National COPD Audit Programme



Pulmonary rehabilitation: Beyond breathing better

National Chronic Obstructive Pulmonary Disease (COPD) Audit Programme: Outcomes from the clinical audit of pulmonary rehabilitation services in England 2015

Results and data analysis December 2017

Prepared by:



Commissioned by:



Working in wider partnership with:





Association of Respiratory Nurse Specialists





Association for Respiratory Technology & Physiology





Imperial College London

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Introduction

The first national clinical audit of pulmonary rehabilitation (PR) services in England and Wales aimed to capture data for all patients with a primary respiratory diagnosis of COPD who were assessed (or, if not assessed, began PR) between 12 January and 10 April 2015. 7413 patient records were included.

Outcomes data, extracted automatically from Hospital Episode Statistics (HES) and the Office for National Statistics (ONS) in order to compute mortality and hospital admission within the 180-day period after the initial assessment, were available **for England only** (please see the methodology for more details). The outcomes report denominator is, therefore, 7135. This, in combination with data incompleteness and subgroup analyses, means that some tables of findings have different denominators. Therefore, for the sake of clarity and simplicity, this report does not include a total row on every table.

Analyses are presented at three time points throughout – within 90 days, within 180 days, and in the 91–180-day bracket. Please note that all analysis of the 91–180-day period has those patients from within 90 days excluded, and thus the denominator is 7085 rather than 7135.

If you have any questions about any of the report tables, please contact the audit team on COPD@rcplondon.ac.uk.



Section 1: Hospital admissions

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Key findings

- Of those assessed for PR, **18.6%** had **at least one admission within 90 days**, and **29.6%** had at least one admission within 180 days.
- **COPD was the most common coded cause for admission**; however, it accounted for just less than **20%** of coded episodes within both 90 and 180 days.
- There were associations, as expected, between admission rates and other disease/demographic indices, such as:
 - Age (the admission rate for the over 70s was 32.5% within 180 days),
 - Global Initiative for Chronic Obstructive Lung Disease (GOLD) stage (for those with a forced expiratory volume (FEV₁) score of under 50%, the hospital admission rate was 29.8% within 180 days),
 - **Medical Research Council (MRC) score** (in those with an MRC score of 5, the admission rate was **41.9%** within 180 days),
 - **Number of comorbidities** (in those with four or more comorbidities, the admission rate was **41.9%** within 180 days),
 - **Previous admissions** (those who had been admitted three times or more for their COPD within the past 12 months had an admission rate of **52.2%** within 180 days).

For full key findings and recommendations, please see the full supplementary report Beyond Breathing Better available at www.rcplondon.ac.uk/beyondbreathingbetter.

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Section 1.1 Hospital admissions Back to contents

The audit received HES data to look at the incidence of all-cause admissions following a PR programme, as well as noting the primary diagnosis code for each admission. Nearly one-fifth (18.6%) of patients were admitted within 90 days of assessment for a PR programme, and nearly one-third (29.6%) were admitted within 180 days.

- Hospital admission rate within 90 days was 18.6% (1328/7135), 95% confidence interval 17.7–19.5%
- Hospital admission rate within 180 days was 29.6% (2114/7135), 95% confidence interval 28.6–30.7%
- Hospital admission rate within 91–180 days was 17.8% (1259/7085), 95% confidence interval 16.9–18.7%

NB: hospital admission rate refers to the proportion admitted at least once in the respective time frame.

1.1a Admission within 90 days

Admissions within 90 days	Percentage (number) of patients	
None	81.4% (5807/7135)	
One	13.5% (965/7135)	
Тwo	3.6% (259/7135)	
Three or more	1.5% (104/7135)	

1.1b Admission within 180 days

Admissions within 180 days	Percentage (number) of patients	
None	70.4% (5021/7135)	
One	17.6% (1256/7135)	
Тwo	7.4% (527/7135)	
Three	2.6% (184/7135)	
Four or more	2.1% (147/7135)	

1.1c Admission within 91–180 days

Admissions within 91–180 days	Percentage (number) of patients	
None	82.2% (5826/7085)	
One	12.8% (907/7085)	
Тwo	3.2% (228/7085)	
Three	1.0% (72/7085)	
Four or more	0.7% (52/7085)	

1.1d Admission rate: scatter plots by unit

The two graphics below are 'funnel plots' that show admission rates for each PR service plotted against audit sample size, in comparison to a (red) line that indicates the overall national result and dotted lines that indicate limits of control.

Control limits serve as boundaries, and any results falling above the upper boundary or below the lower boundary are considered to be statistical outliers. The probability of results being outside these limits owing to chance alone is small (5% for the inner and 0.2% for the outer limits), so when results do fall outside; these are inconsistent with the overall national result in relation to their sample size. This implies that something else is happening that is non-random in nature, probably systematic organisational differences rather than randomness of scatter.



PR service variation in the percentage of one or more admission within 90 days



PR service variation in the percentage of one or more admission within 180 days

1.1e Cause of first admission within 90 days

Data on cause of admission (based only on primary admission diagnosis code) were grouped into five categories, namely COPD (ICD codes J44.0, J44.1, J44.8, J44.9), pneumonia (J18.9, J18.0, J18.1), other respiratory (all J codes minus the COPD and pneumonia codes), cardiovascular (ICD codes I00–I99), other (all other codes).

COPD was the leading cause of *first* admission within both 90 and 180 days, as well as being the leading cause of *all* admissions within the analysed timeframe.

Diagnosis of first admission within 90 days	Percentage (number) of patients	
COPD	21.2% (282/1328)	
Pneumonia	9.3% (124/1328)	
Other respiratory	8.1% (108/1328)	
Cardiovascular	7.2 (95/1328)	
Other	54.1% (719/1328)	
Median (IQR) days to first admission	39 (19–63) days	

IQR = interquartile range.

1.1f Cause of first admission within 180 days

Diagnosis of first admission within 180 days	Percentage (number) of patients
COPD	19.4% (410/2114)
Pneumonia	7.7% (163/2114)
Other respiratory	7.4% (156/2114)
Cardiovascular	7.4% (157/2114)
Other	58.1% (1228/2114)
Median (IQR) days to first admission	68 (30–115) days

1.1g Cause of all admissions within 90 days

Diagnosis of all admissions within 90 days	Percentage (number) of patients
COPD	18.9% (360/1901)
Pneumonia	8.6% (164/1901)
Other respiratory	7.9% (150/1901
Cardiovascular	7.3% (139/1901)
Other	57.2% (1088/1901)

1.1h Cause of all admissions within 180 days

Diagnosis of all admissions within 180 days	Percentage (number) of patients
COPD	18.5% (701/3798)
Pneumonia	7.0% (264/3798)
Other respiratory	7.3% (279/3789)
Cardiovascular	7.4% (281/3789)
Other	59.8% (2273/3798)

1.1i Admission stratified by gender

There was no significant relationship between gender and hospital admission.

Gender	One or more admission	One or more admission	One or more admission
	within 90 days	within 180 days	within 91–180 days
Male	19.2% (732/3803)	30.4% (1156/3803)	18.2% (686/3771)
Female	17.9% (596/3332)	28.8% (958/3332)	17.3% (573/3314)
Male	19.2% (732/3803)	30.4% (1156/3803)	18.2% (686/3771)
Female	17.9% (596/3332)	28.8% (958/3332)	17.3% (573/3314)

p = 0.14 for 90 days, p = 0.13 for 180 days, and p = 0.33 for 91–180 days.

1.1j Admission stratified by age

There was a notable relationship between increasing age and admission.

Age	One or more admission within 90 days	One or more admission within 180 days	One or more admission within 91–180 days
<60	16.6% (186/1121)	25.1% (281/1121)	14.7% (165/1119)
60–64	16.8% (165/982)	26.2% (257/982)	15.1% (148/978)
65–69	17.1% (266/1553)	28.8% (447/1553)	17.3% (267/1544)
70–74	18.5% (266/1434)	30.3% (435/1434)	17.8% (254/1427)
75–79	21.0% (237/1130)	34.4% (389/1130)	22.3% (249/1117)
≥80	22.8% (208/914)	33.4% (305/914)	19.6% (176/899)

p = 0.001 for 90 days, and p < 0.001 for 180 days and 91–180 days.

1.1k Admission stratified by deprivation

Deprivation covers a broad range of issues, and refers to unmet needs caused by a lack of resources of all kinds. England produces its own separate index of multiple deprivation (IMD) using postcodes, and for this audit, patient postcodes at the time of PR assessment were used. The IMD 2010 ranks 32482 small geographical areas within England from most deprived (rank 1) to least deprived (rank 32482).

For the purpose of presentation, these areas were grouped into quintiles, with the most deprived quintile comprising ranks 1–6496, the next quintile comprising ranks 6497–12993, and so on up to the least deprived quintile (ranks 25986–32482).

IMD quintile	One or more admission within 90 days	One or more admission within 180 days	One or more admission within 91–180 days
Q1 (most deprived)	19.0% (352/1853)	30.2% (560/1853)	18.2% (335/1842)
Q2	19.6% (294/1498)	32.2% (482/1498)	19.7% (293/1485)
Q3	18.3% (260/1421)	27.9% (397/1421)	15.7% (222/1410)
Q4	17.9% (215/1198)	29.0% (347/1198)	17.6% (210/1192)
Q5 (least deprived)	17.5% (178/1020)	27.9% (285/1020)	17.4% (176/1012)

There was no notable relationship between deprivation and admission.

p = 0.64 for 90 days, p = 0.08 for 180 days, and p = 0.09 for 91–180 days.

1.11 Admission stratified by comorbidity

There was a clear relationship between increasing number of comorbidities (possible range 0–23) and all-cause admission within 90 and 180 days.

Number of comorbidities	One or more admission	One or more admission	One or more admission
	within 90 days	within 180 days	within 91–180 days
None	14.0% (241/1716)	23.9% (410/1716)	14.9% (254/1707)
One	17.4% (401/2309)	26.9% (622/2309)	15.3% (351/2292)
Тwo	21.4% (342/1595)	32.5% (519/1595)	18.6% (295/1583)
Three	19.7% (176/892)	33.9% (302/892)	22.6% (200/886)
Four or more	27.0% (168/623)	41.9% (261/623)	25.8% (159/617)

p < 0.001 for 90 days, 180 days and 91–180 days.

1.1m Admission stratified by smoking status

There was no notable relationship between smoking status and admission.

Smoking status	One or more admission within 90 days	One or more admission within 180 days	One or more admission within 91–180 days
Current	17.4% (272/1565)	28.2% (442/1565)	17.5% (273/1556)
Ex-smoker	18.6% (923/4968)	29.8% (1479/4968)	17.8% (876/4929)
Never	20.7% (90/435)	32.2% (140/435)	19.1% (83/435)
Not known	25.7% (43/167)	31.7% (53/167)	16.4% (27/165)

p = 0.26 for 90 days (excl NK), p = 0.24 for 180 days (excl NK), and p = 0.74 for 91–180 days (excl NK). Excl NK = excluding not known.

1.1n Admission stratified by previous admissions

The more frequently a patient had been admitted to hospital in the 12 months prior to their PR assessment, the more likely they were to also be admitted in the 90 and 180 days subsequent to their PR assessment.

Times hospitalised for COPD exacerbation in the past 12 months	One or more admission within 90 days	One or more admission within 180 days	One or more admission within 91–180 days
None	14.7% (613/4171)	24.4% (1019/4171)	14.8% (615/4156)
One	22.6% (293/1294)	35.5% (460/1294)	20.7% (264/1277)
Тwo	34.8% (119/342)	52.0% (178/342)	34.0% (114/335)
Three	31.1% (41/132)	52.3% (69/132)	35.6% (47/132)
Four or more	42.5% (48/113)	52.2% (59/113)	30.9% (34/110)
Not known	19.8% (214/1083)	30.3% (329/1083)	17.2% (185/1075)

p < 0.001 for 90 days, 180 days and 91–180 days (excl NK).

1.10 Admission stratified by living arrangements

Living arrangements	One or more admission within 90 days	One or more admission within 180 days	One or more admission within 91–180 days
Community hospital /			
rehabilitation ward /	0.0% (0/4)	0.0% (0/4)	0.0% (0/4)
equivalent			
House/flat alone	17.6% (355/2021)	29.1% (589/2021)	18.2% (366/2008)
House/flat with another	18 6% (810/4404)	20 1% (1282/4404)	17 2% (757/4270)
person	10.070 (010/ 4404)	23.170 (1203/4404)	17.570 (75774570)
Residential placement	61.1% (11/18)	77.8% (14/18)	47.1% (8/17)
Sheltered accommodation	28.6% (26/91)	45.1% (41/91)	23.1% (21/91)
Other	18.6% (8/43)	37.2% (16/43)	20.9% (9/43)
Not known	19.7% (109/554)	30.9% (171/554)	17.8% (98/552)

Admission at all time points was higher for those in residential placements.

p < 0.001 for 90 days and 180 days (excl NK), and p = 0.02 for 91–180 days (excl NK).

1.1p Admission stratified by GOLD stage

The greater the disease severity the greater the incidence of admission.

GOLD stage	One or more admission within 90 days	One or more admission within 180 days	One or more admission within 91–180 days
FEV ₁ > 80%	14.8% (70/473)	25.6% (121/473)	15.7% (74/471)
FEV ₁ 50-80%	16.4% (327/1990)	27.1% (539/1990)	16.5% (327/1983)
FEV ₁ 30–50%	17.3% (251/1452)	29.3% (425/1452)	17.9% (257/1439)
FEV ₁ < 30%	21.2% (91/429)	31.7% (136/429)	19.4% (82/423)
Not known	21.1% (589/2791)	32.0% (893/2791)	18.7% (519/2769)

p = 0.06 for 90 days (excl NK), p = 0.10 for 180 days (excl NK), and p = 0.35 for 91–180 days (excl NK).

1.1q Admission stratified by MRC score

The higher the MRC score, the greater the rate of admission.

MRC score	One or more admission within 90 days	One or more admission within 180 days	One or more admission within 91–180 days
Grade 1	6.1% (7/114)	9.6% (11/114)	5.3% (6/114)
Grade 2	13.6% (144/1061)	21.5% (228/1061)	11.5% (121/1056)
Grade 3	16.3% (411/2518)	26.6% (670/2518)	16.1% (402/2504)
Grade 4	21.5% (480/2236)	33.8% (755/2236)	20.3% (451/2220)
Grade 5	25.1% (157/625)	41.9% (262/625)	27.7% (170/614)
Not known	22% (129/581)	32.4% (188/581)	18.9% (109/577)

p < 0.001 for 90 days, 180 days (excl NK) and 91–180 days (excl NK).

Grade 1 - not troubled by breathlessness or strenuous exercise

Grade 2 - short of breath when hurrying or walking up a slight hill

Grade 3 - walks slower than contemporaries on level ground because of breathlessness or has to stop for breath

Grade 4 – stops to breathe after walking 100 m (109 yards) or after a few minutes walking on level ground

Grade 5 – too breathless to leave the house or breathless when dressing or undressing



Section 1.2 Programme uptake and completion Back to contents

1.2a Admission stratified by enrolment on PR programme

Those who were enrolled onto a PR programme had a lower incidence of hospital admission within 90 and 180 days than those who were not.

Enrolled on PR programme	One or more admission within 90 days	One or more admission within 180 days	One or more admission within 91–180 days
No	27.6% (295/1070)	38.2% (409/1070)	22.2% (233/1049)
Yes	17.0% (1033/6065)	28.1% (1705/6065)	17.0% (1026/6036)

p < 0.001 for 90 days, 180 days and 91–180 days.

1.2b Admission stratified by length in days between receipt of referral to enrolment

Days from receipt of referral to enrolment	One or more admission within 90 days	One or more admission within 180 days	One or more admission within 91–180 days
≤91 days	17.7% (664/3747)	28.8% (1078/3747)	17.2% (640/3730)
>91 days	16.2% (327/2022)	27.2% (549/2022)	16.5% (332/2011)

p = 0.14 for 90 days, p = 0.20 for 180 days, and p = 0.56 for 91–180 days.

1.2c Admission stratified by days between assessment and enrolment

There was no significant relationship between the length of time between assessment and enrolment, and admission.

Days from assessment	One or more admission	One or more admission	One or more admission
to enrolment	within 90 days	within 180 days	within 91–180 days
0 days	17.8% (247/1386)	28.5% (395/1386)	17.4% (240/1376)
1–6 days	16.4% (175/1066)	27.7% (295/1066)	17.5% (185/1060)
7–13 days	17.7% (240/1358)	28.9% (392/1358)	17.0% (230/1351)
14–27 days	17.2% (185/1076)	27.6% (297/1076)	15.4% (165/1071)
≥28 days	15.8% (186/1179)	27.7% (326/1179)	17.5% (206/1178)

p = 0.62 for 90 days, p = 0.93 for 180 days, and p = 0.64 for 91–180 days.

1.2d Admission stratified by programme type

There was a weak relationship between type of programme (rolling vs cohort) and admission within 90 and 180 days of PR assessment.

Type of programme	One or more admission within 90 days	One or more admission within 180 days	One or more admission within 91–180 days
Rolling	17.6% (570/3236)	29.0% (939/3236)	17.4% (561/3222)
Cohort	15.8% (417/2633)	26.2% (689/2633)	15.9% (416/2622)
Other	23.5% (46/196)	39.3% (77/196)	25.5% (49/192)

p = 0.07 for 90 days (excl other), p = 0.02 for 180 days (excl other), and p = 0.12 for 91–180 days (excl other). Excl other = excluding other.

1.2e Admission stratified by enrolment and non-completion of a PR programme

Those who completed their PR programmes were less likely to be admitted to hospital than those who did not.

Completion	One or more admission within 90 days	One or more admission within 180 days	One or more admission within 91–180 days
Assessed, not enrolled	27.6% (295/1070)	38.2% (409/1070)	22.2% (233/1049)
Assessed, enrolled, not completed	26.0% (469/1803)	37.8% (681/1803)	20.9% (372/1778)

p = 0.36 for 90 days, p = 0.81 for 180 days and p = 0.42 for 91–180 days.

1.2f Admission stratified by completion of PR programme

Completion	One or more admission within 90 days	One or more admission within 180 days	One or more admission within 91–180 days
Assessed but did not complete	26.6% (764/2873)	37.9% (1090/2873)	21.4% (605/2827)
Assessed, enrolled, completed	13.2% (564/4262)	24.0% (1024/4262)	15.4% (654/4258)

p < 0.001 for 90 days, 180 days and 91–180 days.

1.2f Admission stratified by discharge assessment

There was a significant relationship between the patient receiving a discharge assessment and admission to hospital.

Discharge assessment	One or more admission within 90 days	One or more admission within 180 days	One or more admission within 91–180 days
No	26.4% (784/2974)	37.9% (1127/2974)	21.7% (634/2927)
Yes	13.1% (544/4161)	23.7% (987/4161)	15.0% (625/4158)

p < 0.001 for 90 days, 180 days and 91–180 days.

1.2g Admission stratified by discharge exercise plan

For those patients who had a discharge assessment (see table 2.2f), there was no relationship between hospital admission and the provision of a written discharge plan.

For those with a discharge assessment:			
Written discharge	One or more admission	One or more admission	One or more admission
exercise plan	within 90 days	within 180 days	within 91–180 days
No	11.6% (119/1025)	23.8% (244/1025)	15.8% (162/1025)
Yes	13.5% (416/3079)	23.6% (728/3079)	14.7% (453/3076)
Not known	15.8% (9/57)	26.3% (15/57)	17.5% (10/57)

p = 0.12 for 90 days (excl NK), p = 0.93 for 180 days (excl NK), and p = 0.12 for 91–180 days (excl NK).

1.2h Admission stratified by number of sessions attended

Those who attended fewer classes (ie fewer than 12) were significantly more likely to be admitted to hospital than those who attended 12 or more classes.

Supervised PR sessions	One or more admission	One or more admission	One or more admission
attended	within 90 days	within 180 days	within 91–180 days
<12	20.3% (723/3554)	31.3% (1113/3554)	18.0% (634/3526)
12	10.5% (140/1334)	22.6% (302/1334)	15.6% (208/1333)
>12	14.6% (170/1164)	24.7% (288/1164)	15.6% (182/1164)

p < 0.001 for 90 days and 180 days, and p = 0.06 for 91–180 days.

1.2i Admission stratified by number of supervised sessions scheduled

There was no relationship between the number of sessions scheduled and admission rates in the 90 and 180 days following assessment.

Supervised PR sessions	One or more admission	One or more admission	One or more admission
scheduled	within 90 days	within 180 days	within 91–180 days
<12	18.2% (188/1034)	28.4% (294/1034)	16.6% (171/1028)
12	15.6% (460/2944)	26.9% (792/2944)	16.6% (486/2925)
>12	18.5% (385/2086)	29.7% (619/2086)	17.7% (369/2082)

p = 0.02 for 90 days, p = 0.10 for 180 days, and p = 0.56 for 91–180 days.

1.2j Admission stratified by number of sessions attended relative to sessions scheduled

If a patient missed five or more scheduled sessions, they were more likely to be admitted to hospital within 90 and 180 days of their PR assessment.

Supervised PR sessions attended	One or more admission within 90 days	One or more admission within 180 days	One or more admission within 91–180 days
More than scheduled	16.2% (22/136)	29.4% (40/136)	20.0% (27/135)
Same as scheduled	11.7% (257/2204)	22.1% (488/2204)	14.5% (320/2200)
1–4 fewer than scheduled	16.6% (361/2171)	27.9% (606/2171)	17.0% (368/2170)
≥5 fewer than scheduled	25.5% (393/1541)	36.9% (569/1541)	20.4% (309/1518)

p < 0.001 for 90 days, 180 days and for 91–180 days.

1.2k Admission stratified by length of programme

This examines the length of time over which the PR programme classes were conducted (rather than the number of classes attended, per se). Those who attended shorter PR programmes (ie that spanned fewer weeks) were more likely to be admitted to hospital.

Days from enrolment to last supervised session	One or more admission within 90 days	One or more admission within 180 days	One or more admission within 91–180 days
<42 days	19.6% (445/2275)	30.5% (694/2275)	18.0% (406/2250)
42 days (6 weeks) or longer	15.5% (588/3789)	26.7% (1011/3789)	16.4% (620/3785)

p < 0.001 for 90 days, p = 0.001 for 180 days, and p = 0.10 for 91–180 days.

1.21 Admission stratified by the use of supplementary oxygen during exercise

The number of patients on supplementary oxygen was low; however, these patients appeared to be more likely to be admitted at all time points than those did not require supplementary oxygen.

Supplementary oxygen during exercise	One or more admission within 90 days	One or more admission within 180 days	One or more admission within 91–180 days
No	16.4% (898/5470)	27.1% (1485/5470)	16.4% (893/5449)
Yes	21.9% (117/535)	36.8% (197/535)	23.3% (123/527)
Not known	30.0% (18/60)	38.3% (23/60)	16.7% (10/60)

p = 0.002 for 90 days (excl NK), p < 0.001 for 180 days and 91–180 days (excl NK).



Section 1.3 Clinical outcomes of PR Back to contents

1.3a Admission stratified by exercise test

Admission rates were slightly lower in those who achieved an MCID following their PR programme.

Exercise test change data	One or more admission within 90 days	One or more admission within 180 days	One or more admission within 91–180 days
At least one MCID achieved	12.4% (288/2316)	22.2% (514/2316)	13.6% (314/2316)
Improvement but below MCID	14.2% (106/745)	26.4% (197/745)	17.6% (131/745)
No improvement or worse	13.4% (89/662)	24.9% (165/662)	16.1% (106/659)

p = 0.40 for 90 days, p = 0.04 for 180 days, and p = 0.02 for 91–180 days.

MCID = minimum clinically important difference.



Admissions within 180 days of assessment according to exercise test





1.3b Admission rates stratified by health status

There was no relationship between achieving an MCID in health status tests and admission rates.

Health status change data One or more admission within 90 days		One or more admission within 180 days	One or more admission within 91–180 days
≥At least one MCID achieved	13.3% (280/2112)	24.0% (506/2112)	14.7% (310/2111)
Improvement but below MCID	11.5% (53/461)	20.6% (95/461)	14.4% (66/459)
No improvement or worse	12.6% (114/907)	23.5% (213/907)	14.4% (131/907)

p = 0.57 for 90 days, p = 0.31 for 180 days, and p = 0.98 for 91–180 days.



Section 2: Bed days Back to contents

Key findings

- For those patients admitted to hospital, the **mean number of days spent in hospital** within 90 days was **5.5**, and within 180 days was **7.3**. Median values were **substantially lower** (2 days within 90 days, and 3 days within 180 days), indicating the skew of the data.
- The **mean number of days spent in hospital** (of those admitted) within 180 days was also **higher** for patients who were **assessed but did not complete PR** (9.6) than for those who did complete PR (4.8).
- The admission rates and number of days spent in hospital were not notably different between patients achieving or not achieving MCID thresholds for health status after PR.
- There was no meaningful relationship between admissions or days spent in hospital and time to enrolment at PR.

For full key findings and recommendations, please see the full supplementary report Pulmonary rehabilitation: Beyond breathing better (available at www.rcplondon.ac.uk/beyondbreathingbetter).

Navigation

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Section 2.1 Overall hospitalisation Back to contents

For all patients, the total number of days spent in hospital was calculated. This was done by summing the length of stay (using the admission and discharge dates supplied in the HES data) for each admission that occurred within 90 days and 180 days.

2.1a Bed days within 90 days

Bed days within 90 days	Percentage (number) of patients	
None	81.4% (5807/7135)	
1	6.8% (487/7135)	
2	2.6% (185/7135)	
3	1.7% (124/7135)	
4–5	2.1% (150/7135)	
6–9	2.4% (169/7135)	
10–19	2.0% (141/7135)	
≥20	1.0% (72/7135)	
If admitted:		
Patients	1328	
Mean	5.5 days	
95% confidence interval for mean	5.01–5.89 days	
Median (IQR)	2 (1–6) days	

2.1b Bed days within 180 days

Bed days within 180 days	Percentage (number) of patients
None	70.4% (5021/7135)
1	9.3% (664/7135)
2	4.3% (305/7135)
3	2.5% (177/7135)
4–5	3.3% (234/7135)
6–9	3.9% (280/7135)
10–19	3.5% (253/7135)
20–29	1.6% (113/7135)
≥30	1.2% (88/7135)
If admitted:	
Patients	2114
Mean	7.3
95% confidence interval for the mean	6.75–7.77 days
Median (IQR)	3 (1–8) days

2.1c Bed days within 91–180 days

Bed days within 91–180 days	Percentage (number) of patients
None	81.8% (5792/7085)
1	6.8% (483/7085)
2	2.6% (182/7085)
3	1.1% (79/7085)
4–5	2.2% (155/7085)
6–9	2.2% (155/7085
10–19	1.9% (138/7085)
20–29	0.8% (60/7085)
≥30	0.6% (41/7085)
If admitted:	
Patients	1293*
Mean	6.3
95% confidence interval for the mean	5.73–6.83 days
Median (IQR)	2 (1–7) days

*This 1293 is slightly larger than the 1259 admitted during 91–180 days, and reflects the fact that some patients admitted within 90 days continued their stay beyond 90 days.

2.1d Bed days stratified by gender (for those who were admitted)

There was no relationship between gender and number of bed days.

Gender	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 mean, median (IQR)
Male	3803	5.3, 3 (1–6), n=732	7.3, 3 (1–8), n=1156	6.4, 2 (1–7), n=708
Female	3332	5.6, 2 (1–7), n=596	7.3, 3 (1–8), n=958	6.1, 2 (1–6), n=585

p = 0.89 for 90 days, p = 0.40 for 180 days, and p = 0.47 for 91–180 days.

2.1e Bed days stratified by age (for those who were admitted)

There was an age-related increase in number of bed days at all time points (within 90 days, 180 days, and within 91–180 days).

Age	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 days: mean, median (IQR)
<60	1121	4.5, 2 (1–6), n=186	6.4, 3 (1–7), n=281	5.7, 2 (1–6), n=168
60–64	982	4.6, 3 (1–6), n=165	5.9, 3 (1–8), n=257	5.0, 3 (1–6), n=151
65–69	1553	5.0, 2 (1–5), n=266	6.7, 3 (1–7), n=447	6.1, 2 (1–7), n=270
70–74	1434	4.8, 2 (1–6), n=266	6.6, 3 (1–8), n=435	6.1, 2 (1–6), , n=263
75–79	1130	6.4, 3 (1–7), n=237	8.4, 3 (1–9), n=389	6.9, 2 (1–8), n=256
≥80	914	7.3, 3 (1–8), n=208	9.6, 4 (1–11), n=305	7.6, 3 (1–10), n=185

p = 0.11 for 90 days, p = 0.02 for 180 days, and p = 0.30 for 91–180 days.

2.1f Bed days stratified by deprivation (for those who were admitted)

Deprivation covers a broad range of issues, and refers to unmet needs caused by a lack of resources of all kinds. England produces its own separate IMD using postcodes, and for this audit, patient postcodes at the time of PR assessment were used. The IMD 2010 ranks 32482 small geographical areas within England from most deprived (rank 1) to least deprived (rank 32482).

For the purpose of presentation, these areas were grouped into quintiles, with the most deprived quintile comprising ranks 1–6496, the next quintile comprising ranks 6497–12993, and so on up to the least deprived quintile (ranks 25986–32482).

There appeared to be no notable relationship between deprivation and number of bed days following PR.

IMD quintile	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 days: mean, median (IQR)
Q1 (most deprived)	1853	5.5, 3 (1–7), n=352	7.8, 3 (1–8), n=560	7.2, 3 (1–8), n=346
Q2	1498	5.8, 3 (1–7), n=294	7.5, 3 (1–8), n=482	6.4, 2 (1–7), n=300
Q3	1421	5.6, 3 (1–7), n=260	7.0, 3 (1–8), n=397	5.9, 2 (1–6), n=227
Q4	1198	5.5, 2 (1–6), n=215	6.7, 3 (1–8), n=347	5.2, 2 (1–6), n=218
Q5 (least deprived)	1020	5.0, 2 (1–6), n=178	7.2, 3 (1–8), n=285	6.4, 2 (1–7), n=179

p = 0.69 for 90 days, p = 0.61 for 180 days, and p = 0.70 for 91–180 days.

2.1g Bed days stratified by comorbidities (for those who were admitted)

The audit asked whether the patient had other significant medical conditions. There appeared to be a weak association between number of comorbidities and number of bed days.

Comorbidities	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 days: mean, median (IQR)
None	1716	4.4, 2 (1–6), n=241	6.3, 3 (1–7), n=410	6.0, 2 (1–6), n=258
One	2309	5.4, 3 (1–6), n=401	6.7, 3 (1–8), n=622	5.6, 2 (1–6), n=360
Two	1595	5.1, 2 (1–6), n=342	7.1, 3 (1–8), n=519	6.3, 2 (1–8), n=304
Three	892	7.2, 3 (1–8), n=176	9.2, 4 (1–10), n=302	7.3, 3 (1–8), n=208
Four or more	623	6.0, 2 (1–7), n=168	8.2, 3 (1–9), n=261	6.9, 3 (1–7), n=163

p = 0.20 for 90 days, p = 0.32 for 180 days, and p = 0.16 for 91–180 days.

2.1h Bed days stratified by smoking status (for those who were admitted)

There was no notable relationship between smoking status and number of bed days.

Smoking status	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 days: mean, median (IQR)
Current	1565	5.2, 2 (1–7), n=272	7.1, 3 (1–9), n=442	6.2, 3 (1–8), n=280
Ex-smoker	4968	5.5, 3 (1–7), n=923	7.4, 3 (1–8), n=1479	6.5, 2 (1–7), n=898
Never	435	4.4, 2 (1–4), n=90	5.7, 2 (1–5), n=140	4.5, 2 (1–5), n=87
Not known	167	8.1, 4 (2–11), n=43	10.2, 4 (1–10), n=53	6.9, 3 (1–5), n=28

p = 0.03 for 90 days (excl NK), p = 0.02 for 180 days and 91–180 days (excl NK).

2.1i Bed days stratified by prior admissions (for those who were admitted)

The number of times a patient had been admitted in the 12 months prior to their PR assessment for an acute exacerbation of COPD was computed. There was a strong association between this number and the number of bed days.

Times hospitalised for COPD in past 12 months	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 days: mean, median (IQR)
None	4171	4.7, 2 (1–6), n=613	5.9, 2 (1–7), n=1019	5.0, 2 (1–5), n=628
One	1294	5.6, 3 (1–6), n=293	7.6, 4 (1–9), n=460	6.9, 3 (1–8), n=271
Two	342	8.4, 5 (2–10), n=119	10.8, 7 (2–13), n=178	7.7, 4 (1–10), n=119
Three	132	6.4, 3 (1–8), n=41	12.5, 6 (2–14), n=69	12.4, 7 (1–19), n=48
Four or more	113	8.2, 4 (2–8), n=48	13.1, 8 (3–20), n=59	9.9, 7 (3–14), n=38
Not known	1083	4.9, 2 (1–6), n=214	6.8, 3 (1–7), n=329	6.4, 2 (1–7), n=189

pP < 0.001 for 90 days, 180 days and 91–180 days (excl NK).

2.1j Bed days stratified by living arrangements (for those who were admitted)

There was no significant relationship between living arrangements and number of bed days.

Living arrangements	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91– 180 days: mean, median (IQR)
Community hospital /				
rehabilitation ward /	4	-	-	-
equivalent				
House/flat alone	2021	6.4, 3 (1–7), n=355	8.6, 3 (1–10), n=589	7.5, 3 (1–8), n=377
House/flat with another	4404	5.1, 2 (1–6), n=819	6.7, 3 (1–8), n=1283	5.6, 2 (1–6), n=778
person	-	- / (-//	- / - (- //	
Residential placement	18	4.5, 4 (1–7), n=11	8.6, 7 (2–14), n=14	8.0, 6 (–), n=9
Sheltered accommodation	91	3.0, 3 (1–4), n=26	6.3, 3 (1–7), n=41	8.6, 4 (1–10), n=21
Other	43	7.8, 3 (–), n=8	8.8, 3 (1–11), n=16	8.8, 3 (–), n=9
Not known	554	5.5, 3 (1–6), n=109	7.0, 3 (1–8), n=171	6.1, 2 (1–6), n=99

p = 0.65 for 90 days, p = 0.17 for 180 days, and p = 0.20 for 91–180 days (excl NK).

2.1k Bed days stratified by GOLD stage (for those who were admitted)

The number of bed days increased with disease severity.

GOLD stage	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 days: mean, median (IQR)
FEV ₁ > 80%	473	3.3, 2 (1–3), n=70	4.9, 2 (1–5), n=121	4.9, 2 (1–5), n=74
FEV ₁ 50-80%	1990	5.0, 2 (1–5), n=327	6.4, 2 (1–7), n=539	5.5, 2 (1–6), n=333
FEV ₁ 30–50%	1452	5.3, 3 (1–7), n=251	7.1, 3 (1–8), n=425	6.5, 3 (1–8), n=263
FEV ₁ < 30%	429	8.0, 5 (2–10), n=91	12.8, 6 (2–14), n=136	11.5, 5 (2–12), n=88
Not known	2791	5.6, 3 (1–7), n=589	7.3, 3 (1–8), n=893	6.0, 2 (1–7), n=535

p < 0.001 for 90 days, 180 days and 91–180 days (excl NK).

2.11 Bed days stratified by MRC score (for those who were admitted)

There was an association between MRC scores and the number of bed days.

MRC score	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 days: mean, median (IQR)
Grade 1	114	3.9, 2 (–), n=7	4.9, 3 (1–9), n=11	4.5, 3 (–), n=6
Grade 2	1061	3.7, 2 (1–4), n=144	4.6, 2 (1–4), n=228	4.1, 1 (1–4), n=124
Grade 3	2518	4.4, 2 (1–5), n=441	5.9, 3 (1–7), n=670	5.2, 2 (1–6), n=410
Grade 4	2236	5.9, 2 (1–7), n=480	7.9, 3 (1–9), n=755	6.6, 3 (1 – 8), n=466
Grade 5	625	8.8, 6 (2–12), n=157	11.7, 6 (2–15), n=262	9.5, 4 (1–11), n=176
Not known	581	4.9, 2 (1–6), n=129	7.0, 3 (1–7), n=188	6.1, 2 (1–7), n=111

p < 0.001 for 90 days, 180 days and 91–180 days (excl NK).

Grade 1 – not troubled by breathlessness or strenuous exercise

Grade 2 - short of breath when hurrying or walking up a slight hill

Grade 3 - walks slower than contemporaries on level ground because of breathlessness or has to stop for breath

Grade 4 – stops to breathe after walking 100 m (109 yards) or after a few minutes walking on level ground

Grade 5 – too breathless to leave the house or breathless when dressing or undressing



Section 2.2 PR uptake and completion Back to contents

2.2a Bed days stratified by enrolment on a PR programme (for those who were admitted)

Those who did not enrol on a PR programme were more likely to have a higher number of bed days in the 90 and 180 days following their PR assessment than those who did enrol.

Enrolled on PR programme	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 days: mean, median (IQR)
No	1070	8.4, 4 (1–11), n=295	10.9, 5 (2–12), n=409	8.0, 4 (1–8), n=248
Yes	6065	4.6, 2 (1–5), n=1033	6.4, 3 (1–7), n=1705	5.9, 2 (1–7), n=1045

p<0.001 for 90 days and 180 days, and p = 0.02 for 91–180 days.

2.2b Bed days stratified by length in days between receipt of referral to enrolment (for those who were admitted)

The number of bed days was not associated with the length of time that the patient had to wait before commencing PR.

Days from receipt of referral to enrolment	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 days: mean, median (IQR)
≤91 days	3747	4.5, 2 (1–5), n=664	6.4, 3 (1–7), n=1078	6.0, 2 (1–7), n=652
>91 days	2022	4.7, 2 (1–6), n=327	6.4, 3 (1–7), n=549	6.0, 2 (1–6), n=338

p = 0.22 for 90 days, p = 0.26 for 180 days, and p = 0.43 for 91–180 days.

2.2c Bed days stratified by days from assessment to enrolment (for those who were admitted)

There was no notable relationship between the length of time between a patient's assessment and enrolment on a PR programme, and the number of bed days during their admission(s).

Days from assessment to enrolment	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 days: mean, median (IQR)
0 days	1386	4.9, 2 (1–6), n=247	7.0, 3 (1–8), n=395	6.4, 2 (1–7), n=245
1–6 days	1066	4.9, 3 (1–6), n=175	6.3, 3 (1–8), n=295	5.3, 2 (1–6), n=188
7–13 days	1358	4.7, 2 (1–5), n=240	6.5, 3 (1–7), n=392	6.2, 3 (1–7), n=234
14–27 days	1076	4.1, 2 (1–5), n=185	6.2, 2 (1–6), n=297	6.4, 3 (1–6), n=170
≥28 days	1179	4.5, 2 (1–6), n=186	5.8, 3 (1–7), n=326	5.1, 2 (1–5), n=208

p = 0.27 for 90 days, p = 0.61 for 180 days, and p = 0.19 for 91–180 days.

2.2d Bed days stratified by type of programme (for those who were admitted)

There was no notable relationship between type of programme (rolling vs cohort) and the number of bed days.

Type of programme	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 days: mean, median (IQR)
Rolling	3236	5.0, 2 (1–6), n=570	6.5, 3 (1–7), n=939	5.7, 2 (1–6), n=572
Cohort	2633	4.0, 2 (1–5), n=417	6.0, 3 (1–7), n=689	5.9, 2 (1–7), n=423
Other	196	5.4, 3 (1–6), n=46	8.1, 3 (1–10), n=77	7.4, 2 (1–8), n=50

p = 0.02 for 90 days, p = 0.41 for 180 days and 91–180 days.

2.2e Bed days stratified by enrolment and completion of a programme (for those who were admitted)

Those who completed their PR programme had a significantly lower number of bed days within all time points that those who did not enrol, or than those who enrolled but did not complete their PR programme.

Completion	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 days: mean, median (IQR)
Assessed, not enrolled	1070	8.4, 4 (1-11), n=295	10.9, 5 (2-12), n=409	8.0, 4 (1-8), n=248
Assessed, enrolled, not completed	1803	6.5, 3 (1-8) n=469	8.8, 4 (2-10), n=681	7.7, 4 (1-9), n=384

P = 0.09 for 90 days, p=0.28 for 180 days, and p=0.57 for 91-180 days

Completion	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 days: mean, median (IQR)
Assessed but did not complete	2873	7.2, 4 (1-9), n=764	9.6, 5 (2-11), n=1090	7.8, 4 (1-9), n=632
Assessed, enrolled, completed	4262	3.0, 1 (1-4), n=564	4.8, 2 (1-5), n=1024	4.8, 2 (1-5), n=661

p < 0.001 for 90 days, 180 days and 91–180 days.

2.2f Bed days stratified by discharge assessment (for those who were admitted)

There was a significant relationship between the patient receiving a discharge assessment and number of bed days. This echoes the findings from the relationship between number of bed days and completion.

Discharge assessment	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 days: mean, median (IQR)	
No	2974	7.1, 3 (1–9), n=784	9.4, 4 (2–11), n=1127	7.6, 3 (1–9), n=661	
Yes	4161	3.1, 1 (1–4), n=544	4.8, 2 (1–5), n=987	4.9, 2 (1–5), n=632	

p < 0.001 for 90 days, 180 days and 91–180 days.

2.2g Bed days stratified by discharge exercise plan

For those patients who had a discharge assessment (see table 2.2f), there was no notable relationship between number of bed days and the provision of a written discharge exercise plan.

For those with a discharge assessment:					
Written exercise	Casaa	Bed days within 90 days:	Bed days within 180 days:	Bed days within 91–180	
plan	Cases	mean, median (IQR)	mean, median (IQR)	days: mean, median (IQR)	
No	1025	3.4, 2 (1–4), n=119	5.9, 2 (1–6), n=244	6.4, 2 (1–7), n=163	
Yes	3079	3.0, 1 (1–4), n=416	4.5, 2 (1–5), n=728	4.4, 2 (1–5), n=459	
Not known	57	4.1, 1 (–), n=9	4.5, 2 (1–9), n=15	3.0, 1 (1–4), n=10	

p = 0.19 for 90 days, p = 0.11 for 180 days and p = 0.04 for 91–180 days (all excl NK).

2.2h Bed days stratified by number of supervised sessions attended (for those who were admitted)

Patients who attended more supervised PR sessions had significantly fewer bed days.

Supervised PR sessions attended	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 days: mean, median (IQR)
<12	3554	5.2, 2 (1–6), n=723	7.2, 3 (1–8), n=1113	6.6, 3 (1–7), n=650
12	1334	3.8, 2 (1–5), n=140	4.8, 2 (1–5), n=302	4.4, 2 (1–5), n=210
>12	1164	2.7, 1 (1–3), n=170	4.8, 2 (1–5), n=288	5.1, 2 (1–6), n=183

p < 0.001 for 90 days, 180 days and 91–180 days.

2.2i Bed days stratified by number of supervised sessions scheduled (for those who were admitted)

There was no notable relationship between bed days and the number of PR sessions that the patient had been scheduled to attend.

Supervised PR sessions scheduled	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 days: mean, median (IQR)
<12	1034	5.1, 2 (1–6), n=188	7.4, 3 (1–8), n=294	6.8, 2 (1–7), n=175
12	2944	4.7. 2 (1–6), n=460	6.3, 3 (1–8), n=792	5.8, 2 (1–6), n=496
>12	2086	4.3, 2 (1–5), n=385	6.0, 3 (1–7), n=619	5.5, 2 (1–6), n=374

p = 0.81 for 90 days, p = 0.77 for 180 days, and p = 0.49 for 91–180 days.

2.2j Bed days stratified by number of supervised sessions attended relative to sessions scheduled (for those who were admitted)

If a patient missed five or more of their scheduled sessions, this was associated with a greater number of bed days.

Supervised PR sessions attended	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 days: mean, median (IQR)
More than scheduled	136	2.6, 1 (1–4), n=22	5.2, 2 (1–5), n=40	5.6, 2 (1–6), n=27
Same as scheduled	2204	3.4, 1 (1–4), n=257	4.8, 2 (1–5), n=488	4.6, 2 (1–5), n=323
1–4 fewer than scheduled	2171	3.7, 2 (1–4), n=361	5.7, 2 (1–7), n=606	5.7, 2 (1–7), n=374
≥5 fewer than scheduled	1541	6.4, 3 (1–8), n=393	8.6, 4 (2–10), n=569	7.4, 3 (1–8), n=319

p < 0.001 for 90 days, 180 days and 91–180 days.

2.2k Bed days stratified by days from enrolment to last supervised session (for those who were admitted)

This examines the length of time over which the PR programme classes were conducted (rather than the number of classes attended, per se). Those who attended shorter PR programmes (ie that spanned fewer weeks) had significantly more bed days at all time points.

Days from enrolment to last supervised PR session	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 days: mean, median (IQR)
<42 days	2275	6.1, 3 (1–8), n=445	8.2, 3 (1–9), n=694	7.3, 3 (1–8), n=415
42 days (6 weeks) or longer	3789	3.5, 2 (1–4), n=588	5.1, 2 (1–6), n=1011	5.0, 2 (1–6), n=630

p < 0.001 for 90 days, 180 days and 91–180 days.

2.21 Bed days stratified by supplementary oxygen during exercise (for those who were admitted)

The number of patients on supplementary oxygen was low; however, these patients appeared to have more bed days at all time points than those who did not require supplementary oxygen.

Supplementary oxygen during exercise	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 days: mean, median (IQR)
No	5470	4.5, 2 (1–5), n=898	6.2, 2 (1–7), n=1485	5.8, 2 (1–6), n=909
Yes	535	5.7, 3 (1–8), n=117	7.7, 5 (2–10), n=197	6.8, 3 (1–8), n=125
Not known	60	3.9, 3 (1–5), n=18	4.9, 3 (2–7), n=23	3.8, 2 (1–6), n=11

p < 0.001 for 90 days and 180 days (excl NK), and p = 0.03 for 91–180 days (excl NK).



Section 2.3 Clinical outcomes Back to contents

2.3a Bed days stratified by exercise test (for those who were admitted)

There was no notable relationship between the number of bed days and whether the patient achieved an MCID in their exercise tests.

Exercise test change data	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 days: mean, median (IQR)
≥1 MCID achieved	2316	2.4, 1 (1–3), n=288	4.1, 2 (1–4), n=514	4.5, 2 (1–5), n=314
Improvement but below MCID	745	3.8, 2 (1–5), n=106	5.5, 3 (1–7), n=197	5.0, 2 (1–6), n=135
No improvement or worse	662	3.5, 2 (1–4), n=89	4.4, 2 (1–5), n=165	3.9, 2 (1–4), n=107

p = 0.003 for 90 days, p = 0.004 for 180 days and p = 0.12 for 91–180 days.

2.3b Bed days stratified by health status (for those who were admitted)

There was no notable relationship between the number of bed days and whether the patient achieved an MCID in their health status tests.

Health status change data	Cases	Bed days within 90 days: mean, median (IQR)	Bed days within 180 days: mean, median (IQR)	Bed days within 91–180 days: mean, median (IQR)
≥1 MCID	2112	3,2,2,(1-4) n=280	472(1-5) n=506	4.8.2(1-5) n=312
achieved	2112	5.2, 2 (1 4), II-200	4.7, 2 (1 3), 11-300	4.0, 2 (1 3), 11-312
Improvement but	461	3.0. 1 (1–4), n=53	4.6. 2 (1–5), n=95	4.2. 1 (1–5), n=67
below MCID		0.0, 2 (2 .,,, 00		, _ (_ 0,,, 0,
No improvement	907	271(1-3)n=114	4 4 2 (1-5) n=213	4.6 2 (1–5) n=134
or worse	507	2, 1 (1 0), 11 114	, 2 (1 3), 11 213	

p = 0.04 for 90 days, p = 0.28 for 180 days and p = 0.83 for 91–180 days.



Section 3: Mortality Back to contents

Key findings

- Mortality following assessment for PR was 0.7% within 90 days and 1.6% within 180 days.
- This is **substantially lower** than observed in the 2014 secondary care audit (**8.0%** at 90 days for those discharged from hospital).
- There were associations, as expected, between mortality and other disease/demographic indices, such as:
 - Age (mortality for the over 70s was 2.2% within 180 days),
 - GOLD stage (mortality for those with an FEV₁ of under 30% predicted was 2.6% within 180 days),
 - MRC score (mortality for those with an MRC score of 5 was 4.3% within 180 days),
 - Number of comorbidities (for those with four or more comorbidities, mortality was 3.2% within 180 days),
 - **Previous admissions (3.6%** of those who had been admitted for COPD two or more times in the past 12 months died within 180 days).
- There was **no notable association** of mortality with either **smoking status or deprivation score** (IMD).
- The mortality rate was higher in men (0.8% at 90 days and 2.1% at 180 days for men, in contrast to 0.5% at 90 days and 1.0% at 180 days for women). More women than men, however, were under 65 years old (33% vs 26%), which may account for this mortality difference.

For full key findings and recommendations, please see the full supplementary report Pulmonary rehabilitation: Beyond breathing better available at www.rcplondon.ac.uk/beyondbreathingbetter.

Navigation

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Section 3.1: Overall mortality Back to contents

The ONS data provided to the National COPD Audit Programme from NHS Digital were for audit patients who had died up to year 2015/2016. The data provided included the codes for the cause of death. From the information received, we are able to report 90-day and 180-day mortality for audit patients in England.

- Mortality within 90 days was **0.7%** (50/7135); 95% confidence interval 0.52%–0.92%.
- Mortality within 180 days was **1.6%** (112/7135); 95% confidence interval 1.3%–1.9%.
- Mortality within 91–180 days was **0.9%** (62/7085); 95% confidence interval 0.67%–1.12%.

3.1a 90/180-day mortality: scatter plots by unit

The two graphics below are 'funnel plots' that show service mortality rates for audit patients plotted against audit sample size, in comparison to a (red) line that indicates the overall national result and dotted lines that indicate limits of control.

Control limits serve as boundaries, and any results falling above the upper boundary or below the lower boundary are considered to be statistical outliers. The probability of results being outside these limits owing to chance alone is small (5% for the inner and 0.2% for the outer limits), so when results do fall outside, these are inconsistent with the overall national result in relation to their sample size. This implies that something else is happening that is non-random in nature, probably systematic organisational differences rather than randomness of scatter.



PR service variation in percentage mortality within 90 days

PR service variation in percentage mortality within 180 days



3.1b Cause of mortality within 90 days

ONS data on cause of death were grouped into five categories, namely COPD (ICD codes J44.0, J44.1, J44.8, J44.9), pneumonia (J18.9, J18.0, J18.1), other respiratory (all J codes minus the COPD and pneumonia codes), cardiovascular (ICD codes I00–I99), other (all other codes).

Cause of mortality within 90 days	Percentage (number) of patients
COPD	40% (20/50)
Pneumonia	4% (2/50)
Other respiratory	10% (5/50)
Cardiovascular	18% (9/50)
Other	28% (14/50)

3.1c Cause of mortality within 180 days

Cause of mortality during within 180 days	Percentage (number) of patients
COPD	36% (40/112)
Pneumonia	4% (4/112)
Other respiratory	9% (10/112)
Cardiovascular	17% (19/112)
Other	35% (39/112)

3.1d Cause of mortality within 91–180 days

Cause of mortality during within 91–180 days	Percentage (number) of patients
COPD	32% (20/62)
Pneumonia	3% (2/62)
Other respiratory	8% (5/62)
Cardiovascular	16% (10/62)
Other	40% (25/62)

3.1e Mortality stratified by gender

There was a gender-related increase in mortality for men; however, there was a higher proportion of women than men in the under-65 group (33% vs 26%).

Gender	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
Male	0.8% (32/3803)	2.1% (79/3803)	1.2% (47/3771)
Female	0.5% (18/3332)	1.0% (33/3332)	0.5% (15/3314)

p = 0.16 for within 90 days, p < 0.001 for within 180 days and within 91–180 days.

3.1f Mortality stratified by age

There was an age-related increase in mortality at all time points (within 90 days, within 180 days, and between 91 and 180 days).

Age	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
<60	0.2% (2/1121)	0.7% (8/1121)	0.5% (6/1119)
60–64	0.4% (4/982)	0.9% (9/982)	0.5% (5/978)
65–69	0.6% (9/1553)	1.1% (17/1553)	0.5% (8/1544)
70–74	0.5% (7/1434)	1.3% (18/1434)	0.8% (11/1427)
75–79	1.2% (13/1130)	2.5% (28/1130)	1.3% (15/1117)
≥80	1.6% (15/914)	3.5% (32/914)	1.9% (17/899)

p = 0.001 for 90 days, p < 0.001 for 180 days and p = 0.005 for 91–180 days.



Mortality within 180 days of assessment stratified by age





3.1g Mortality stratified by deprivation

Deprivation covers a broad range of issues, and refers to unmet needs caused by a lack of resources of all kinds. England produces its own separate index of multiple deprivation (IMD) using postcodes, and for this audit, patient postcodes at the time of PR assessment were used. The IMD 2010 ranks 32482 small geographical areas within England from most deprived (rank 1) to least deprived (rank 32482).

For the purpose of presentation, these areas were grouped into quintiles, with the most deprived quintile comprising ranks 1–6496, the next quintile comprising ranks 6497–12993, and so on up to the least deprived quintile (ranks 25986–32482).

There appeared to be no notable relationship between deprivation and mortality following PR.

IMD quintiles	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
Q1 (most deprived)	0.6% (11/1853)	1.6% (30/1853)	1.0% (19/1842)
Q2	0.9% (13/1498)	2.0% (30/1498)	1.1% (17/1485)
Q3	0.8% (11/1421)	1.8% (25/1421)	1.0% (14/1410)
Q4	0.5% (6/1198)	1.2% (14/1198)	0.7% (8/1192)

Q5 (least deprived)	0.8% (8/1020)	1.2% (12/1020)	0.4% (4/1012)
p = 0.77 for 90 days, p = 0.37 for 180 days and p = 0.25 for 91–180 days.			

3.1h Mortality stratified by comorbidity

The audit asked whether the patient had other significant medical conditions. There appeared to be associations between the number of comorbidities (possible range 0–23) and incidence of mortality.

Comorbidities	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
None	0.5% (9/1716)	0.7% (12/1716)	0.2% (3/1707)
One	0.7% (17/2309)	1.6% (36/2309)	0.8% (19/2292)
Two	0.8% (12/1595)	1.7% (27/1595)	0.9% (15/1583)
Three	0.7% (6/892)	1.9% (17/892)	1.2% (11/886)
Four or more	1.0% (6/623)	3.2% (20/623)	2.3% (14/617)

p = 0.80 for 90 days, p < 0.001 for 180 days and 91–180 days.





Mortality within 91–180days of assessment stratified by comorbidity



3.1i Mortality stratified by smoking status

There was no significant relationship between smoking status and mortality.

Smoking status	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
Current	0.6% (9/1565)	2.0% (31/1565)	1.4% (22/1556)
Ex–smoker	0.8% (39/4968)	1.4% (72/4968)	0.7% (33/4929)
Never	0.0% (0/435)	1.4% (6/435)	1.4% (6/435)
Not known	1.2% (2/167)	1.8% (3/167)	0.6% (1/165)

p = 0.13 for 90 days (excl NK), p = 0.34 for 180 days (excl NK), and p = 0.01 (excl NK) for 91–180 days.

3.1j Mortality stratified by the number of hospitalisations for COPD in the past 12 months

The number of times that a patient had been admitted owing to an acute exacerbation of COPD in the 12 months prior to their PR assessment was examined. Increased number of COPD-related hospital admissions was associated with higher mortality at all time points.

Times hospitalised for COPD exacerbation in the past 12 months	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
None	0.4% (15/4171)	1.0% (43/4171)	0.7% (28/4156)
One	1.3% (17/1294)	2.6% (34/1294)	1.3% (17/1277)
Two	2.0% (7/342)	4.1% (14/342)	2.1% (7/335)
Three	0.0% (0/132)	1.5% (2/132)	1.5% (2/132)
Four or more	2.7% (3/113)	4.4% (5/113)	1.8% (2/110)
Not known	0.7% (8/1083)	1.3% (14/1083)	0.6% (6/1075)

p < 0.001 for 90 days (excl NK) and 180 days (excl NK), and p = 0.01 for 91–180 days (excl NK).



Mortality within 180 days of assessment stratified by COPD hospitalisations in the past 12 months



Mortality within 91–180 days of assessment stratified by COPD hospitalisations in the past 12 months

3.1k Mortality stratified by living arrangements

Mortality at all time points was higher for those in residential placements.

Living arrangements	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
Community hospital /			
rehabilitation ward /	0.0% (0/4)	0.0% (0/4)	0.0% (0/4)
equivalent			
House/flat alone	0.6% (13/2021)	1.4% (29/2021)	0.8% (16/2008)
House/flat with another	0.8% (34/4404)	1 6% (72/4404)	0.9% (38/4370)
person		10,0 (, 2, 110)	0.070 (0.07 107 07
Residential placement	5.6% (1/18)	27.8% (5/18)	23.5% (4/17)
Sheltered	0.0% (0/91)	0.0% (0/91)	0.0% (0/91)
accommodation	0.070 (07.51)	0.070 (07.51)	0.070 (07.51)
Other	0.0% (0/43)	0.0% (0/43)	0.0% (0/43)
Not known	0.4% (2/554)	1.1% (6/554)	0.7% (4/552)

p = 0.29 for 90 days (excl NK), p < 0.001 for 180 days (excl NK) and p = 0.001 for 91–180 days (excl NK).

3.11 Mortality stratified by GOLD stage

Mortality increased with disease severity.

GOLD stage	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
FEV ₁ > 80%	0.4% (2/473)	0.8% (4/473)	0.4% (2/471)
FEV ₁ 50-80%	0.4% (7/1990)	0.9% (17/1990)	0.5% (10/1983)
FEV ₁ 30–50%	0.9% (13/1452)	1.6% (23/1452)	0.7% (10/1439)
FEV ₁ < 30%	1.4% (6/429)	2.6% (11/429)	1.2% (5/423)
Not known	0.8% (22/2791)	2.0% (57/2791)	1.3% (35/2769)

p = 0.04 for 90 days (excl NK), p = 0.02 for 180 days (excl NK), and p = 0.39 for 91–180 days (excl NK).



Mortality within 180 days of assessment stratified by GOLD stage





3.1m Mortality stratified by MRC score

There was an association between mortality and higher MRC score.

MRC score	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
Grade 1	0.0% (0/114)	0.0% (0/114)	0.0% (0/114)
Grade 2	0.5% (5/1061)	0.6% (6/1061)	0.1% (1/1056)
Grade 3	0.6% (14/2518)	1.1% (27/2518)	0.5% (13/2504)
Grade 4	0.7% (16/2236)	2.1% (46/2236)	1.4% (30/2220)
Grade 5	1.8% (11/625)	4.3% (27/625)	2.6% (16/614)
Not known	0.7% (4/581)	1.0% (6/581)	0.3% (2/577)

p = 0.05 for 90 days (excl NK), p < 0.001 for 180 days and 91–180 days (excl NK).

Grade 1 – not troubled by breathlessness or strenuous exercise

Grade 2 – short of breath when hurrying or walking up a slight hill

Grade 3 - walks slower than contemporaries on level ground because of breathlessness or has to stop for breath

Grade 4 - stops to breathe after walking 100 m (109 yards) or after a few minutes walking on level ground

Grade 5 – too breathless to leave the house or breathless when dressing or undressing



Mortality within 180 days of assessment stratified by MRC score





Section 3.2 Programme uptake and completion Back to contents

3.2a Mortality stratified by enrolment on a PR programme

Those who did not enrol on a PR programme had a higher mortality than those who did enrol.

Enrolled on PR programme	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
No	2.0% (21/1070)	3.5% (37/1070)	1.5% (16/1049)
Yes	0.5% (29/6065)	1.2% (75/6065)	0.8% (46/6036)

p < 0.001 for 90 days and 180 days, and p = 0.02 for 91–180 days.

3.2b Mortality stratified by length in days between receipt of referral to enrolment

Mortality was not associated with the length of time that the patient had to wait before commencing PR.

Days from receipt of referral to enrolment	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
≤91 days	0.5% (17/3747)	1.4% (51/3754)	0.9% (34/3730)
>91 days	0.5% (11/2022)	1.0% (21/2022)	0.5% (10/2011)

p = 0.69 for 90 days, p = 0.32 for 180 days, and p = 0.11 for 91–180 days.

3.2c Mortality stratified by days between assessment and enrolment

Mortality was not associated with the length of time the patient had to wait between assessment and enrolment onto PR.

Days from assessment to enrolment	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
0 days	0.7% (10/1386)	1.4% (20/1386)	0.7% (10/1376)
1–6 days	0.6% (6/1066)	1.1% (12/1066)	0.6% (6/1060)
7–13 days	0.5% (7/1358)	1.3% (17/1358)	0.7% (10/1351)
14–27 days	0.5% (5/1076)	1.2% (13/1076)	0.7% (8/1071)
≥28 days	0.1% (1/1179)	1.1% (13/1179)	1.0% (12/1178)

p = 0.14 for 90 days, p = 0.95 for 180 days, and p = 0.83 for 91–180 days.

3.2d Mortality stratified by programme type

There was no notable relationship between type of programme (rolling vs cohort) and mortality within 90 or 180 days of PR assessment.

Type of programme	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
Rolling	0.4% (14/3236)	1.2% (38/3236)	0.7% (24/3222)
Cohort	0.4%(11/2633)	1.1% (30/2633)	0.7% (19/2622)
Other	2.0% (4/196)	3.6% (7/196)	1.6% (3/192)

p > 0.99 for 90 days, 180 days and 91–180 days (excl other).

3.2e Mortality stratified by enrolment and non-completion of a PR programme

There was a significant relationship between mortality and attendance and/or completion of a PR programme. Patients who completed their PR programme had a significantly lower mortality rate than those who were assessed, but either did not complete or did not enrol.

Completion	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
Assessed, not enrolled	2.0% (21/1070)	3.5% (37/1070)	1.5% (16/1049)
Assessed, enrolled, not completed	1.4% (25/1803)	3.0% (54/1803)	1.6% (29/1778)

p=0.28 for 90 days, p=0.51 for 180 days and p=0.88 for 91-180 days.

NB The denominator for deaths within 91–180 days excluded those who died within 90 days.

3.2f Mortality stratified by completion of PR programme

Completion	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
Assessed but did not complete	1.6% (46/2873)	3.2% (91/2873)	1.6% (45/2827)
Assessed, enrolled, completed	0.1% (4/4262)	0.5% (21/4262)	0.4% (17/4258)

p < 0.001 for 90 days, 180 days and 91–180 days.

NB The denominator for deaths within 91–180 days excluded those who died within 90 days.

3.2g Mortality stratified by discharge assessment

There was a significant relationship between the patient receiving a discharge assessment and mortality.

Discharge assessment	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
No	1.6% (47/2974)	3.2% (94/2974)	1.6% (47/2927)
Yes	0.1% (3/4161)	0.4% (18/4161)	0.4% (15/4158)

p > 0.001 for 90 days, 180 days and 91–180 days.

3.2h Mortality stratified by written discharge exercise plan

For those patients who had a discharge assessment (see table 1.2f), there was no relationship between mortality and the provision of a written discharge exercise plan.

For those with a discharge assessment:				
Written discharge exercise plan	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days	
No	0.0% (0/1025)	0.3% (3/1025)	0.3% (3/1025)	
Yes	0.1% (3/3079)	0.5% (15/3079)	0.4% (12/3076)	
Not known	0.0% (0/57)	0.0% (0/57)	0.0% (0/57)	

p = 0.99 for 90 days and 91–180 days (excl NK), and p = 0.59 for 180 days (excl NK).

3.2h Mortality stratified by number of sessions attended

There was a weak relationship between the number of supervised PR sessions attended and mortality within 90 and 180 days.

Supervised PR sessions attended	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
<12	0.8% (28/3554)	1.8% (63/3554)	1.0% (35/3526)
12	0.1% (1/1334)	0.4% (6/1334)	0.4% (5/1333)
>12	0.0% (0/1164)	0.5% (6/1164)	0.5% (6/1164)

p<0.001 for 90 days and 180 days, and p = 0.05 for 91–180 days.

3.2i Mortality stratified by number of sessions scheduled

There was no notable relationship between mortality and the number of PR sessions the patient had been scheduled to attend.

Supervised PR sessions scheduled	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
<12	0.6% (6/1034)	1.7% (18/1034)	1.2% (12/1028)
12	0.6% (19/2944)	1.2% (36/2944)	0.6% (17/2925)
>12	0.2% (4/2086)	1.0% (21/2086)	0.8% (17/2082)

p = 0.05 for 90 days, p = 0.22 for 180 days, and p = 0.17 for 91–180 days.

3.2j Mortality stratified by number of sessions attended relative to sessions scheduled

Failure to attend five or more scheduled sessions was associated with higher mortality.

Supervised PR sessions attended	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
More than scheduled	0.7% (1/136)	0.7% (1/136)	0.0% (0/135)
Same as scheduled	0.2% (4/2204)	0.7% (15/2204)	0.5% (11/2200)
1–4 fewer than scheduled	0.0% (1/2171)	0.6% (12/2171)	0.5% (11/2170)
≥5 fewer than scheduled	1.5% (23/1541)	3.0% (47/1541)	1.6% (24/1518)

p < 0.001 for 90 days and 180 days, and p = 0.002 for 91–180 days.

3.2k Mortality stratified by length of programme

This examines the length of time over which the PR programme classes were conducted (rather than the number of classes attended, per se). Those who attended shorter PR programmes (ie that spanned fewer weeks) were significantly more likely to die at all time points.

Days: enrolment to last supervised PR session	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
<42 days	1.1% (25/2275)	2.3% (52/2275)	1.2% (27/2250)
42 days (6 weeks) or longer	0.1% (4/3789)	0.6% (23/3789)	0.5% (19/3785)

p < 0.001 for 90 days and 180 days, and p = 0.003 for 91–180 days.

3.21 Mortality stratified by use of supplementary oxygen during exercise

The number of patients on supplementary oxygen was low; however, these patients appeared to be more likely to die within 90 and 180 days than those who did not require supplementary oxygen.

Supplementary oxygen during exercise	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
No	0.4% (21/5470)	1.1% (58/5470)	0.7% (37/5449)
Yes	1.5% (8/535)	3.2% (17/535)	1.7% (9/527)
Not known	0.0% (0/60)	0.0% (0/60)	0.0% (0/60)

p = 0.003 for 90 days (excl NK) p < 0.001 for 180 days (excl NK), and p = 0.02 for 91–180 days (excl NK).



Section 3.3 Clinical outcomes of PR Back to contents

3.3a Mortality stratified by exercise test

Mortality was lower within all time points in patients who had achieved an MCID, although the numbers of deaths are too small for meaningful interpretation.

Exercise test change data	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
<u><</u> 1 MCID achieved	0.0% (0/2316)	0.2% (4/2316)	0.2% (4/2316)
Improvement but below MCID	0.0% (0/745)	0.7% (5/745)	0.7% (5/745)
No improvement or worse	0.5% (3/662)	0.9% (6/662)	0.5% (3/659)

p = 0.06 for 90 days, p = 0.008 for 180 days and p = 0.06 for 91–180 days.



Mortality within 180 days of assessment by exercise test results





3.3b Mortality stratified by health status

There was no meaningful relationship between health status results and mortality.

Health status change data	Mortality within 90 days	Mortality within 180 days	Mortality within 91–180 days
≥1 MCID achieved	0.0% (1/2112)	0.3% (6/2112)	0.2% (5/2111)
An improvement but below MCID	0.4% (2/461)	1.1% (5/461)	0.7% (3/459)
No improvement or worse	0.0% (0/907)	0.2% (2/907)	0.2% (2/907)

p = 0.09 for 90 days, p = 0.05 for 180 days, and p = 0.29 for 91–180 days.

Appendix A: How to use this report

The supplementary report (available at www.rcplondon.ac.uk/beyondbreathingbetter) contains the main messages and key recommendations derived from an extensive analysis of data. The results can be accessed either in full (Pulmonary rehabilitation: Beyond breathing better. National Chronic Obstructive Disease (COPD) Audit Programme: Outcomes from the clinical audit of pulmonary rehabilitation services in England 2015. Results and data analysis) or in the following component sections:

- Admissions within 90 and 180 days post-pulmonary rehabilitation
- Bed days
- Mortality

The data are presented largely in tabular form, with explanatory notes throughout. Although these data are available to the interested reader, it is not necessary to review them to appreciate the key messages, which are outlined below. We strongly advise teams to discuss these findings between themselves and with their commissioners.

This report contains data from England only, although the original audit included patients from England and Wales. This, in combination with data incompleteness and subgroup analyses (for the full methodology, please refer to Appendix C), means that some tables of findings have different denominators. Therefore, for the sake of clarity and simplicity, this report does not include a total row on every table. If you have any questions about any of the report tables, please contact the audit team on COPD@rcplondon.ac.uk.

Appendix B: Introduction to the National COPD Audit Programme

The National COPD Audit Programme is a programme of work that aims to drive improvements in the quality of care and services provided for COPD patients in England and Wales. The programme looks at COPD care across the patient pathway, both in and out of hospital, bringing together key elements from the primary, secondary and community care sectors.

There are three programme workstreams.

- Primary care: collection of audit data from general practice patient record systems in Wales. Delivered by the Royal College of Physicians (RCP) and NHS Digital, working with the Primary Care Respiratory Society UK, the Royal College of General Practitioners and the NHS Wales Informatics Service. Another round of audit took place in 2017.
- 2 Secondary care: in 2014, there were snapshot audits of patients admitted to hospital with COPD exacerbation, plus organisational audits of the resourcing of COPD services in acute units. The 2014 audits were delivered by the British Thoracic Society (BTS), working with the RCP. A continuous audit of admission to hospital with COPD exacerbation commenced in 2017.
- 3 Pulmonary rehabilitation: audits of COPD patients attending PR (including outcomes at 180 days), plus organisational audits of the resourcing of PR services for COPD patients. The 2015 round of this audit was delivered by the BTS, working with the RCP. Another round of snapshot clinical and organisational audits took place in 2017.

The audit also delivered a 1-year development project exploring the potential/feasibility of future incorporation of a patient-reported experience measure (PREM) into the audit programme. This was delivered by the British Lung Foundation, working with the Picker Institute Europe.

The programme is commissioned by the Healthcare Quality Improvement Partnership (HQIP) as part of the National Clinical Audit (NCA) Programme. It is included in the list of national audits for inclusion in NHS trusts' quality accounts and also the NHS Wales Clinical Audit and Outcome Review Plan.

Appendix C: Methodology

The first national clinical audit of PR) services in England and Wales aimed to capture all patients with a primary respiratory diagnosis of COPD who were assessed (or, if not assessed, began PR) between **12 January** and **10 April 2015**. **7413 patient records** were included.

To enable the collection of patient identifiable data items without obtaining explicit individual patient consent, Section 251 approval was applied for via the Confidentiality Advisory Group (CAG). However, the CAG rejected the application, stating that it was practicable for the audit to operate under a consent model. This was justified on the basis of prolonged one-to-one contact between the patient and the rehabilitation team (ie programmes tend to run for 6 weeks) and the stable medical status of the patients, both of which allowed a rational discussion to take place without time pressures. Patients were, therefore, asked to consent to the collection and recording of their identifiable information for linkage to data held externally (please refer to our website: www.rcplondon.ac.uk/projects/outputs/pulmonary-rehabilitation-workstream-audit-resources for copies of the consent material used). This consent, and the collection of patient identifiable data, allowed 90- and 180-day outcome data (mortality and hospital admissions) to be requested, extracted from HES and the ONS and linked by NHS Digital (formerly known as the Health and Social Care Information Centre).

Outcome data, however, were available only for England. This is because, in mid-2015, the CAG queried the security of cross-border transfers of patient identifiable data for linkage purposes (ie transfers of identifiable audit data held in England to Wales for linkage to the Patient Episode Database for Wales (PEDW) and then transfer of the appropriate linked dataset back to the audit team in England). CAG stated that these data flows could not take place until a memorandum of understanding between NHS England, the NHS Wales Informatics Service (NWIS) and the CAG in regards to the NWIS security arrangements was drafted and approved by all involved. This issue was not specific to the National COPD Audit Programme, and also affected cross-border linkages planned by other audits. It was not clear how long this would take to resolve and, consequently, in mid-2016 the audit programme, cognisant that there had already been quite some delay between audit end date (March 2015), publication of the national report (February 2016) and the publication of outcome data, proceeded with an application to NHS Digital for a linkage of all patients included in the audit who attended PR in **England** (application reference: DARS-NICE-25780-T1F4G-v0.10). The denominator for this outcome report (n=**7135**) therefore differs slightly from that of the clinical report, because patients who attended PR assessments in Wales were excluded.

Once NHS Digital approved the application, a file containing a study ID and necessary identifiable information (NHS number, date of birth and postcode) was sent to the Data Access Request Service (DARS) at NHS Digital. DARS NHS Digital then supplied a dataset consisting of HES Admitted Patient Care records and ONS mortality records for people in the requested cohort.

A pseudonymised, linked dataset was supplied to the RCP to carry out the analyses in early 2017. The supply of the data was covered by the NHS Digital Framework Contract and a data-sharing agreement between HQIP, NHS Digital and the RCP.

The key points about the data analysis and cleansing methodology are outlined below.

1 Mortality

- All available ONS data for the audit cohort were requested.
 - The ONS file received included **752** patients.

- The data were used to calculate **mortality rates** within 90 and 180 days of the PR assessment date (or date of programme commencement, if the patient was not assessed).
 - The vast majority of patients included in the file (n=640) died more than 180 days after their PR assessment and were, therefore, not included in the analyses.
 - **112** patients died within the 180-day window.
 - The cut-offs taken were the 90th day and the 180th day (meaning day 90 and day 180 **not** inclusive).
 - Anything before the 90th or the 180th day, therefore, was deemed to constitute a definite death within the period.
- The cause of death was broken down by the following conditions and ICD codes:
 - O COPD = J44.0, J44.1, J44.8, J44.9, J44.0-, J44.1-, J44.8-, J44.9-
 - Pneumonia = J18.9, J18.0, J18.1
 - Other respiratory = all with J codes, minus the COPD and pneumonia codes listed above
 - Cardiovascular = all codes between 100 and 199
 - Other = all other codes.

2 General HES data cleaning

(For admissions and bed days)

- HES data for the **2014/2015** and **2015/2016 periods** were requested for the audit cohort.
 - This ensured that all admissions from January 2015 (start of audit period; falling in the 2014/2015 period) to autumn 2015 (6 months (180 days) post-end of audit; falling in the 2015/2016 period) were captured.
- The files received included **11363** (2014/2015) and **11590** (2015/2016) discrete admissions.
 - The vast majority of patients included in the files were admitted to hospital either prior to their PR assessment or more than 180 days after their PR assessment and were, therefore, not included in the analyses.
 - For admissions within the 180-day post-PR assessment period, duplicates were removed (based on same patient ID and same admission date).
 - After removal of inappropriate cases (ie not within the reporting timeframe) and deduplication, the merged HES files (both 2014/2015 and 2015/2016) included **3798** discrete admissions (please note that this number relates to the total number of admissions experienced by the cohort; one patient may have had multiple admissions).

3 Hospital admissions

- HES data were used to compute the number of admissions each patient had within the 90 and 180 days after their PR assessment.
 - The cut-offs taken were the 90th day and the 180th day (meaning day 90 and day 180 **not** inclusive).
 - Each admission was counted once only.
- The reason for each admission was broken down by the following conditions and ICD codes (based on primary diagnosis code only):
 - O COPD = J44.0, J44.1, J44.8, J44.9, J44.0-, J44.1-, J44.8-, J44.9-
 - Pneumonia = J18.9, J18.0, J18.1
 - Other respiratory = all with J codes, minus the COPD and pneumonia codes listed above
 - Cardiovascular = all codes between I00 and I99

• Other = all other codes.

4 Bed days

- The number of bed days for each patient was calculated by summing the length of stay for each individual admission within the appropriate period.
- Rules applied to **length of stay** calculations (for individual admissions):
 - Length of stay for patients admitted and discharged on the same day was counted as 1 day (not 0).
 - \circ For calculations of admissions within 90 days of PR assessment:
 - Length of stay calculations were capped at 90 days.
 - For example, if the patient was admitted once within the 90-day period, eg at day 85 for 10 days, counting was stopped at the 90-day point (length of stay = 6 days).
 - In order to compute the above when required, a separate variable was created: a revised discharge date for the relevant admission (of the last day in the 90-day period, ie 90 days from PR assessment).
 - For calculations of admissions within 180 days of PR assessment:
 - Length of stay calculations were capped at 180 days.
 - For example, if the patient was admitted once within the 180-day period, eg at day 175 for 10 days, counting was stopped at the 180-day point (length of stay = 6 days).
 - In order to compute the above when required, a separate variable was created: a revised discharge date for the relevant admission (of the last day in the 180-day period, ie 180 days from PR assessment).
- Rules applied to calculation of **total number of bed days**:
 - Bed days within 90 days of the PR assessment date:
 - Sum of the length of stays for all admissions within the 90-day period (capped at day 90 as per rules outlined above).
 - Bed days within 180 days of the PR assessment date:
 - Sum of the length of stays for all admissions within the 180-day period (capped at day 180 as per rules outlined above).

5 Stratified analyses

- Within the graphics, the 95% confidence intervals computed by SPSS v22 are asymptotic, ie they were calculated using an approximation to the true distribution, assuming that the sample size was large enough to do so.
 - Within the tables, the p-values for bed days are also computed asymptotically using SPSS v22, whereas the p-values for mortality and admission use an exact (Fisher's) method from the tables' calculator within Stata v13.
- Within the graphics relating to bed days, the 95% confidence interval is for the mean, whereas the non-parametric test of significance that produces the p-value is more a test between distributions and not a specific test of mean values.
 - The distribution of bed days is highly skewed and warrants the non-parametric test. However, the mean number of days has value in the economic aspects of length of stay, and the confidence interval around this has meaning in terms of estimating the economic impact.
 - A key factor in reducing mean length of stay is reducing the length of stay of those who stay the longest.

- The p-values relate to the overall comparison of categories and do not take account of any underlying order in the categories.
- Within the graphics, note that the 95% confidence intervals between groups may overlap and yet the p-value may still produce a statistically significant result.
- There is also the issue of multiple testing and it is a recognised danger to present selected data based solely on statistical significance.
- No p-value correction has been applied for multiple testing and this should be borne in mind when interpreting differences.
- With large samples, there is the possibility of statistically significant results not being clinically relevant. With smaller samples, clinically relevant observed differences may not be statistically significant.

Appendix D: Report preparation

This report was written by the following, on behalf of the national COPD pulmonary rehabilitation audit 2015 workstream group (the full list of workstream group members is included in <u>Appendix E</u>).

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Appendix E: Current members of the pulmonary rehabilitation workstream group

- Professor Michael Steiner, National COPD Audit Programme Clinical Lead pulmonary rehabilitation workstream; Consultant Respiratory and Honorary Professor, NIHR Leicester Biomedical Research Centre – Respiratory, University Hospitals of Leicester NHS Trust, Glenfield Hospital, Leicester.
- Dr Noel Baxter, National COPD Audit Programme Clinical Lead primary care workstream; and GP Clinical Lead, NHS Southwark CCG
- Mrs Katy Beckford, Community Respiratory Team Lead, Berkshire Healthcare NHS Foundation Trust, Bracknell
- Dr Charlotte Bolton, Senior Lecturer at the University of Nottingham; and Consultant Respiratory Physician, Nottingham City Hospital, Nottingham
- Dr Sarah Elkin, Consultant Respiratory Physician, St Mary's Hospital, London
- Mrs Sian Goddard, Specialist Respiratory Physiotherapist, Royal Cornwall Hospitals NHS Trust, Truro
- Mr Ashley Green, Service Development Manager, British Lung Foundation, London
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- Professor C Michael Roberts National COPD Audit Programme Programme Clinical Lead; and clinical academic lead for population health, UCL Partners
- Miss Sophie Robinson, National COPD Audit Programme Coordinator, Care Quality Improvement Department, Royal College of Physicians, London (group member from May 2016)
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- Dr Louise Sewell, Occupational Therapist; Senior Lecturer in Occupational Therapy, Coventry University
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- Miss Victoria Van Loo, National COPD Audit Programme Coordinator, Care Quality Improvement Department, Royal College of Physicians, London
- Dr Paul Walker, Consultant Respiratory Physician, Aintree University Hospital, Liverpool
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- Miss Sally Welham, BTS Deputy Chief Executive; and BTS Project Lead for the National COPD Pulmonary Rehabilitation Audit, British Thoracic Society, London

For further information on the overall audit programme or any of the workstreams, please see our website or contact the national COPD audit team directly:

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If you would like to join our mailing list and be kept informed about updates and developments in the National COPD Audit Programme, please send us your email address and contact details.

Commissioned by:

