior) the NACAP team communicate directly with the hospital to understand the reasons behind lack of participation and to provide support where possible. Regular email updates and newsletters are also sent to participants with reminders about data entry timelines.

Telephone and email support

The audit programme team at the RCP provide a helpdesk from 9am to 5pm every working day, which is available via both telephone and email, so that participants can contact the team directly with any questions.

Analysis methodology

Data transfer

The audit applied for linkage of audit data to outcome data sources via NHS Digital (application reference: DARS-NIC-349273-T3L4K-v3.7) and NHS Wales Informatics Service (NWIS) (application reference 29892).

Following this, a file containing a unique audit ID and necessary identifiable information (NHS number, date of birth and postcode) for the audit cohort (those discharged between 1 February and 13 September 2017) was sent to the Data Access Request Service (DARS) at NHS Digital and NHS Wales Informatics Service (NWIS) by Crown Informatics on 31 July 2018.

DARS NHS Digital and NWIS used these identifiers to provide records for people in the audit cohort from the Hospital Episode Statistics (HES) Admitted Patient Care (APC) dataset (NHS Digital) and the Patient Episode Database for Wales (PEDW) dataset (NWIS). DARS NHS Digital also provided Office for National Statistics (ONS) mortality data for all people within the cohort. Please note, NHS Digital upheld national opt-outs before providing the data.

Two linked datasets, one containing all requested HES and ONS records plus the unique audit ID, and one containing all requested PEDW records plus the unique audit ID, were sent securely to Crown Informatics by NWIS and NHS Digital.

The anonymised files containing non-identifiable patient data was then sent via secure file transfer to the statistical team at Imperial College London (National Heart and Lung Institute) where they were analysed.

Data cleaning

Data received by Imperial College London were imported into R for cleaning. The bulk of the cleaning of the clinical audit data is described in the secondary care clinical report methodology section. The clinical dataset contained 74,845 admissions. We arranged each patient's admissions by date, and retained only the first admission of patients aged 35 and over, to leave 54,166 index admissions to be linked with PEDW, HES and ONS data. A further 263 patients did not match any records in HES or PEDW during the required time frame and so were removed to leave 53,903 index admissions.

HES and PEDW data were prepared and cleaned as follows:

- Data received from HES contained 201,234 admitting episodes and 355,866 episodes in total. Data received from PEDW contained 6,643 admitting episodes and 10,947 episodes in total.
- The first episode of each admission was retained to provide data on the reason for admission and patient morbidity. Unlike PEDW admissions data, HES data provide discharge data (discharge date and type) only for the final episode, so this data was copied to the admitting episode. All other episodes were then dropped from the datasets.
- Admissions that occurred before 14 September 2017 and after 28 December 2018 were removed (HES N=852, PEDW N=166)
- Admissions for patient IDs that did not match patient IDs in the clinical dataset were removed (HES N=2,323, PEDW N=481)
- Discharge dates of 01/01/1800 or 01/01/1801 were recoded as missing (N=103).
- A new variable was created to indicate when an admission should be ignored as a readmission. Admissions should not be classed as a readmission when they occurred on the same day or the next day after discharge from an admission for which discharge was coded as 'hospital transfer' (HES N=1,981, PEDW N=213)
- HES and PEDW datasets were then combined.
- Duplicate admissions were removed (generally due to miscoding of an episode as an admission) (N=963)
- ICD-10 diagnosis codes were converted to 3-character ICD-10 codes.

HES and PEDW data were linked to the audit data as follows:

- Admissions in HES/PEDW were matched to those in the audit using the patient ID, admission date, and discharge date.
- 44,561 HES/PEDW admissions were matched exactly using patient ID, admission date, and discharge date (match type 1, best)
- 4,312 HES/PEDW admissions were matched on patient ID and admission date but not discharge date (match type 2)
- 4,275 HES/PEDW admissions were matched on patient ID and discharge date but not admission date (match type 3)
- 469 were matched on patient ID after allowing for a discrepancy of one day around the admission date and discharge date (match type 4, worst)
- Audit admissions that were matched by multiple HES/PEDW admissions retained the admission that was the best match. When multiple admissions were matched at the same match level, those with the earliest admission and discharge date were retained.
- 536 index audit admissions could not be linked and were dropped, leaving a total of 53,367 linked index admissions remaining in the dataset.

- HES/PEDW admission and discharge dates were used to calculate 30/90-day mortality/readmissions. 45 admissions were missing discharge dates in HES/PEDW so used those in the audit. One admission did not have a discharge date in the audit or HES/PEDW so was removed.

ONS death data were prepared, cleaned and linked as follows:

- 16,062 records were received from ONS, of which 12,383 occurred between 14 September and 28 December
- Cause of death ICD-10 code was converted to a 3-character ICD-10 code.
- 12,010 records were matched on patient ID to the clinical dataset.

Further cleaning of the matched dataset:

- HES/PEDW admissions before the index audit admission were removed to leave 157,878 admissions in the dataset.
- People with an ONS date of death before their index admission were removed (N=1)
- Readmissions that were due to hospital transfer were removed (N=1,555)
- Readmissions that occurred on the same day as discharge were removed (N=170)
- The final number of admissions in the dataset was 156,076, of which 53,365 were index admissions.
- Readmission in 30/90 days was defined as occurring <30/90 days since index admission.
- The number of readmissions following an index admission were counted for each patient and a binary flag was used to indicate whether they occurred within either 30 or 90 days of their index admission.

Data analysis

- Comorbidities were defined using the Charlson comorbidity index (CCI) (www.ncbi.nlm.nih.gov/pubmed/3558716)[11] using primary and all secondary diagnosis codes from the index admission. The 'comorbidity' package in R was used to calculate the CCI for the diagnosis codes of each index admission. When categorising CCI, the lowest category was taken as '0-1' rather than '0' as all patients are expected to have a diagnosis of COPD.
- Mixed effects logistic regression models were created using the R package 'lme4' to find odds of readmission or death by deprivation (quintiles of IMD/WIMD), age (35–44, 45–54, 55–64, 65–74, 75–84, 85+), CCI (0-1, 2, 3, 4, 5, 6, 7+), length of hospital stay (≤4 days, >4 days), receipt of NIV (yes, no). Adjusted models were mutually adjusted for all exposure variables.

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