National Confidential Enquiry into Patient Outcome and Death

Inspiring Change

A review of the quality of care provided to patients receiving acute non-invasive ventilation

www.ncepod.org.uk

#acuteNIV

NCEPOD

Neil Smith

Method

Study aim

To identify and explore avoidable and remediable factors in the process of care for patients treated acutely with non-invasive ventilation

Study objectives

- Prompt recognition of ventilatory failure and rapid initiation of NIV
- Appropriate documentation and management of ventilator settings
- Escalation of treatment decisions and planning including admission to critical care
- Organisational aspects of care delivery for NIV

Study population inclusion criteria

Patients aged 16 years or older who were admitted as an emergency between 1st February 2015 and 31st March 2015 inclusive, and who received NIV acutely

- Patients were excluded if they were
  - Already on long-term NIV treatment at home
  - Received CPAP and not NIV
    (both have the same OPCS code)

Data collection

- Patient identifier spreadsheet
- Clinician questionnaire
- Case notes/peer review
- Organisational questionnaire

Data returns

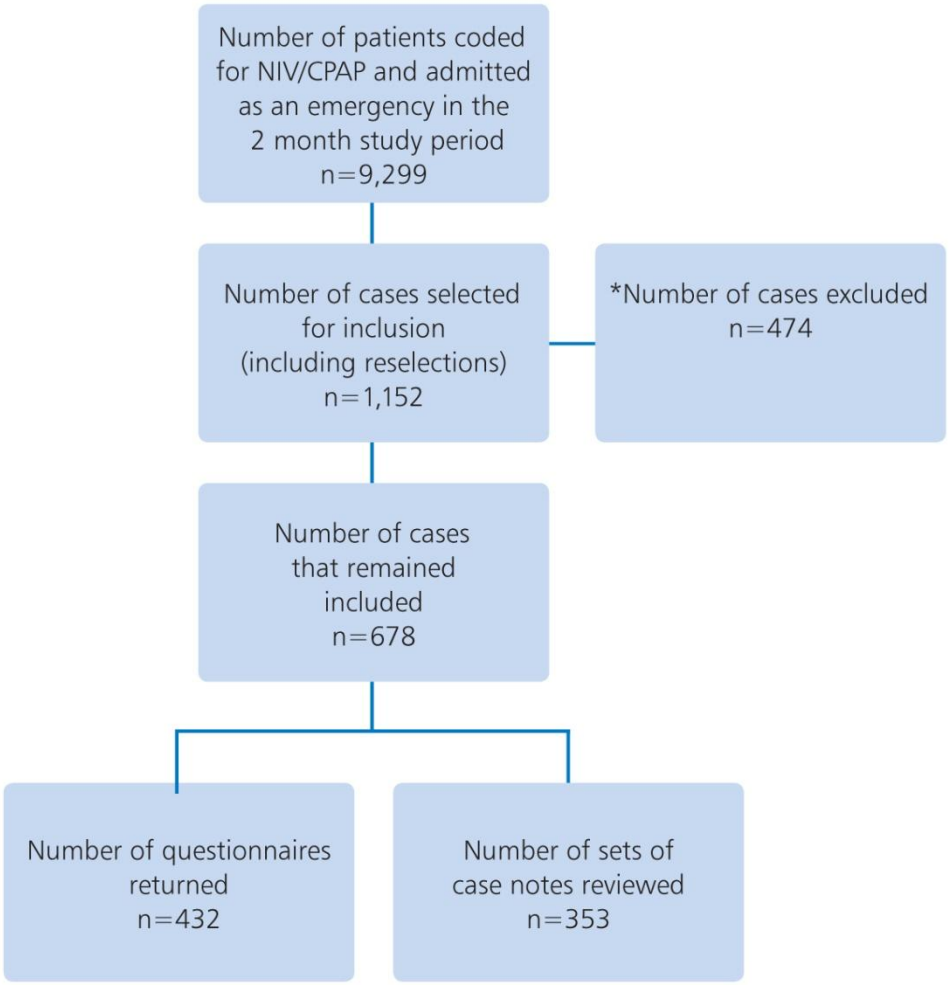


Figure 1.1 Data returns

Clinical coding recommendation

Continuous positive airways pressure (CPAP) and non-invasive ventilation (NIV) should be coded separately. They are two distinct treatments given for different conditions and separate coding will reduce clinical confusion and improve reporting of outcomes.

Gemma Ellis

Sample population & Initial management

Sample population

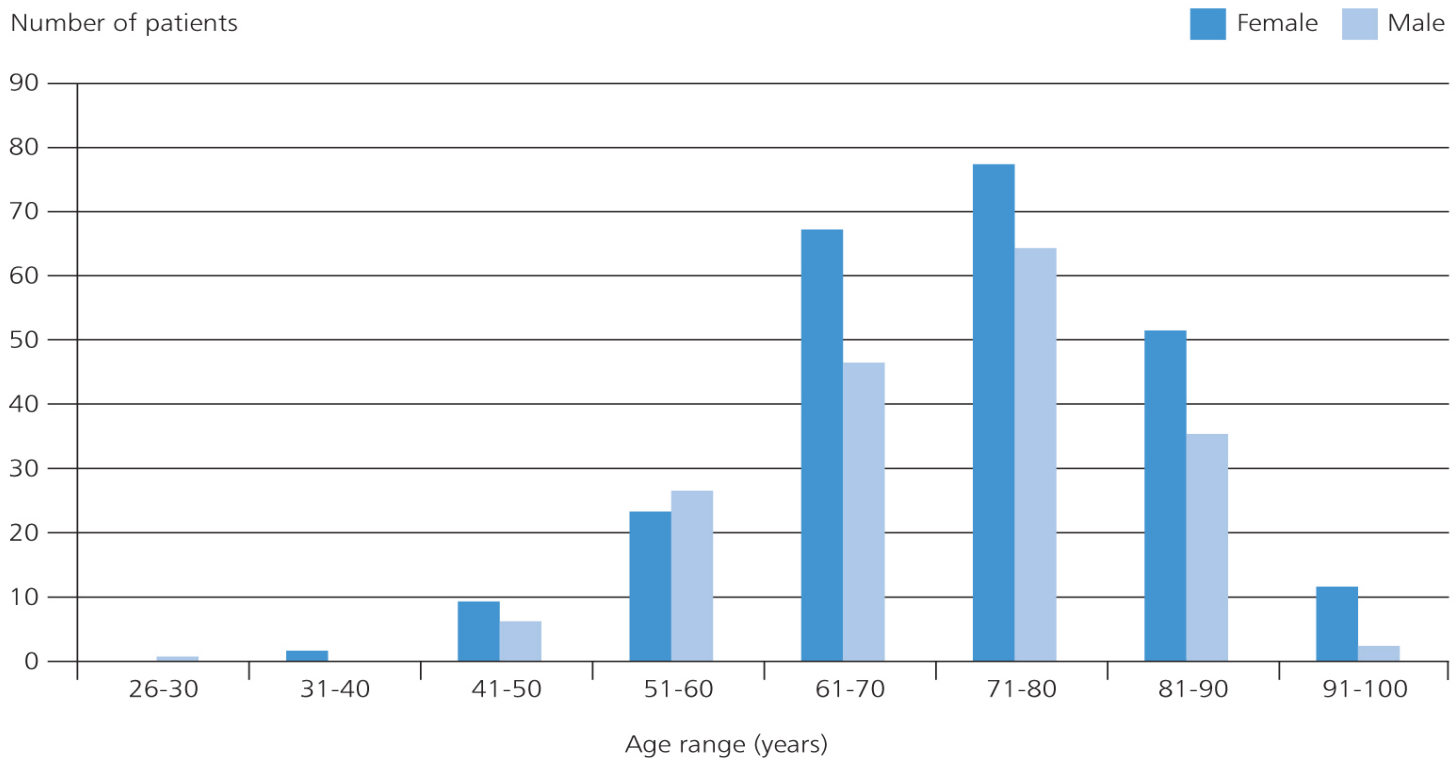


Figure 3.1 Age and gender

Male: 43.1% / age 71.1
Female: 56.9% / age 72.3

ED: 81.5% (270/421 by ambulance)
GP: 55
OPD: 4

Sample population

COPD: 70%

Cardiogenic PO: 9.6%

Obesity hypoventilation: 8.6%

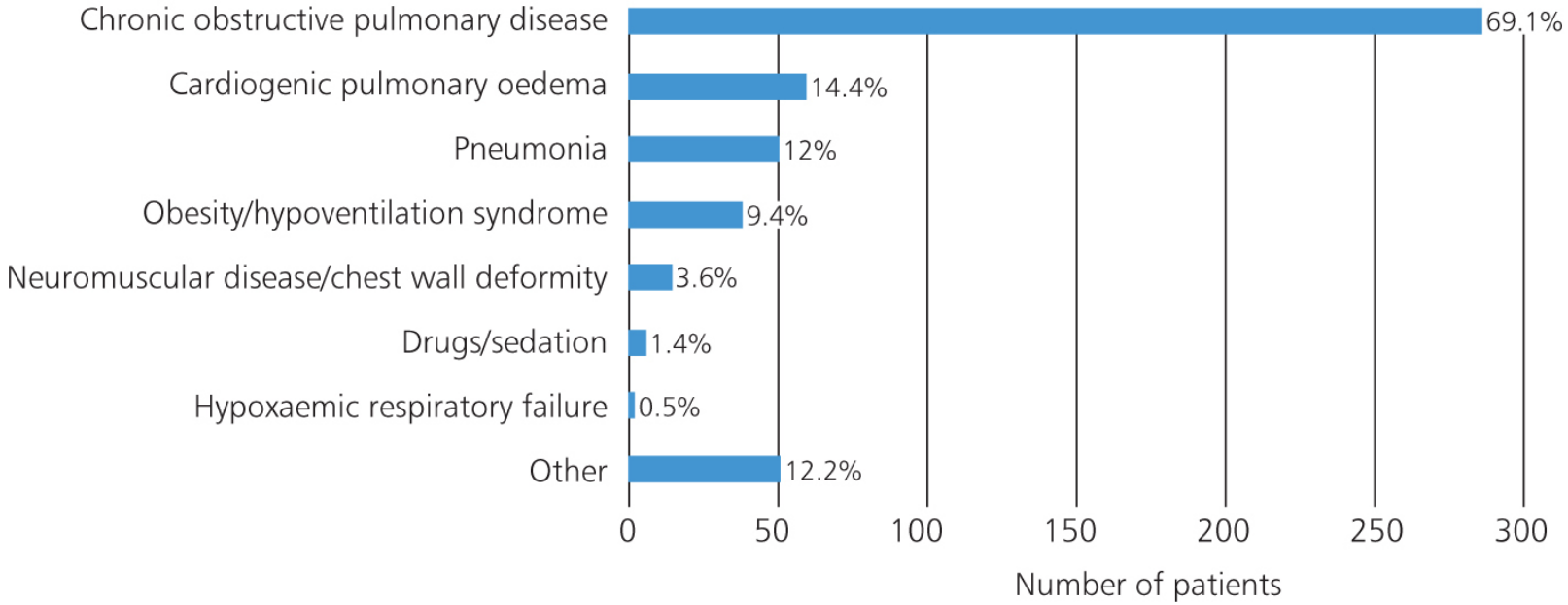


Figure 3.2 Indication for NIV during the study time period; n=417

NIV for pneumonia 50 patients (12%)

20% previous NIV episode

Sample population

Table 3.1 Smoking history – clinician questionnaire

	COPD		Non-COPD	
	Number of patients	**%**	**Number of patients**	**%**
Ex smoker	148	53.6	53	41.7
Current smoker (around the time of admission)	121	43.8	23	18.1
Never smoked	7	2.5	51	40.2
Subtotal	**276**		**127**	
Unknown/not answered	10		19	
Total	**286**		**146**	

COPD: 97.5% current or ex smokers

Non COPD: 23 (18%) current smokers

UK adult smoking rates: 19%

Sample population

Table 3.2 Indication for NIV (this episode) for patients who had never smoked

	Number of patients
Cardiogenic pulmonary oedema	17
Obesity/hypoventilation syndrome	14
Pneumonia	10
Other including chest wall deformity	10
Chronic obstructive pulmonary disease	7
Neuromuscular disease	7
Not documented	3

Answers may be multiple; n=58

14.4% never smoked

Sample population

Table 3.3 Mean values for forced expiratory volume in one second (FEV_1)

FEV_1 (litres)	All patients	COPD
Mean	0.95	0.84
Standard deviation	0.51	0.39
Standard error of the mean	0.04	0.03

LF tests available for 162 patients

129/162 patients had COPD

Sample population

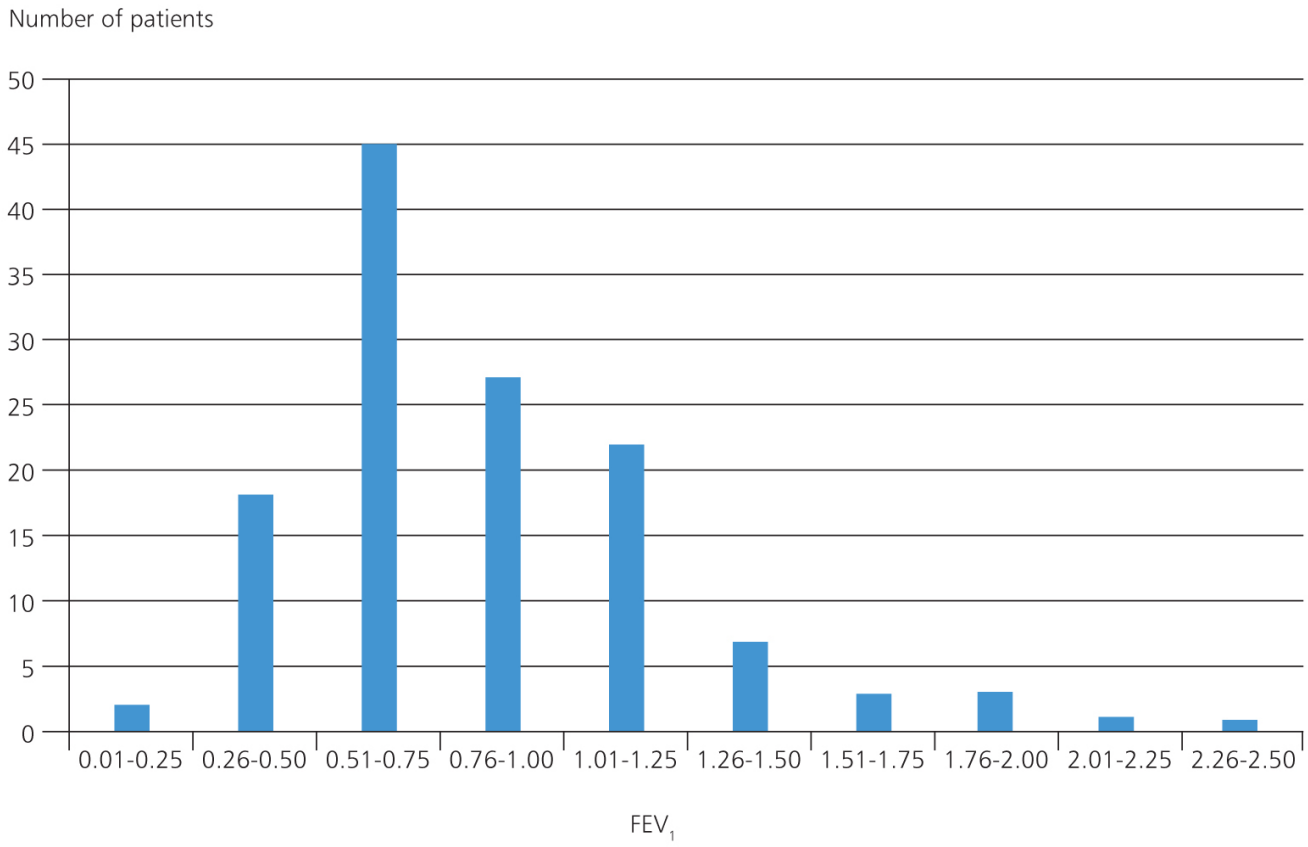


Figure 3.3 The lung function for patients with COPD; n=129

Sample population

Table 3.4 Number of known comorbidities at time of admission

	Number of patients	%
None	43	9.9
1 comorbidity	160	37.0
2 comorbidities	116	26.9
3 or more comorbidities	113	26.2
Total	**432**	

389/432 patients with a co-morbidity

53.1% of patients had 2 or more

Sample population

Average BMI 27.4

54% BMI > 24.9

Obesity hypoventilation in 9.4% of patients with BMI average of 39.3

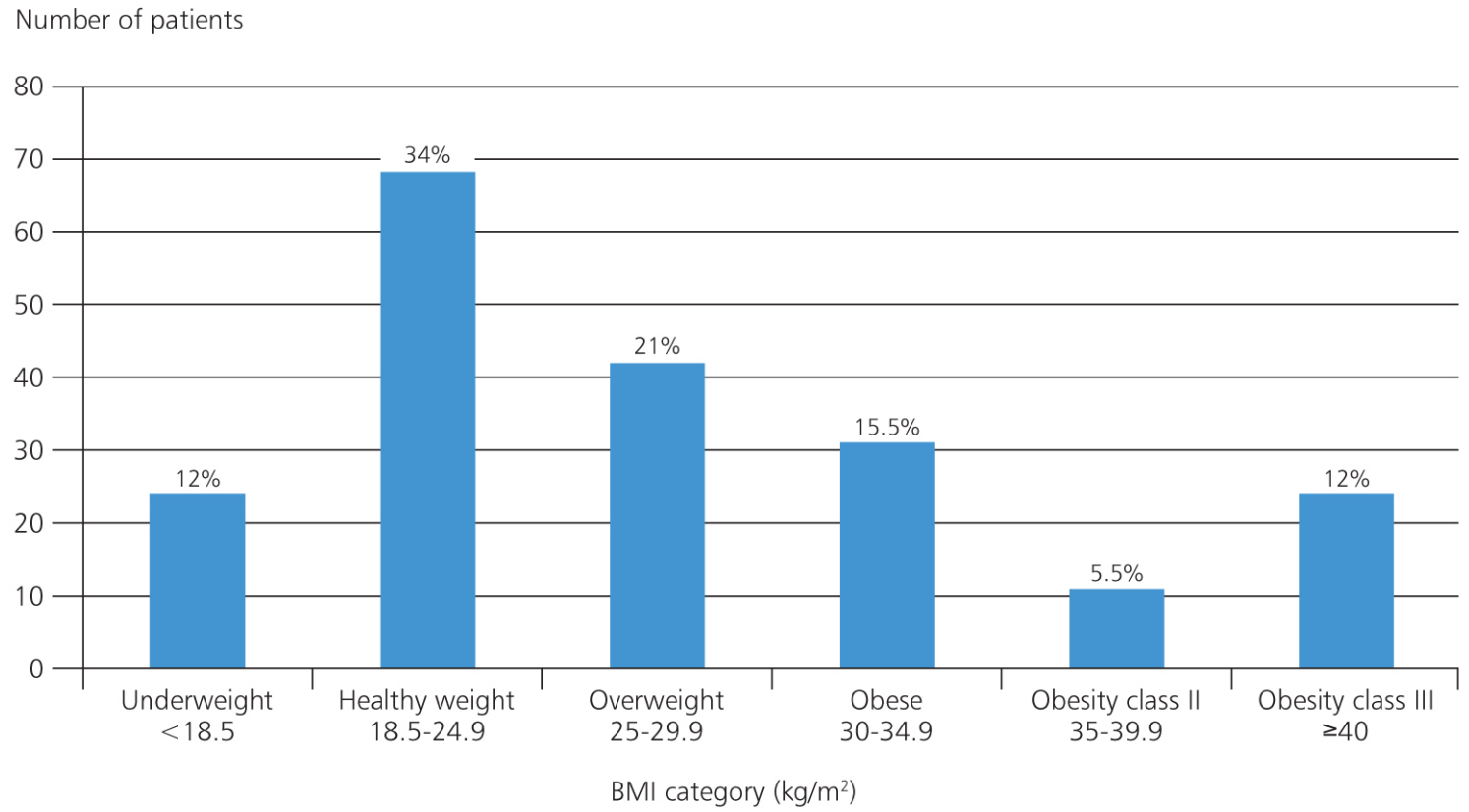


Figure 3.4 Body Mass Index; n=200

Sample population

Rockwood Clinical Frailty Scale

K. Rockwood et al. A global clinical measure of fitness and frailty in elderly people. CMAJ 2005;173:489-495

1 Very Fit – People who are robust, active, energetic and motivated. These people commonly exercise regularly. They are among the fittest for their age.

2 Well – People who have no active disease symptoms but are less fit than category 1. Often, they exercise or are very active occasionally, e.g. seasonally.

3 Managing Well – People whose medical problems are well controlled, but are not regularly active beyond routine walking.

4 Vulnerable – While not dependent on others for daily help, often symptoms limit activities. A common complaint is being "slowed up", and/or being tired during the day.

5 Mildly Frail – These people often have more evident slowing, and need help in high order IADLs (finances, transportation, heavy housework, medications). Typically, mild frailty progressively impairs shopping and walking outside alone, meal preparation and housework.

6 Moderately Frail – People need help with all outside activities and with keeping house. Inside, they often have problems with stairs and need help with bathing and might need minimal assistance (cuing, standby) with dressing.

7 Severely Frail – Completely dependent for personal care, from whatever cause (physical or cognitive). Even so, they seem stable and not at high risk of dying (within ~ 6 months).

8 Very Severely Frail – Completely dependent, approaching the end of life. Typically, they could not recover even from a minor illness.

9 Terminally Ill – Approaching the end of life. This category applies to people with a life expectancy <6 months, who are not otherwise evidently frail.

Scoring frailty in people with dementia

The degree of frailty corresponds to the degree of dementia. Common **symptoms in mild dementia** include forgetting the details of a recent event, though still remembering the event itself, repeating the same question/story and social withdrawal.

In **moderate dementia,** recent memory is very impaired, even though they seemingly can remember their past life events well. They can do personal care with prompting.

In **severe dementia,** they cannot do personal care without help.

Sample population

CFS 426/432 patients

Clinicians and reviewers same score in 70.3%

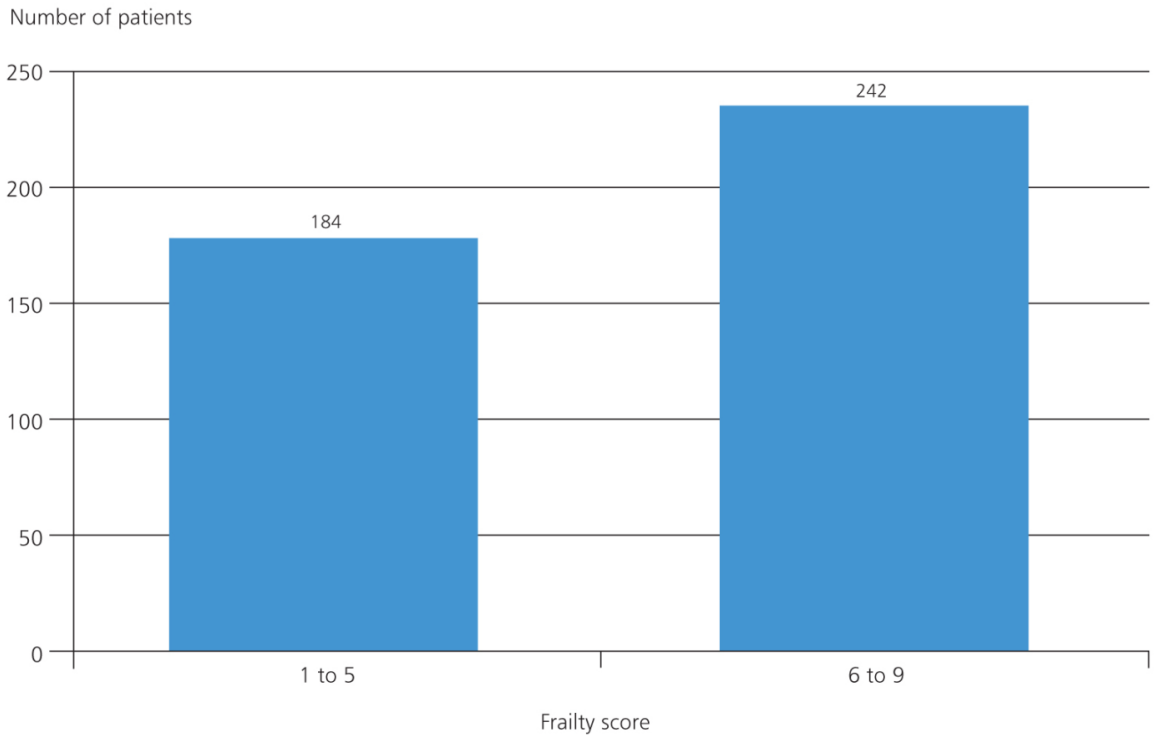


Figure 3.5 Rockwood clinical frailty score - clinical frailty of all patients studied on admission;
n=426 Score of 6 or more means moderately or severely frail

Sample population

The Modified Medical Research Council (MMRC) Dyspnoea Scale

Grade of dyspnoea	Description
0	Not troubled by breathlessness except on strenuous exercise
1	Shortness of breath when hurrying on the level *or* walking up a slight hill
2	Walks slower than people of the same age on the level because of breathlessness *or* has to stop for breath when walking at own pace on the level
3	Stops for breath after walking about 100 m *or* after a few minutes on the level
4	Too breathless to leave the house *or* breathless when dressing or undressing

Sample population

MMRC documented in 41 patients
Estimated in 242/391 cases reviewed
Over 3/4 had MMRC of 3 or 4

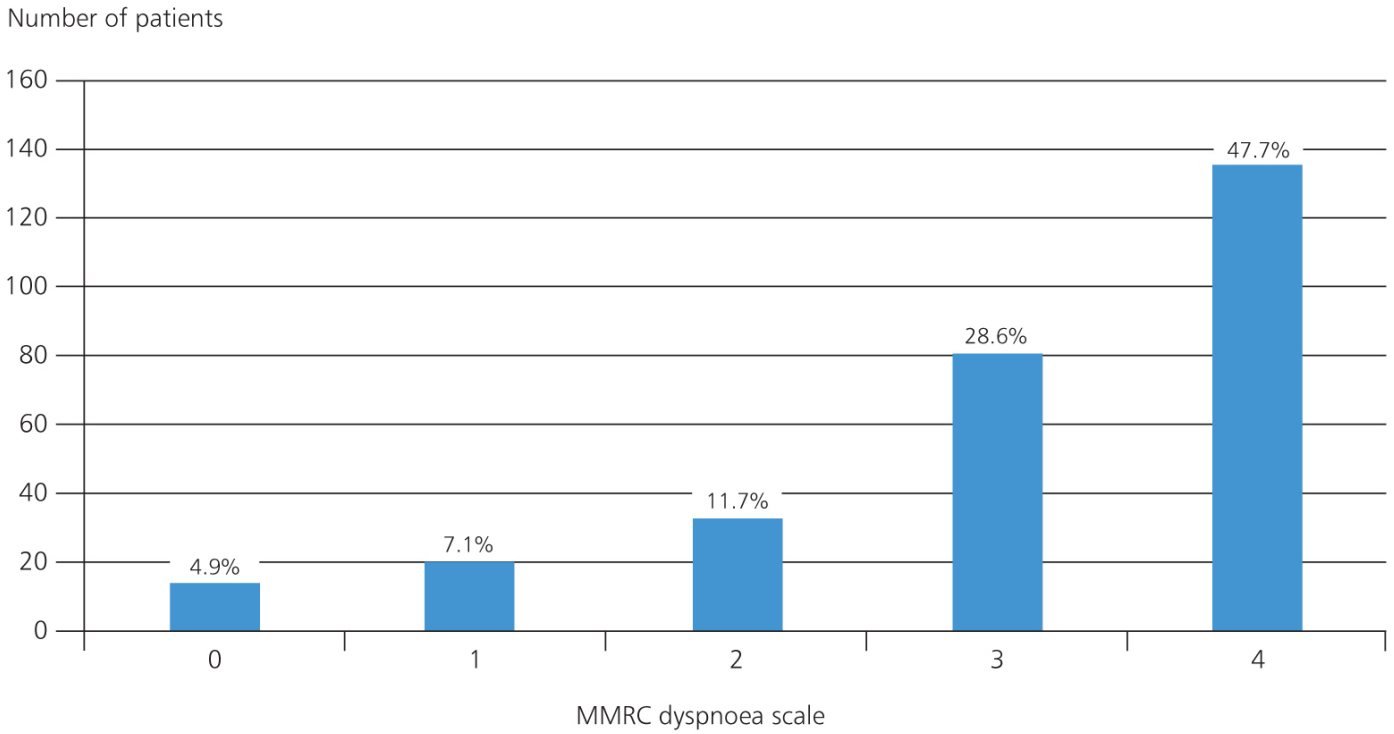
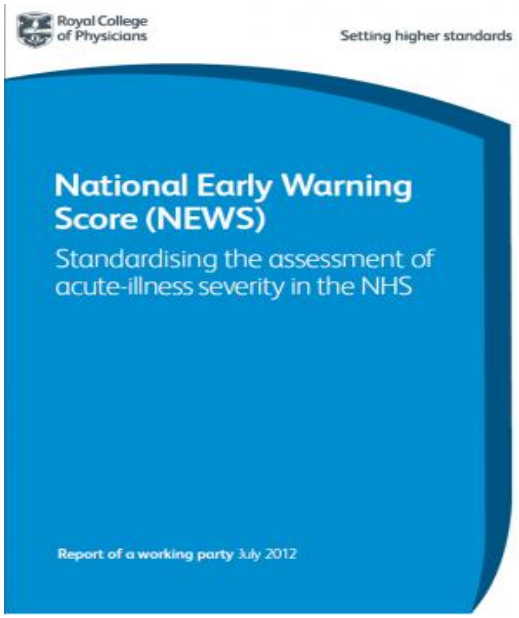
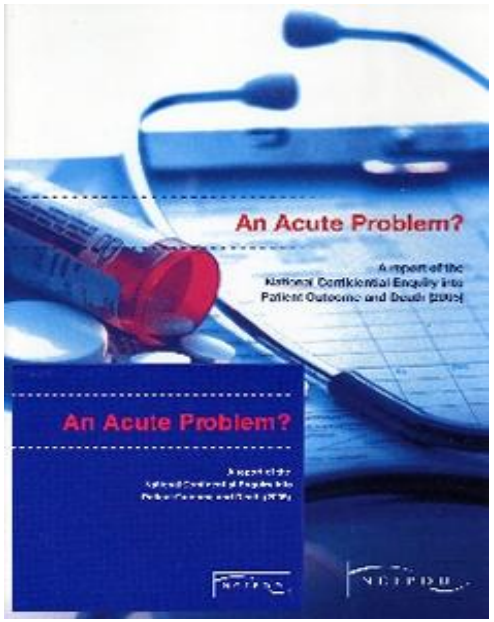
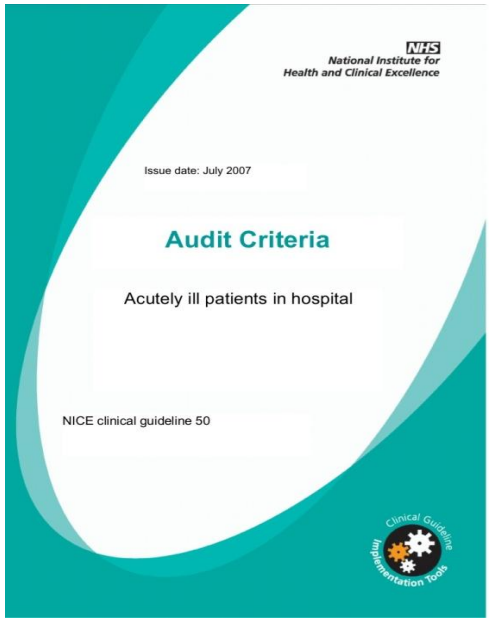


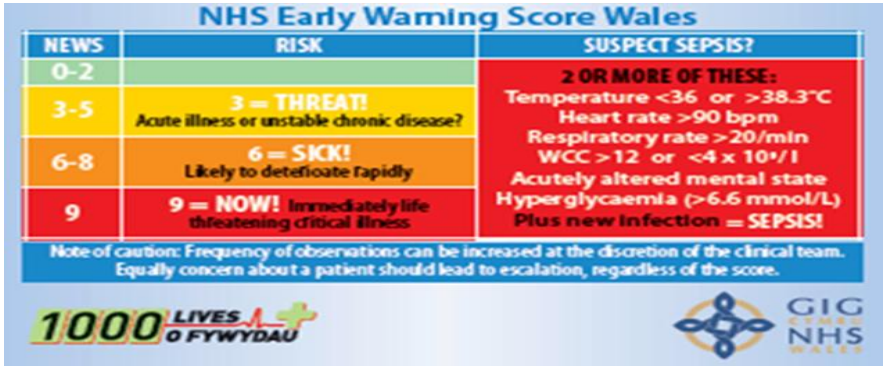
Figure 3.6 MMRC breathlessness score; n=283

Initial management









Initial management

EWS not used in 159/338 (47%)
EWS of 6 or more in 56.4%
EWS 9 or more in 17.3%

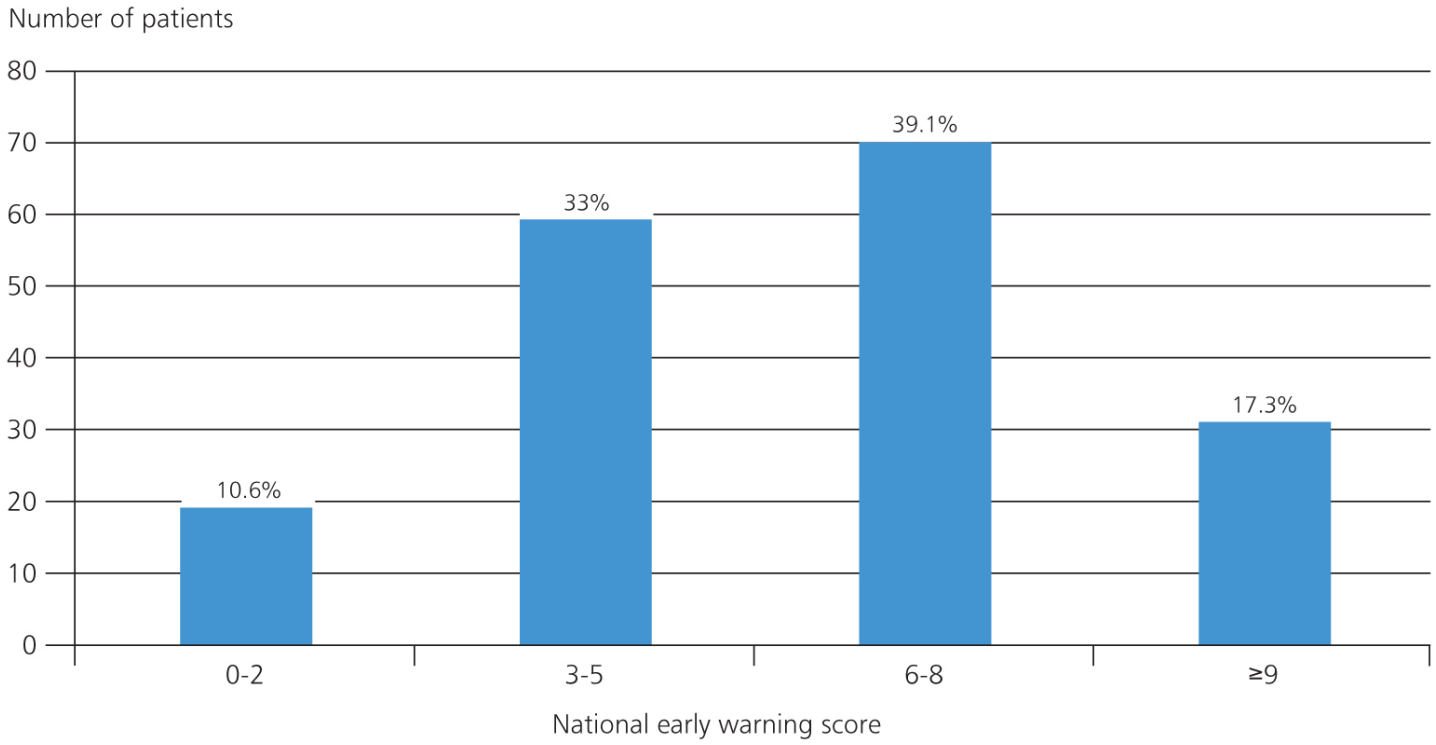


Figure 4.1 Initial early warning score; n=179

Initial management

Respiratory rate documented in 321 cases reviewed
78.2% patients had a RR of 20 or more
56.4% patients had a RR of 25 or more

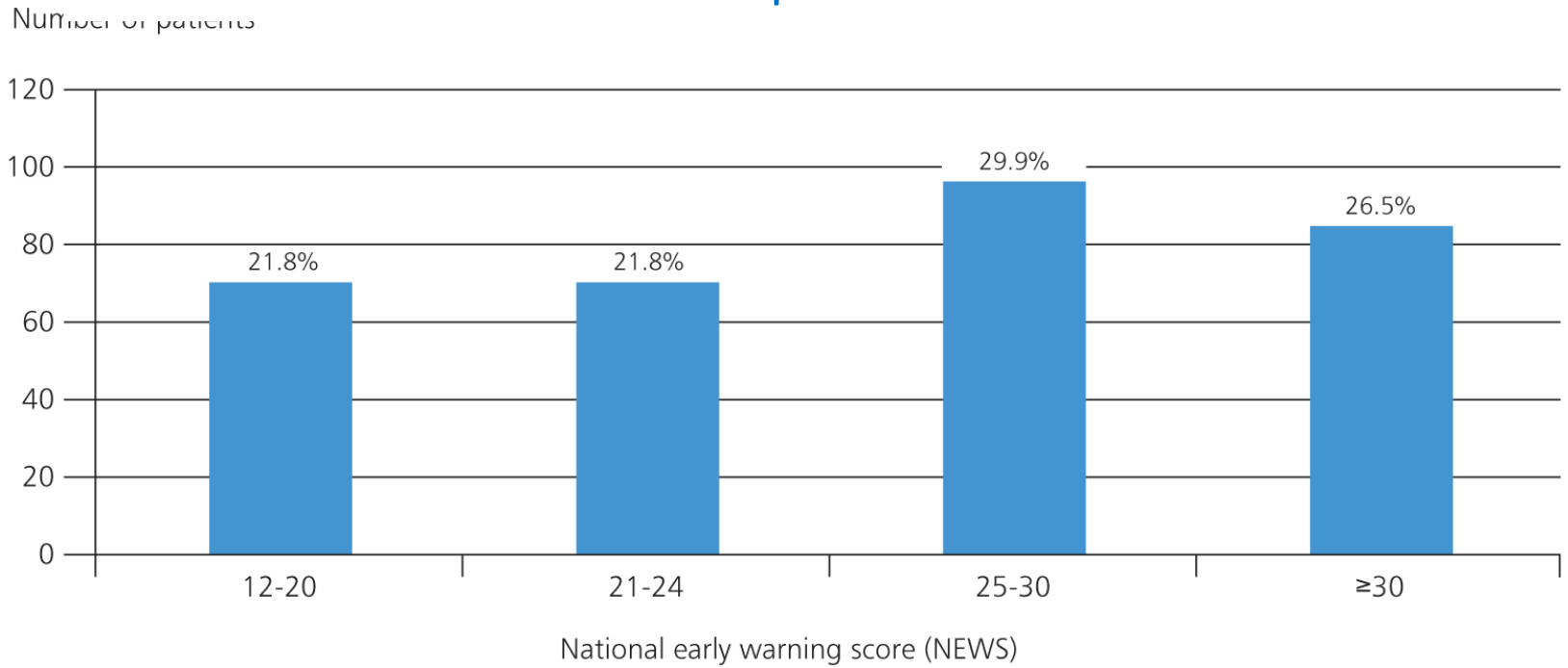


Figure 4.2 Initial triage observation - respiratory rate; n=321

Initial management

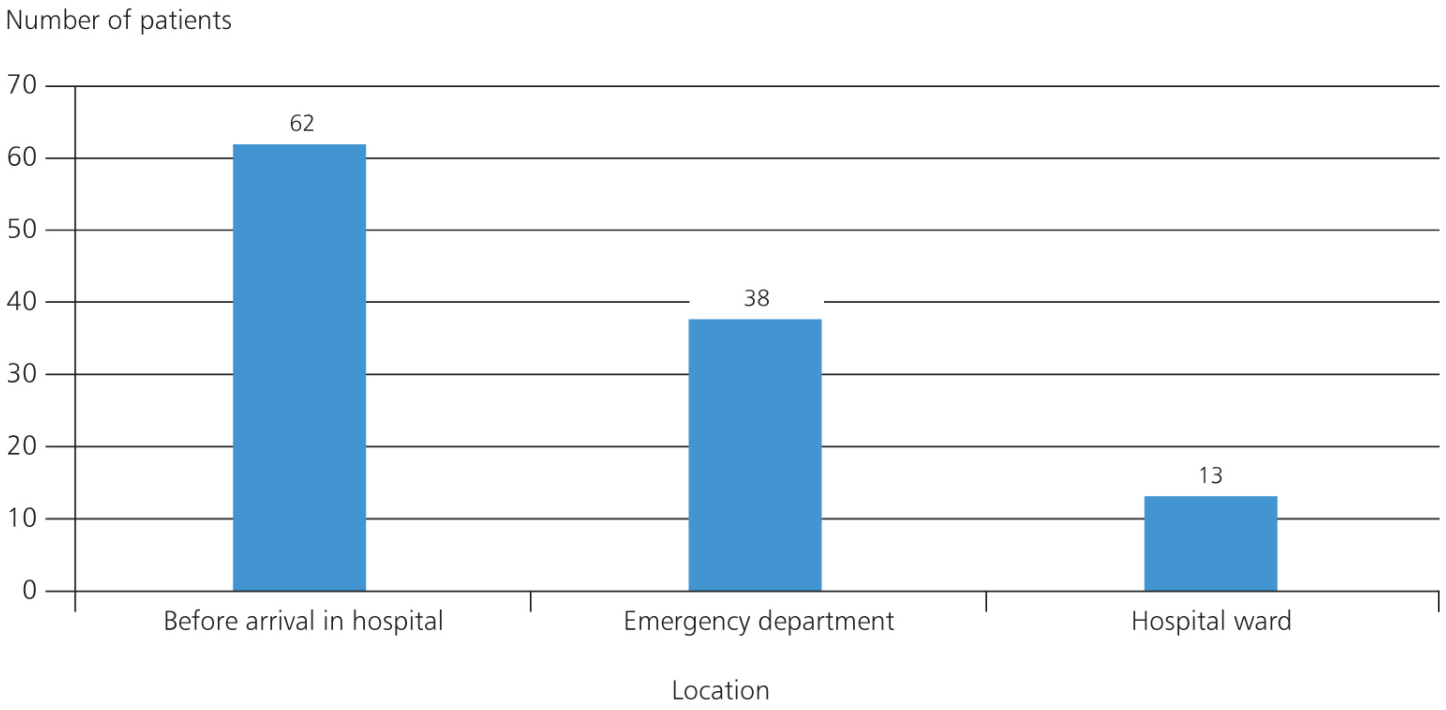


Figure 4.3 Location where excess oxygen was administered – clinician questionnaire
Answers may be multiple; n=91

Initial management

Table 4.1 Oxygen toxicity contributed to hypercapnia

	Reviewers' opinion	%	Clinicians' opinion	%
	Number of patients		Number of patients	
Yes	84	26.9	95	22.6
No	228	73.1	325	77.4
Subtotal	**312**		**420**	
Unknown	41		12	
Total	**353**		**432**	

BTS: Oxygen toxicity in 17%

NCEPOD: 26.9%

Table 4.2 Appropriateness of oxygen administered in the emergency department – reviewers' opinion

	Number of patients	%
Yes	157	67.7
No	75	32.3
Subtotal	**232**	
Unknown	70	
Total	**302**	

Initial management

88-92 in 28.6%
Below 88 in 24.4%
Above 92 in 47%

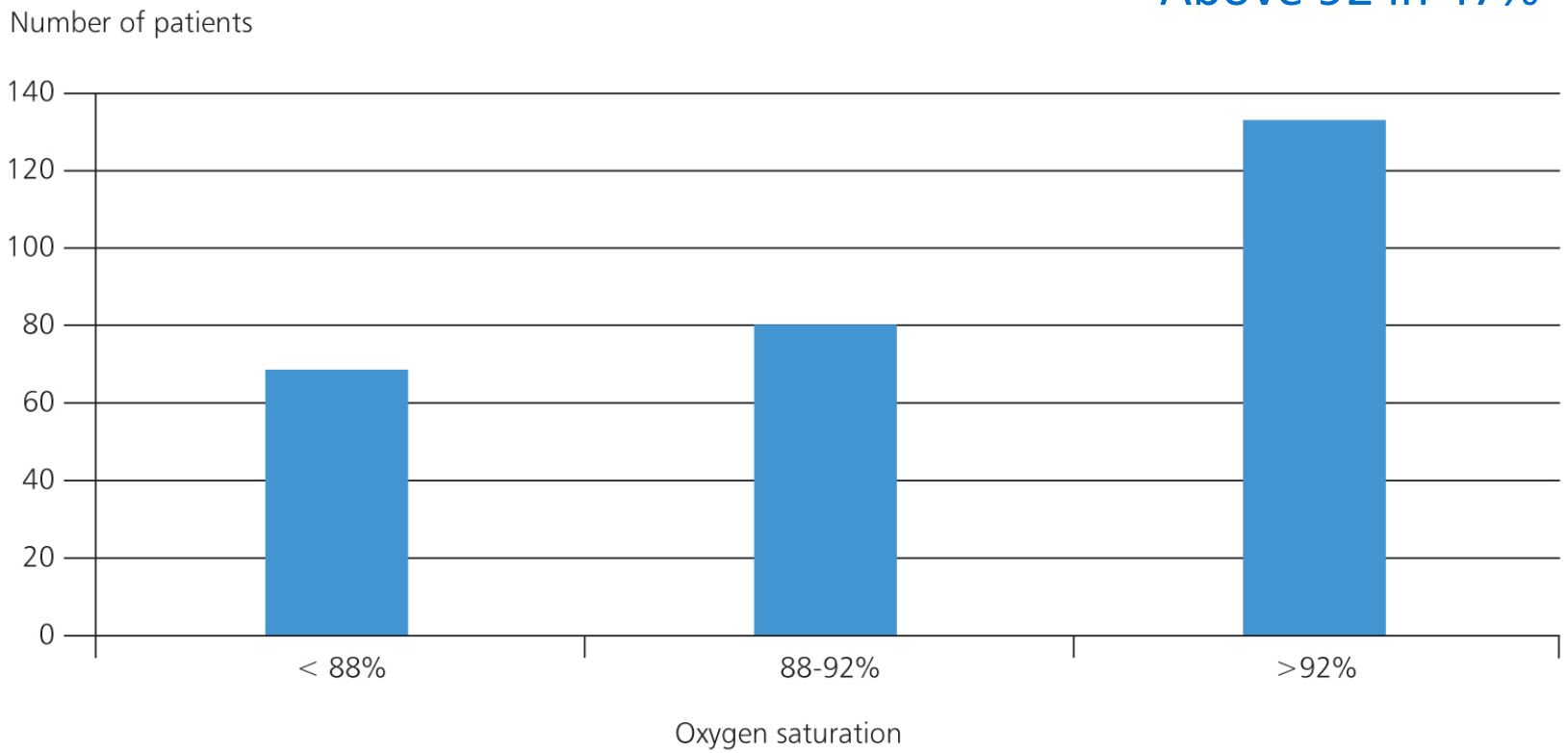


Figure 4.4 Range of oxygen saturation at triage; n=283

Initial management

Table 4.3 Oxygen delivery device in the emergency department

	Number of patients
Nasal cannulae	86
Non-rebreathe device	35
Venturi mask	27
Nebuliser	10
Air	32
Not documented	190
Total	**380**

158 had method recorded

Initial management

Table 6.12 Target saturation prescribed

	Reviewers' opinion		Clinicians' opinion	
	Number of patients	**%**	**Number of patients**	**%**
88-92%	207	59.3	296	71.8
94-98%	16	4.6	17	4.1
Other	21	6.0	8	1.9
Not prescribed	105	30.1	91	22.1
Subtotal	**349**		**412**	
Not answered	4		20	
Total	**353**		**432**	

Table 6.13 Target saturation achieved

	Reviewers' opinion		Clinicians' opinion	
	Number of patients	**%**	**Number of patients**	**%**
Yes	135	59.2	252	82.1
No - too high	77	33.8	40	13.0
No - too low	16	7.0	15	4.9
Subtotal	**228**		**307**	
Not answered	16		13	
Total	**244**		**320**	

Initial management

Table 4.4 Specialty of first consultant review

	Number of patients	%
Respiratory medicine	98	23.9
Acute medicine	97	23.7
General medicine	78	19.0
Critical/intensive care medicine	32	7.8
Geriatric medicine	27	6.6
Gastroenterology	17	4.1
Cardiology	16	3.9
Endocrinology	14	3.4
Other	31	7.6
Subtotal	**410**	
Unanswered	22	
Total	**432**	

Initial management

Table 4.5 Appropriate timing of the consultant review – reviewers' opinion

	Number of patients	%
Yes	280	87.5
No	40	12.5
Subtotal	**320**	
Not answered	33	
Total	**353**	

Initial management

Table 4.6 Clear initial management plan – reviewers' opinion

	Number of patients	%
Yes	324	93.4
No	23	6.6
Subtotal	**347**	
Not answered	6	
Total	**353**	

Table 4.7 Appropriate initial management plan – reviewers' opinion

	Number of patients	%
Yes	268	90.8
No	27	9.2
Subtotal	**295**	
Not answered	29	
Total	**324**	

14.4% had either no clear initial management plan or an inappropriate one

Mark Juniper

Service organisation

Location of NIV provision

- Initiated: acute care areas
- Continued: respiratory service/critical care

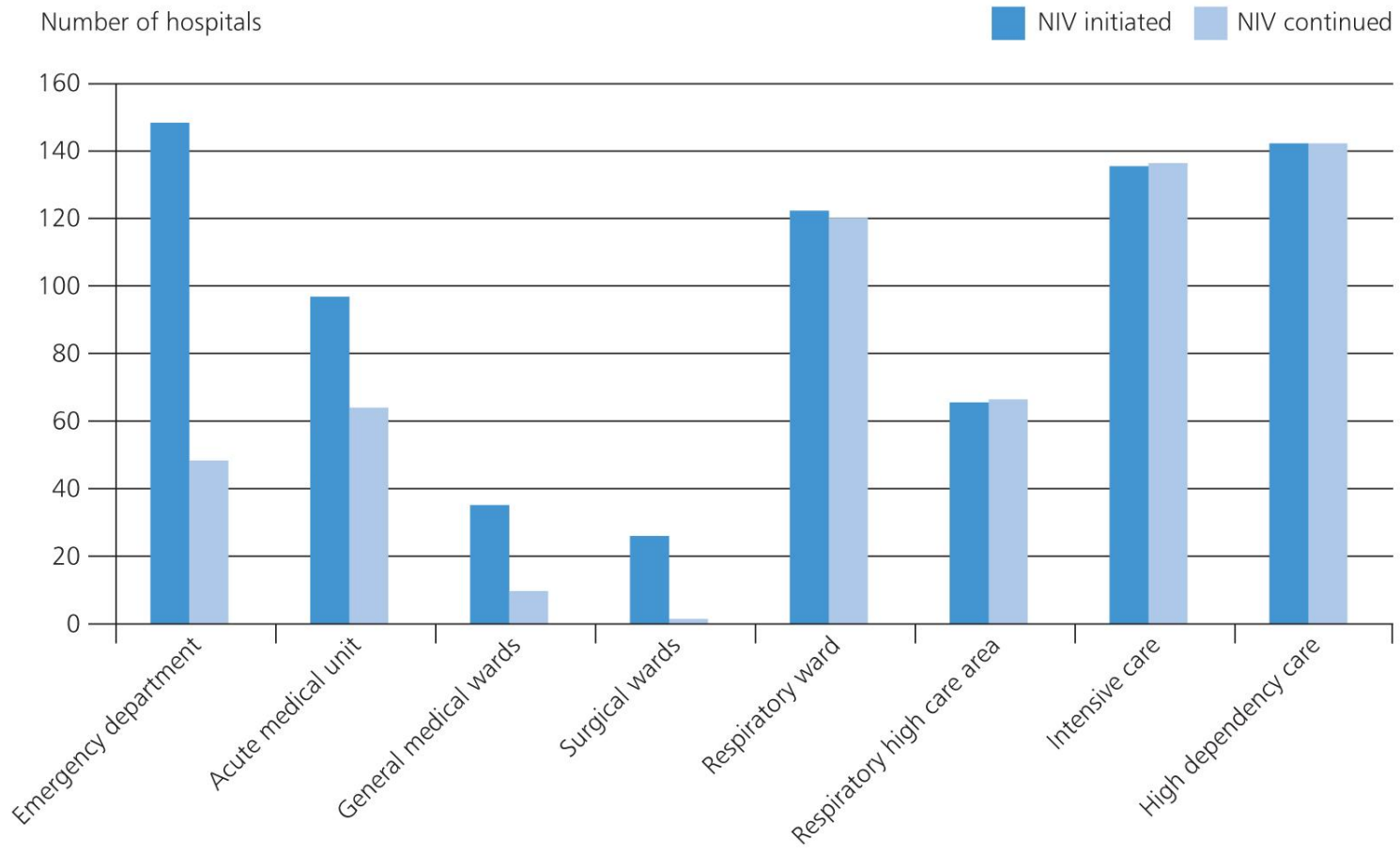


Figure 2.3 Locations where NIV was initiated and continued

Service organisation

Table 2.9 Identified clinical lead for NIV service

	Number of hospitals	%
Yes	144	86.7
No	22	13.3
Subtotal	**166**	
Not answered	2	
Total	**168**	

138/140 respiratory consultant

110/133 no time allocated

160/168 (95.2%) hospitals local guideline

140/157 (89.2%) NIV training programme

Table 2.10 Non-medical lead for NIV

	Number of hospitals	%
Yes – Nursing	69	43.9
Yes – Physiotherapy	23	14.6
No	65	41.4
Subtotal	**157**	
Not answered	11	
Total	**168**	

Staffing

‘Designated NIV unit’

79/162 (48.8%) defined ratio of nurses to NIV patients

Table 2.7 Staff competency assessment for delivery of NIV

	Number of hospitals	%
Yes	126	81.8
No	28	18.2
Subtotal	**154**	
Not answered	14	
Total	**168**	

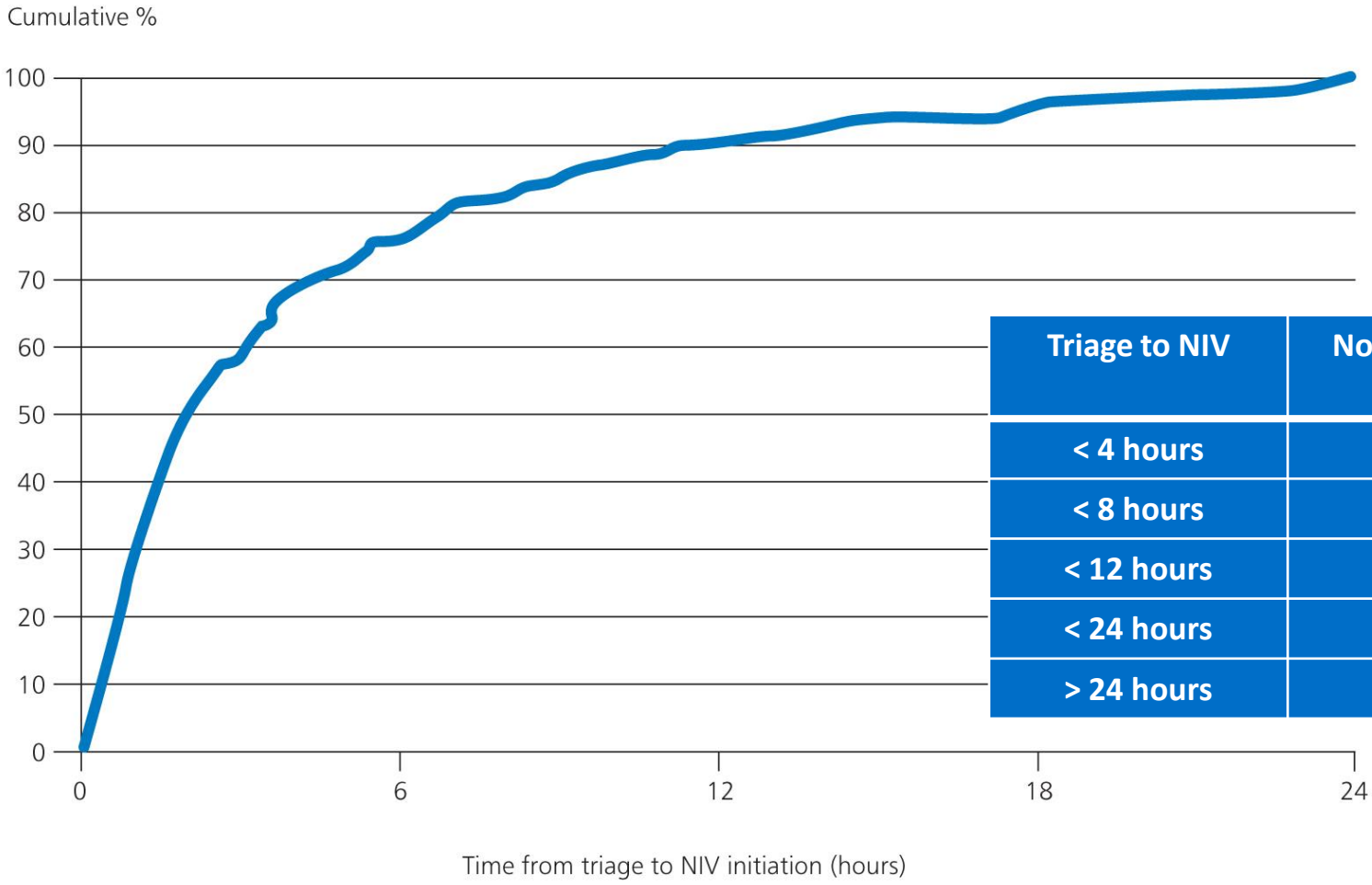
Table 2.8 Staff without competency directly supervise NIV patients

	Number of hospitals	%
Yes	42	37.8
No	69	62.2
Subtotal	**111**	
Not answered	15	
Total	**126**	

70/154 (45.4%) staff without defined competency supervise NIV patients

NIV initiation

NIV initiation



Triage to NIV	No. (%) of patients (n=242)
< 4 hours	116 (47.9)
< 8 hours	140 (57.9)
< 12 hours	154 (63.6)
< 24 hours	171 (70.5)
> 24 hours	71 (29.5)

Figure 5.1 Time from triage to NIV initiation in the first 24 hours; n=171

NIV initiation

Table 5.16 Doctor who made decision to initiate NIV

	Number of patients	%
General medicine	107	29.6
Respiratory medicine	85	23.5
Emergency medicine	61	16.9
Critical/intensive care medicine	43	11.9
Acute internal medicine	32	8.9
Cardiology	9	2.5
Geriatric medicine	8	2.2
Anaesthetics	5	1.4
Gastroenterology	5	1.4
Other	6	1.7
Subtotal	**361**	
Unanswered	71	
Total	**432**	

Table 5.15 Grade of doctor who made decision to initiate NIV (number who were respiratory specialists)

	Number of patients	%
Consultant	108 (41)	28.3
Associate Specialist/Speciality doctor	39 (3)	10.2
Trainee with CCT	2 (0)	0.5
Senior specialist trainee	172 (35)	45.0
Junior specialist trainee	32 (2)	8.4
Basic grade	27 (3)	7.1
Specialist nurse / senior staff nurse	2 (1)	<1
Subtotal	**382**	
Unanswered	50	
Total	**432**	

Case selection for NIV

Case selection for NIV

Table 10.1 Pneumonia and x-ray consolidation

	Evidence of pneumonia		Chest x-ray consolidation	
	Number of patients	%	Number of patients	%
Yes	177	50.4	166	40.7
No	174	49.6	242	59.3
Subtotal	**351**		**408**	
Unknown/ not answered	2		24	
Total	**353**		**432**	

12% primary diagnosis of pneumonia

Case selection for NIV

Table 5.1 Appropriateness of NIV as an intervention – reviewers' opinion

	Number of patients	%
Yes	285	81.2
No	66	18.8
Subtotal	**351**	
Not answered	2	
Total	**353**	

Table 10.2 Evidence of pneumonia and appropriate use of NIV – reviewers' opinion

	NIV an appropriate intervention				
Evidence of pneumonia	**Yes**	**No**	**Subtotal**	**Not answered**	**Total**
Yes	130	45	**175**	2	**177**
No	153	21	**174**	0	**174**
Subtotal	**283**	**66**	**349**	**2**	**351**
Not answered	2	0	**2**	0	**2**
Total	**285**	**66**	**351**	**2**	**353**

Inappropriate NIV

Table 5.2 Reasons why the reviewers believed NIV was inappropriate

Hypoxaemia (not hypercapnia)	5
Metabolic acidosis	5
ICU/intubation preferred option	17
Medical management	11
Advanced/terminal illness	27

Answers may be multiple; n=65

Table 5.3 Outcome for the patients where NIV was considered inappropriate

	Reason (number of patients who were admitted to critical care)				
Outcome	**Futile**	**Intubation**	**Medical**	**Other**	**Total**
Died in hospital	24	8	4	6	**42**
Discharged alive	3(1)	9 (7)	7 (2)	5 (2)	**24**
Total	**27**	**17**	**11**	**11**	**66**

Inappropriate NIV

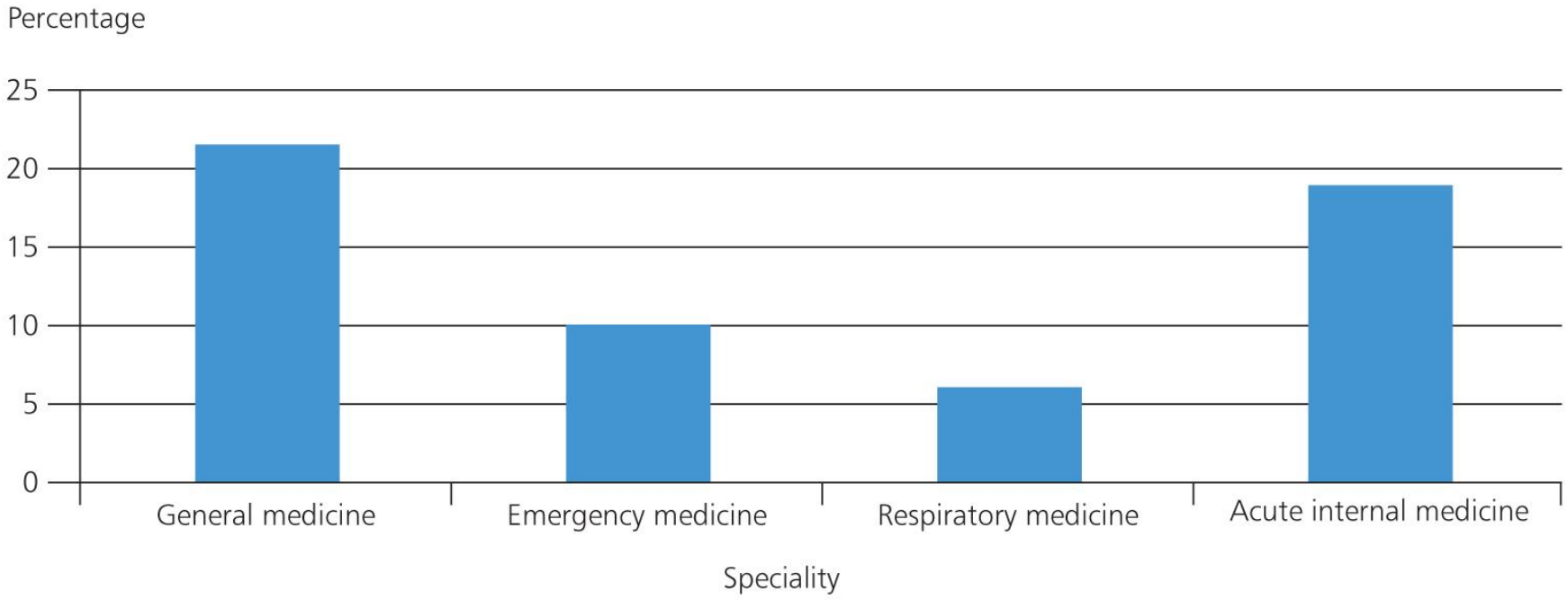


Figure 5.2 Inappropriate NIV by initiating specialty – reviewers' opinion

ITU 15/40 inappropriate as delayed intubation

CASE STUDY 1

An elderly patient with advanced metastatic lung cancer was admitted to hospital with pneumonia and treated with antibiotics and oxygen. On the fifth night after admission they deteriorated. A blood gas showed ventilatory failure. They were transferred to the respiratory unit for acute NIV. On review by the respiratory consultant the following morning NIV treatment was felt to be inappropriate. The patient was treated on an end of life pathway and died a few hours later.

The reviewers agreed that starting NIV was inappropriate. Early in the admission, planning for end of life care in the event of deterioration would have been more appropriate.

Escalation planning

Escalation planning

Table 5.4 Documented plan in event of treatment failure

	Number of patients	%
Yes	224	63.6
No	128	36.4
Subtotal	**352**	
Not answered	1	
Total	**353**	

Plan appropriate in 204/218 (93.6%) cases reviewed

Escalation planning

Table 5.6 Escalation decisions

	Number of patients	%
For CPR	67	22.2
Not for CPR	198	65.6
For invasive ventilation	68	22.5
Not for invasive ventilation	183	60.6
For critical care	79	26.2
Not for critical care	137	45.4

Answers may be multiple; n=302

Plan appropriate in 204/218 (93.6%) cases reviewed

Non-ventilator management

Pre-NIV management

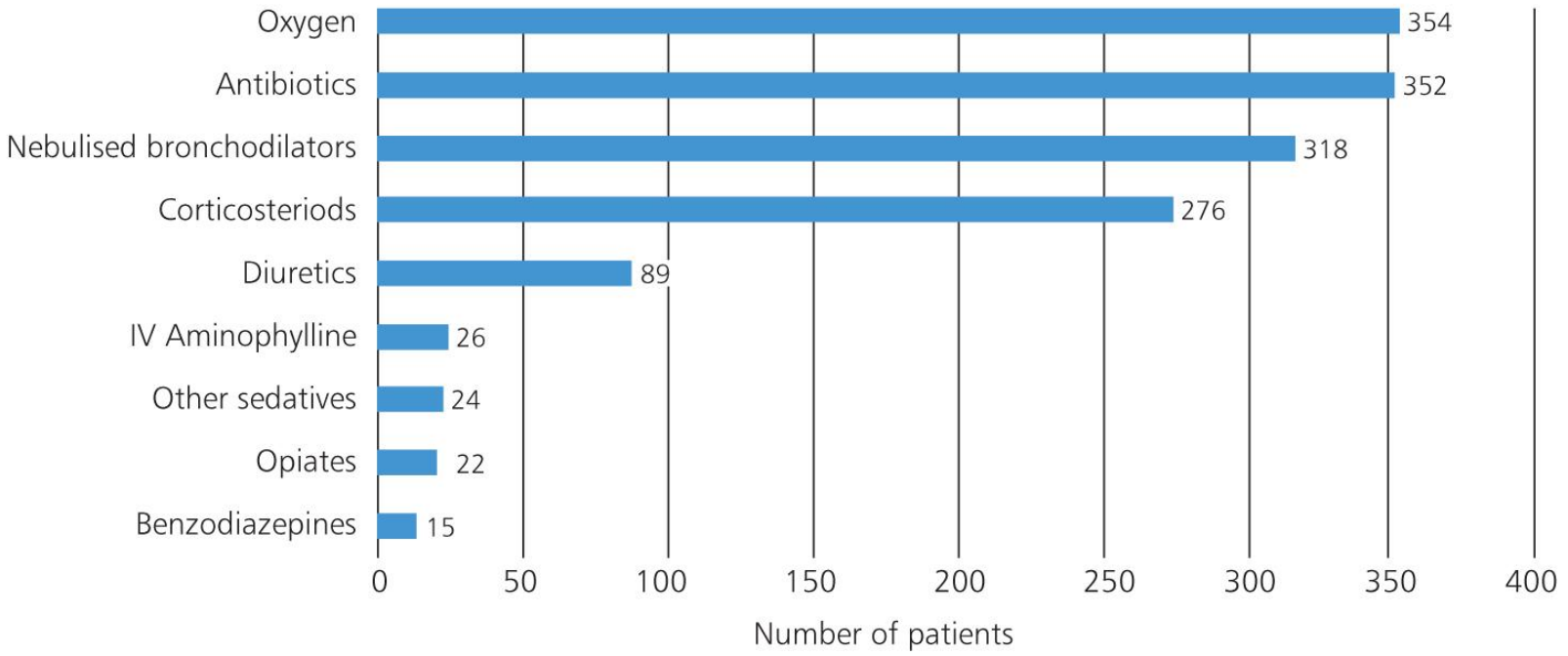


Figure 5.3 Treatments prescribed/administered following admission; n=413

Pre-NIV management

Table 5.7 Non-ventilator management appropriate prior to NIV

	Reviewers' opinion		Clinicians' opinion	
	Number of patients	**%**	**Number of patients**	**%**
Yes	272	77.3	350	82.9
No	80	22.7	72	17.1
Subtotal	**352**		**422**	
Not answered	1		10	
Total	**353**		**432**	

Clinician or reviewer considered potential for improved non-ventilator management in 103/314 patients (32.8%)

Pre-NIV management

Table 5.9 NIV could have been avoided

	Reviewers' opinion	Clinicians' opinion
	Number of patients	Number of patients
Yes	38	26
No	41	39
Subtotal	**79**	**65**
Not answered	0	6
Total	**79**	**71**

CASE STUDY 3

A patient was brought to hospital by ambulance with an exacerbation of COPD. On initial assessment, the patient was wheezy, respiratory rate was 24 and oxygen saturation 98% on a non-rebreathe system. Blood gases revealed pO_2 15.3 kPa, pCO_2 8.2 kPa and pH 7.28. The patient was started on NIV and improved rapidly. NIV was discontinued six hours later.

Reviewers considered that oxygen toxicity contributed to the ventilatory failure and that NIV could have been avoided with better management including controlled oxygen and nebulised bronchodilators.

Specialist review

Specialist review

91/165 (55.2%) hospitals NIV cover out of hours via GIM on call rota

119/158 (75.3%) respiratory cover <50% of rota

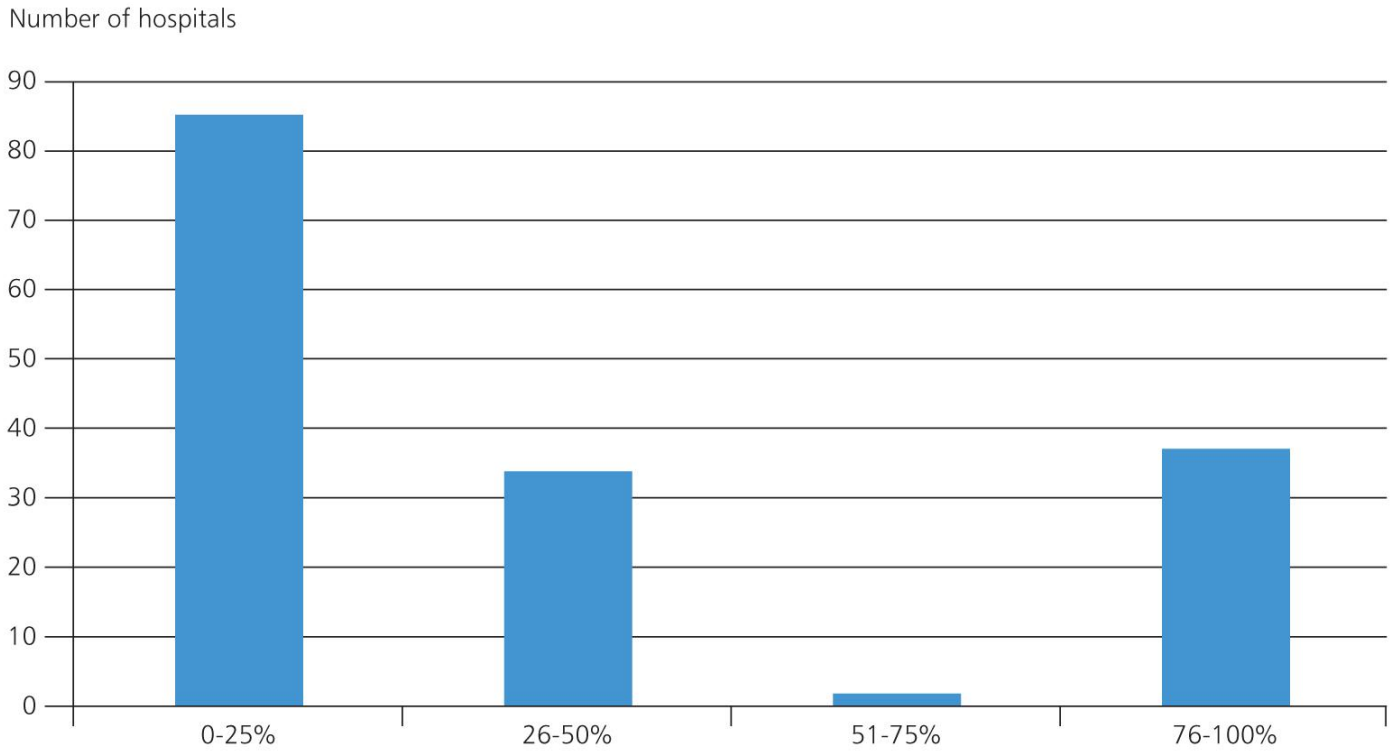


Figure 2.2 Percentage of out of hours coverage by a respiratory consultant

Specialist review

Appropriate review in 290/348 (83.3%)

Table 5.11 Specialty of the specialist review

	Number of patients	%
Respiratory medicine	159	61.4
Critical care medicine	60	23.2
Other	14	5.4
General medicine	11	4.2
Cardiology	5	1.9
Acute medicine	5	1.9
Anaesthetics	5	1.9
Subtotal	**259**	
Not documented	31	
Total	**290**	

Respiratory specialist review

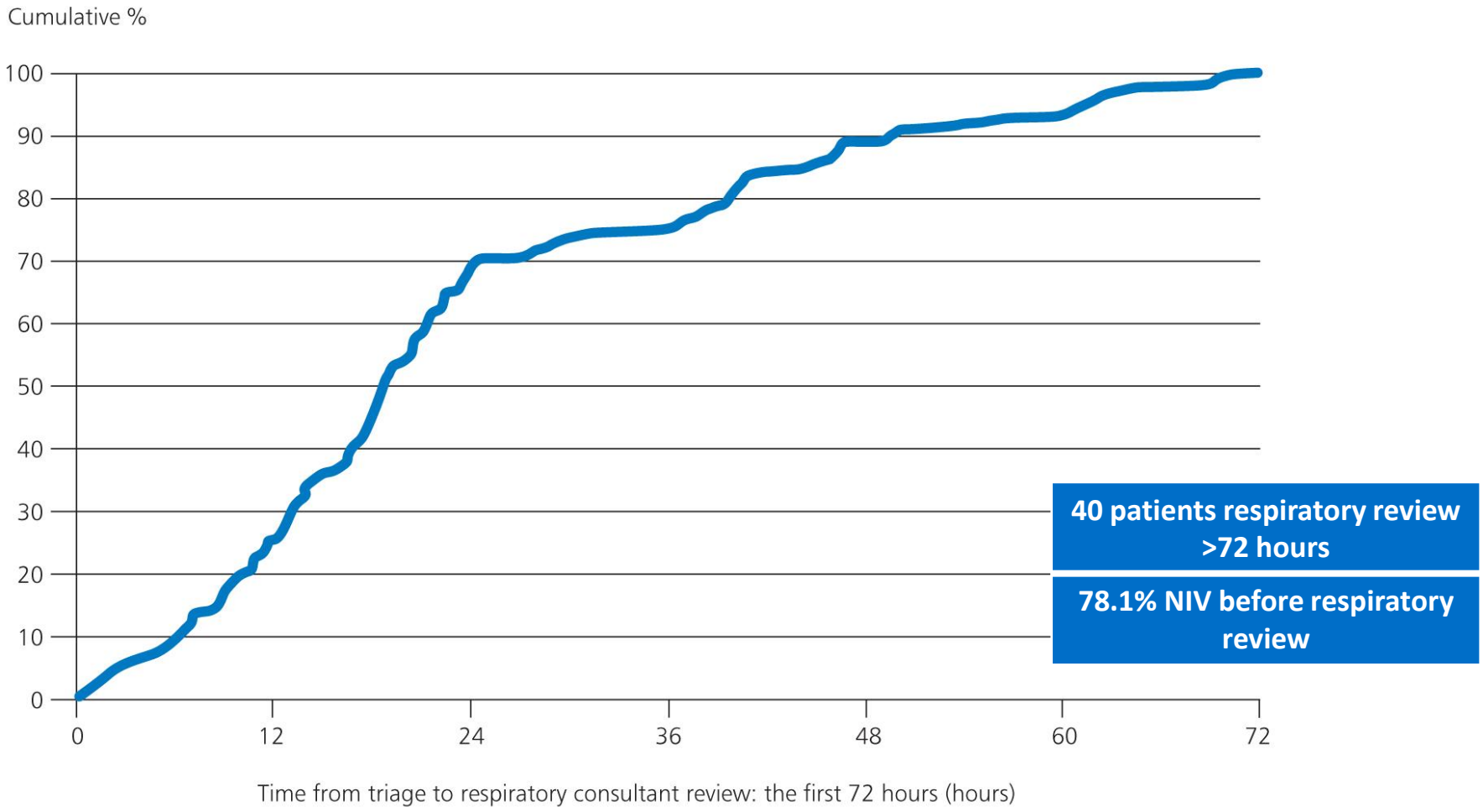


Figure 5.4 Time from triage to respiratory consultant review in the first 72 hours; n=133

Specialist review

Table 5.13 Specialist review resulted in treatment changes

	Number of patients	%
Yes	151	53.2
No	133	46.8
Subtotal	**284**	
Not answered	6	
Total	**290**	

Table 5.14 Changes made

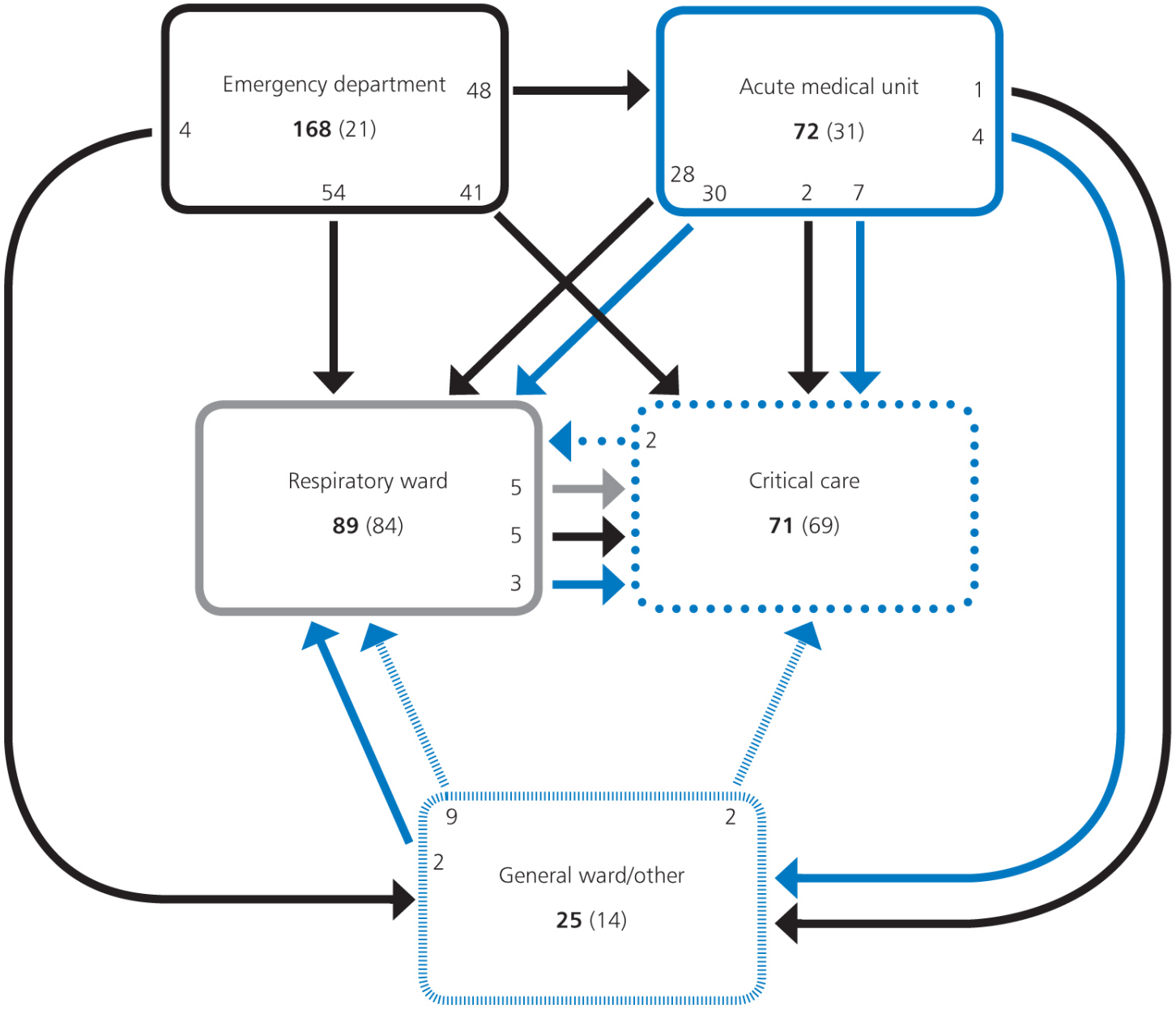
	Change in ventilator settings		Change in non-ventilator treatments	
	Number of patients	%	Number of patients	%
Yes	72	50.7	105	73.4
No	70	49.3	38	26.6
Subtotal	**142**		**143**	
Not answered	9		8	
Total	**151**		**151**	

Medical review on NIV

Table 5.17 Daily senior medical review (ST3 or above) while on NIV recorded in the notes

	Number of patients	%
Yes	242	80.7
No	58	19.3
Subtotal	**300**	
Unknown	53	
Total	**353**	

Non-invasive ventilation episode



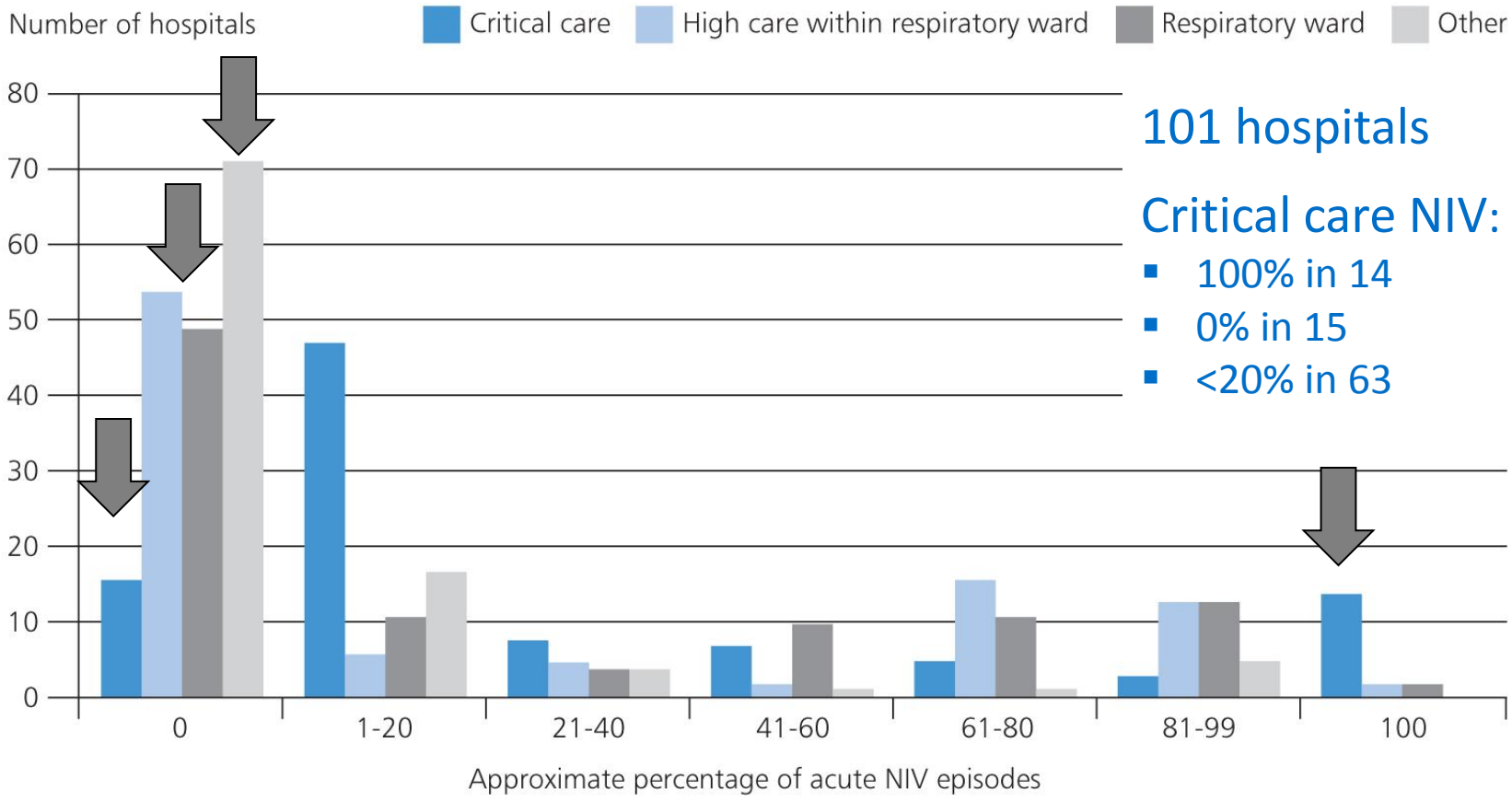
Respiratory ward: 214/425 (50.4%)

Critical care: 136/425 (32%)

AMU: 120/425 (28.2%)

Figure 6.1 The flow of NIV patients through clinical areas in the hospital. Numbers in bold show where NIV was started, numbers in brackets where NIV was completed in the same location it was started, numbers by arrows where patients moved between locations whilst on NIV (arrows coded by the location NIV was started).

Proportion of NIV in clinical areas



101 hospitals

Critical care NIV:

- 100% in 14
- 0% in 15
- <20% in 63

Figure 2.4 Approximate percentage of NIV episodes provided in different clinical areas

NIV location

Table 6.1 NIV delivered in appropriate location – reviewers' opinion

	Number of patients	%
Yes	265	93.3
No	19	6.7
Subtotal	**284**	
Unknown	69	
Total	**353**	

Delay in NIV treatment

Delay in NIV treatment

Table 6.2 Delay in Starting NIV

	Reviewers' opinion		Clinicians' opinion	
	Number of patients	**%**	**Number of patients**	**%**
Yes	96	27.4	63	15.0
No	254	72.6	357	85.0
Subtotal	**350**		**420**	
Not answered	3		12	
Total	**353**		**432**	

Delay in NIV treatment

Table 6.4 Reason for the delay in NIV treatment

	Reviewers' opinion (n=96)	Clinicians' opinion (n=63)
Failure to recognise need	41	18
Required transfer	28	27
Lack of beds	11	0
Other	33	18

Answers may be multiple

Delay in NIV treatment

Table 6.5 Ward transfer for treatment with NIV

	Number of patients	%
Yes - transferred before starting treatment	118	28.0
Yes - treatment initiated then transferred	113	26.8
No	191	45.3
Subtotal	**422**	
Not answered	10	
Total	**432**	

CASE STUDY 5

An elderly patient was admitted with an exacerbation of COPD. A blood gas sample in the emergency department showed a pH of 7.28 and CO_2 of 8.7 kPa. The patient was referred for admission and reviewed by the medical registrar three hours later. The need for NIV was identified but the patient waited a further four hours for a bed on the respiratory ward. NIV was eventually started 8 hours after the blood gas revealed acute hypercapnic respiratory failure. The patient improved with NIV treatment and was discharged five days later.

The reviewers thought that delay was caused by both the clinical assessment and the local arrangements for NIV provision. Either NIV should have been started in the emergency department, or rapid transfer to the NIV unit should have been facilitated.

Documentation

Documentation

Table 2.12 NIV prescription form

	Number of hospitals	%
Yes	114	68.7
No	52	31.3
Subtotal	**166**	
Not answered	2	
Total	**168**	

Table 2.13 Specific NIV observation chart

	Number of hospitals	%
Yes	136	83.4
No	27	16.6
Subtotal	**163**	
Not answered	5	
Total	**168**	

Documentation

Table 6.7 Ventilator settings adequately documented – reviewers' opinion

	Number of patients	%
Yes	170	48.6
No	180	51.4
Subtotal	**350**	
Not answered	3	
Total	**353**	

CASE STUDY 6

A patient with and exacerbation of COPD, was admitted to the acute respiratory unit with a respiratory rate of 28 and a CO_2 9.4 kPa, pH 7.25. They were started promptly on NIV and slowly improved. Ventilation was continued for four days and the patient was discharged home after a week.

The reviewers commented that the records contained a well-designed NIV observation chart. Despite the good outcome, it was difficult to comment on the quality of NIV treatment as the chart for monitoring vital signs and ventilator settings was poorly completed.

Ventilator management

Ventilator management

Table 5.18 Appropriate grade of clinician involved in adjusting ventilator settings – reviewers' opinion

	Number of patients	%
Yes	187	85.8
No	31	14.2
Subtotal	**218**	
Not documented	135	
Total	**353**	

Ventilator management

245/314 (78%) starting EPAP 4 or 5 cmH_2O

16/314 (5.1%) EPAP > 6 cmH_2O

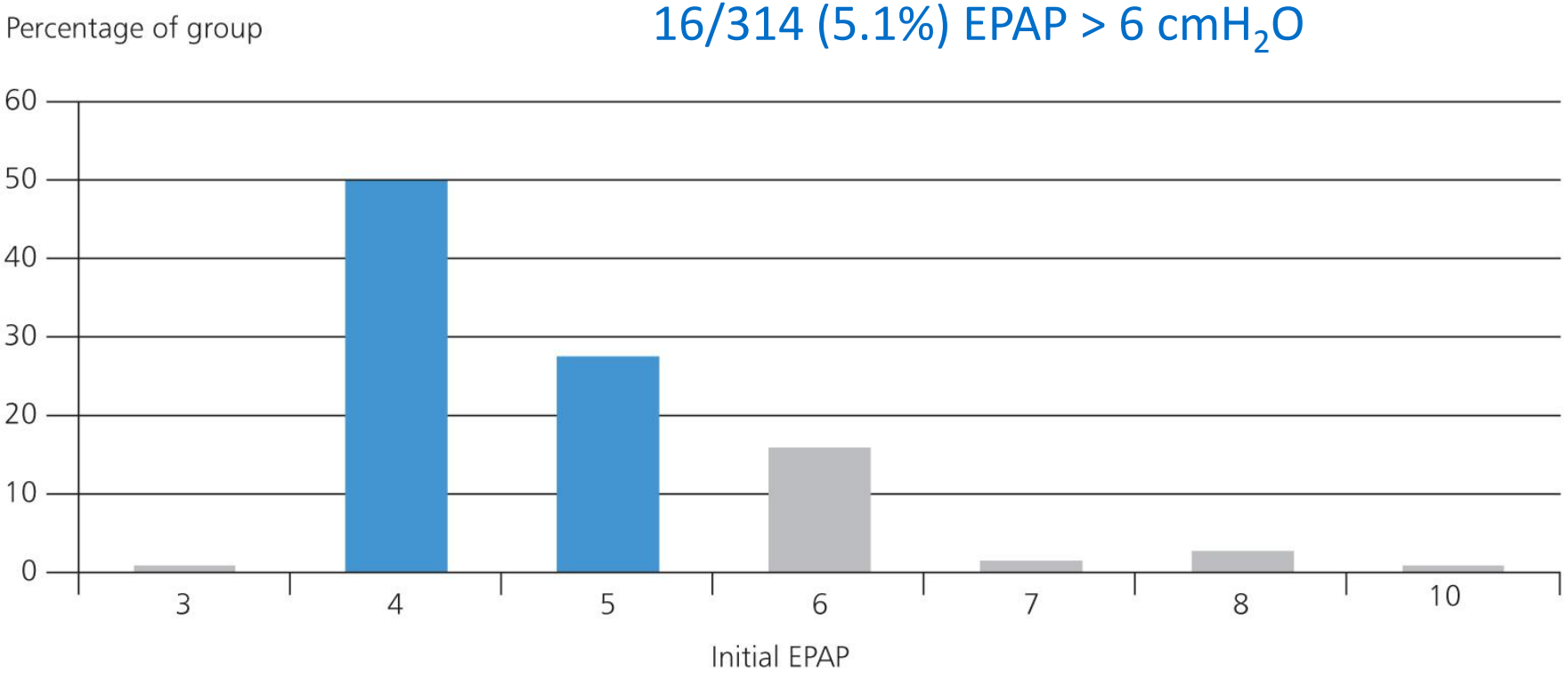


Figure 6.5 Initial expiratory positive airway pressure (EPAP); n=314 (guideline recommended pressure in blue)

Ventilator management

213/312 (68.3%) starting IPAP 10-15 cmH_2O

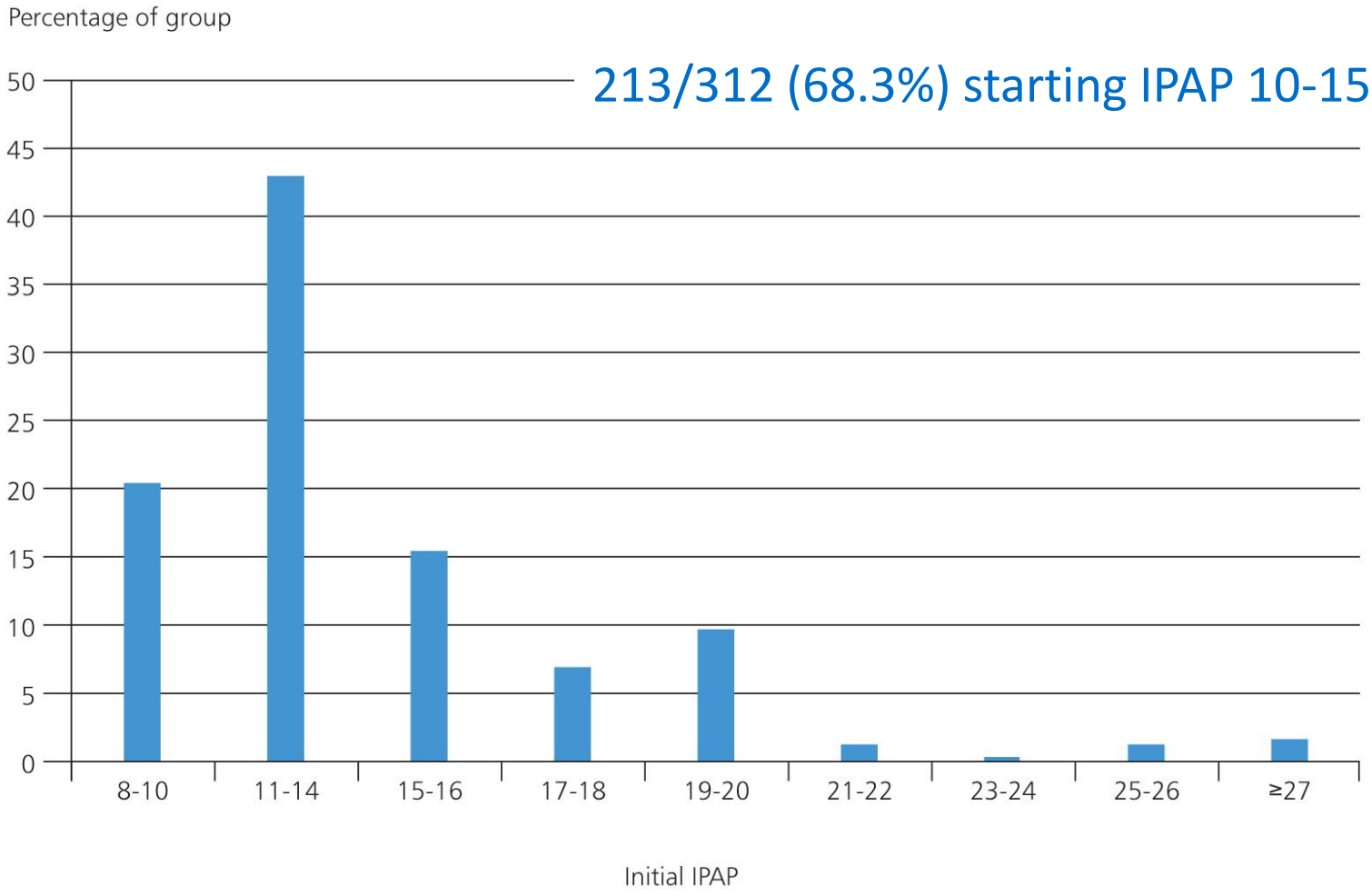


Figure 6.6 Initial inspiratory positive airway pressure (IPAP); n=312

Ventilator management

Table 6.16 Appropriate initial ventilator settings – reviewers' opinion

	Number of patients	%
Yes	236	80.0
No	59	20.0
Subtotal	**295**	
Not answered	58	
Total	**353**	

Ventilator management

43/241 (17.8%) highest EPAP > 6 cmH_2O

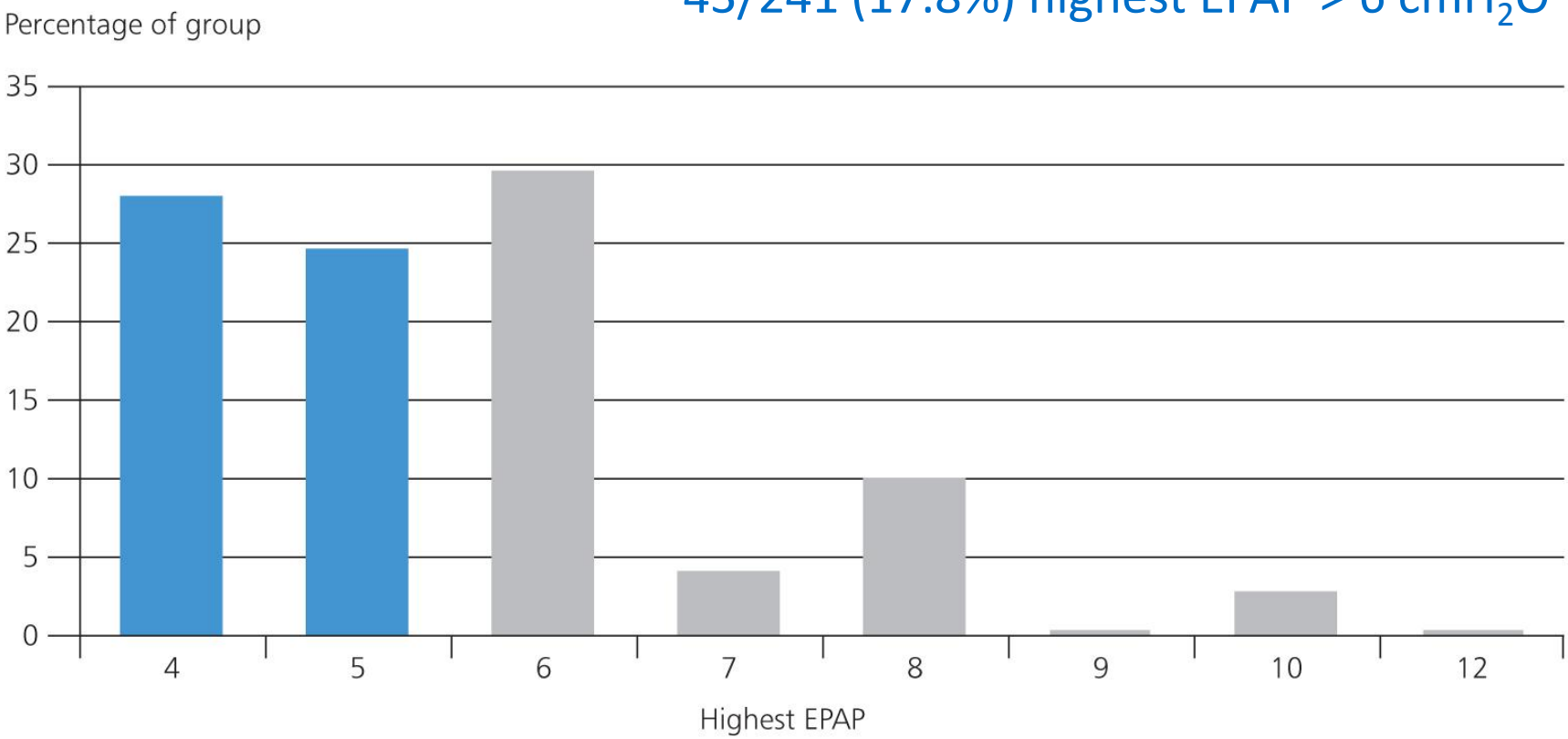


Figure 6.7 Highest expiratory positive airway pressure (EPAP); n=241 (guideline recommended initial pressure in blue)

Ventilator management

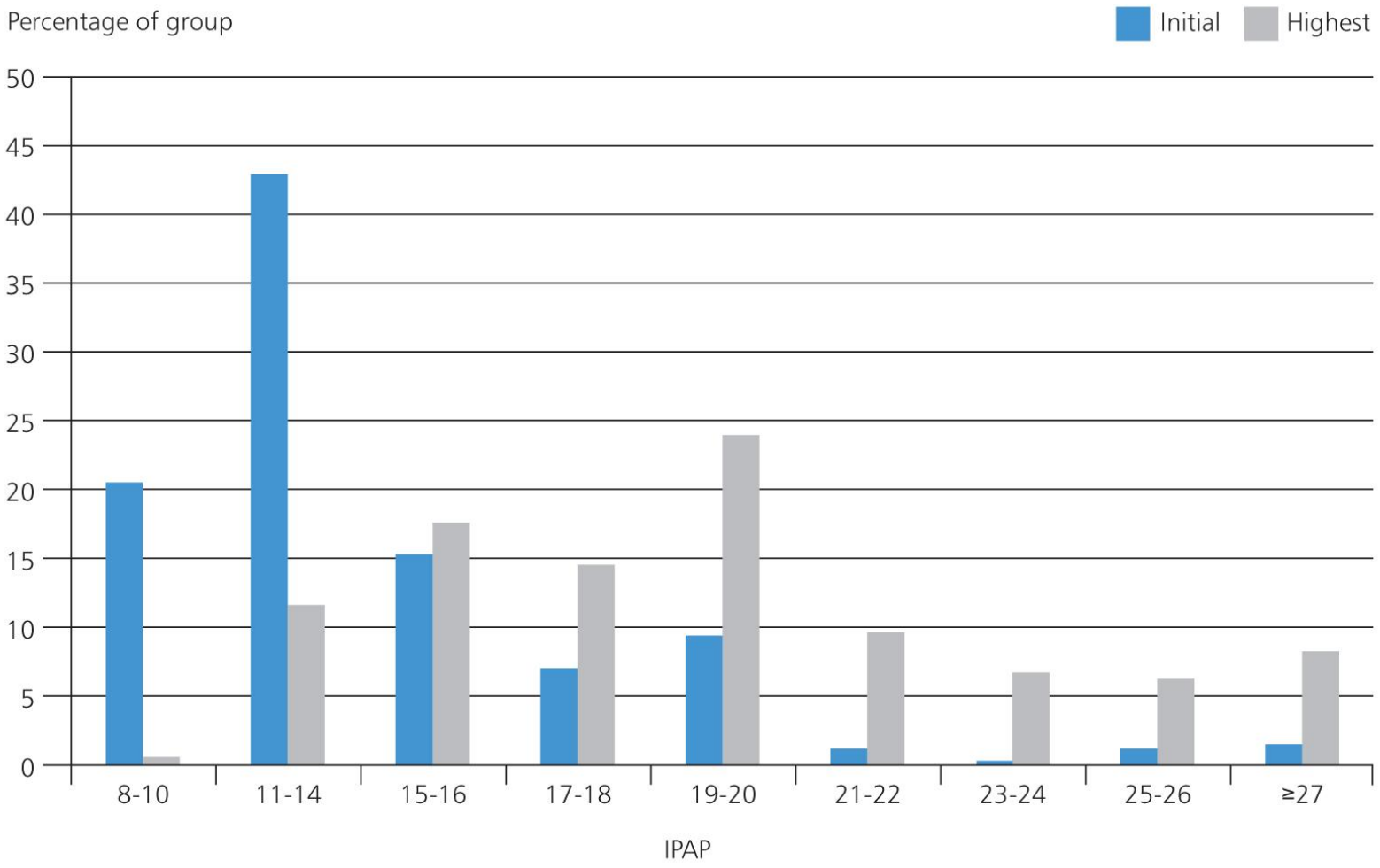


Figure 6.8 Highest delivered inspiratory positive airway pressures (IPAP); n=266 (% at initial values shown for comparison)

Ventilator management

87/353 (24.6%) Highest IPAP not documented

120/266 (45.1%) IPAP below 20 cmH_2O

52/252 (20.6%) no IPAP increase

Table 6.17 Appropriate subsequent ventilator management – reviewers' opinion

	All Reviewed cases		No pressure increase		IPAP <20 cm H_2O	
	Number of patients	%	Number of patients	%	Number of patients	%
Yes	188	65.3	30	66.6	64	58.2
No	100	34.7	15	33.3	46	41.8
Subtotal	**288**		**45**		**110**	
Not answered	65		7		10	
Total	**353**		**52**		**120**	

112/264 (42.4%) inappropriate ventilator management (initial and/or subsequent)

CASE STUDY 4

An elderly patient with COPD presented to hospital with breathing difficulty and drowsiness. Blood gas analysis confirmed severe respiratory acidosis. Acute NIV was commenced promptly at an inspiratory pressure of 12cm H_2O. NIV was delivered for three days with a maximum inspiratory pressure of 14cm H_2O. The patient was reviewed several times daily by junior medical staff. The patient remained tachypnoeic, drowsy and acidotic.

The reviewers thought that a higher inspiratory pressure should have been used and more senior review would have resulted in better NIV management.

Ventilator management

Table 6.32 Room for improvement in decision making about ventilator management – reviewers' opinion

	Number of patients	%
Yes	174	60.4
No	114	39.6
Subtotal	**288**	
Unknown	65	
Total	**353**	

Monitoring & response to NIV

Blood gas measurement

Blood gas sampling:

Arterial	97%
Capillary	34%
Venous	22%

Table 2.3 Dedicated blood gas machine in designated NIV unit

	Number of hospitals	%
Yes	118	72.8
No	44	27.2
Subtotal	**162**	
Not answered	6	
Total	**168**	

Table 6.10 Frequency of blood gas sampling – reviewers' opinion

	Number of patients	%
Appropriate	195	58.9
Too infrequent	107	32.3
Too frequent	29	8.8
Subtotal	**331**	
Not answered	22	
Total	**353**	

Clinical response to NIV

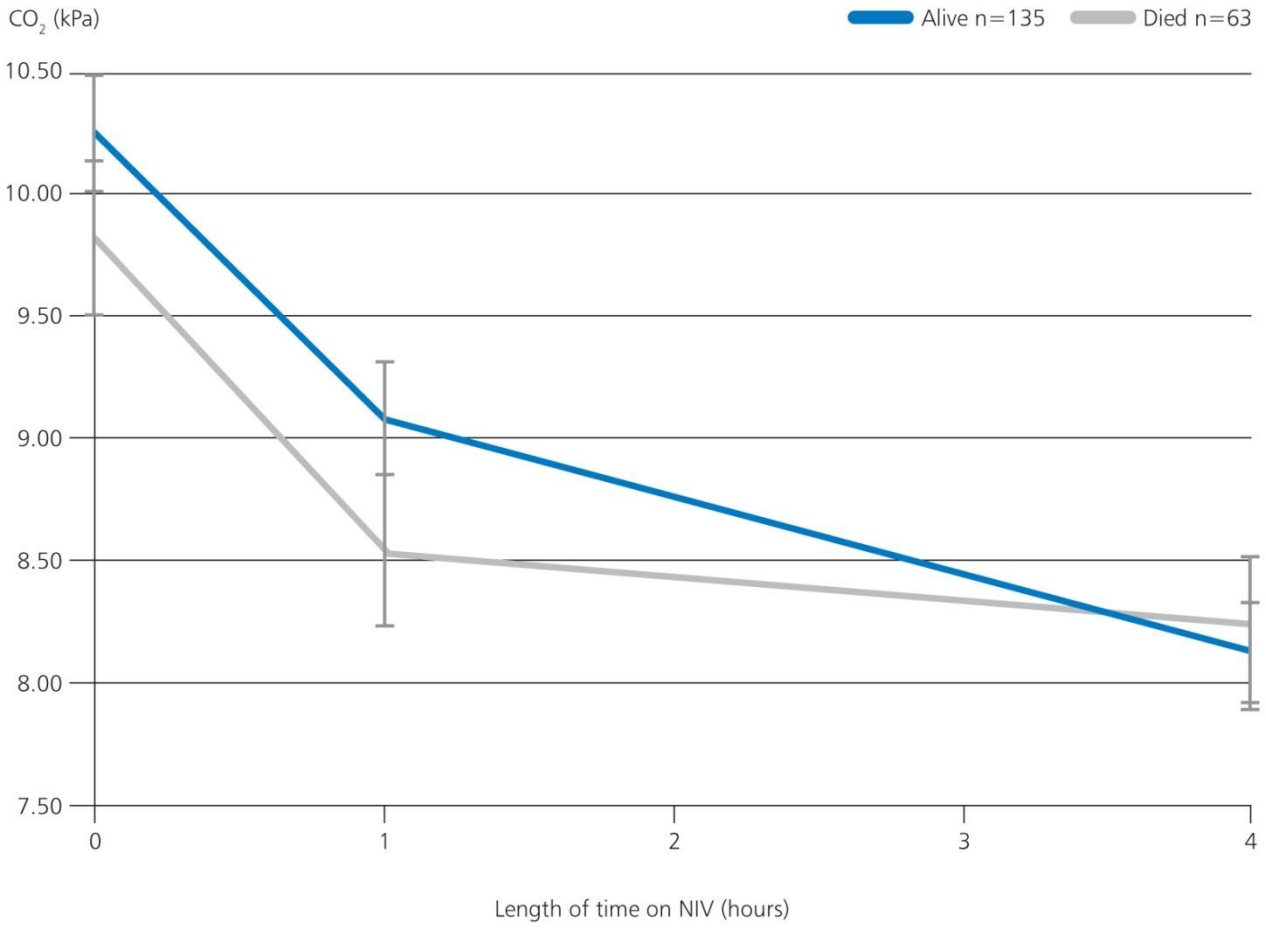


Figure 6.11 Change in CO_2 on NIV (mean and standard error) for patients who survived and those who died (where values recorded at the three time points were available)

Clinical response to NIV

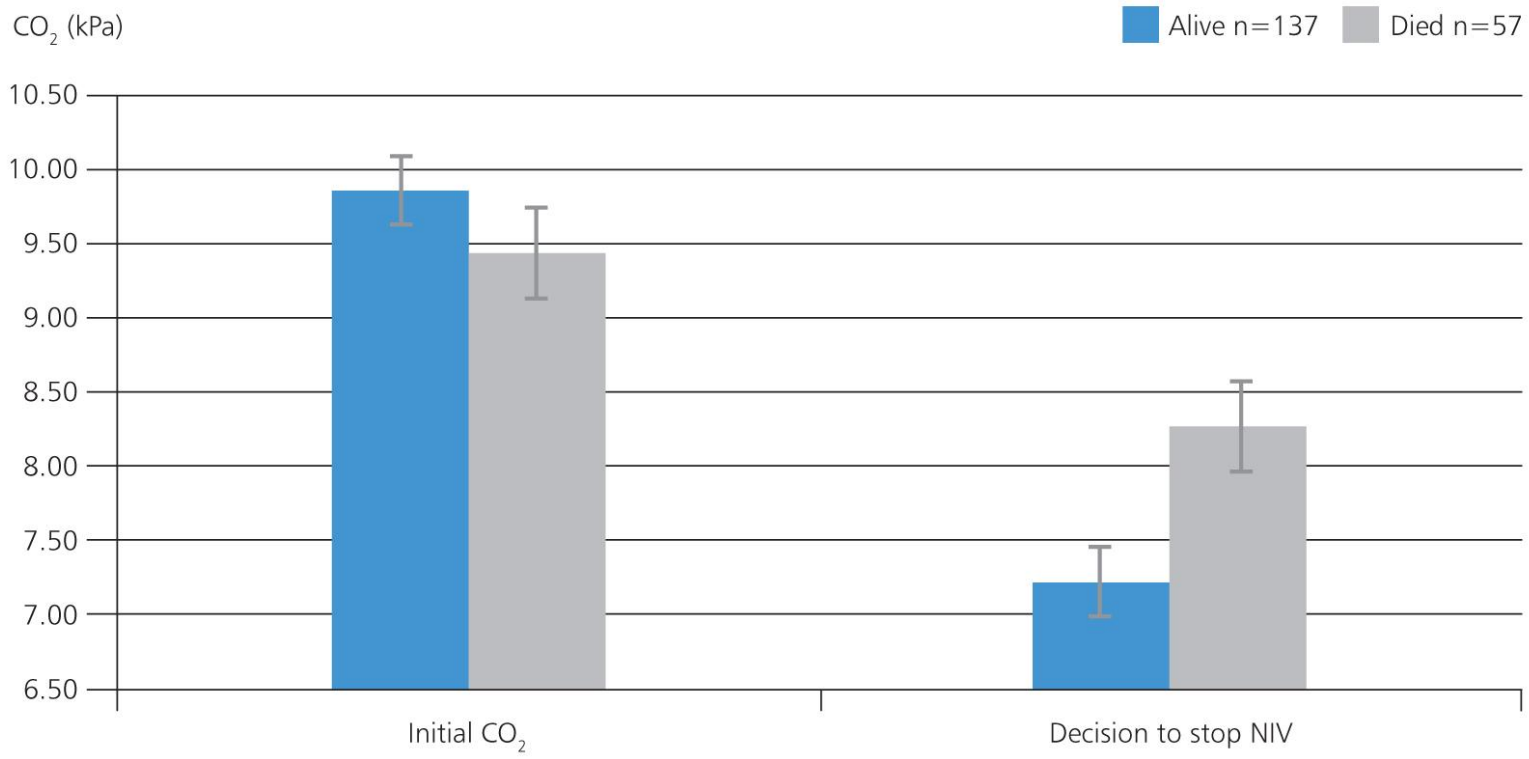


Figure 6.12 CO_2 level at start and end of ventilation (mean and standard error)

Clinical response to NIV

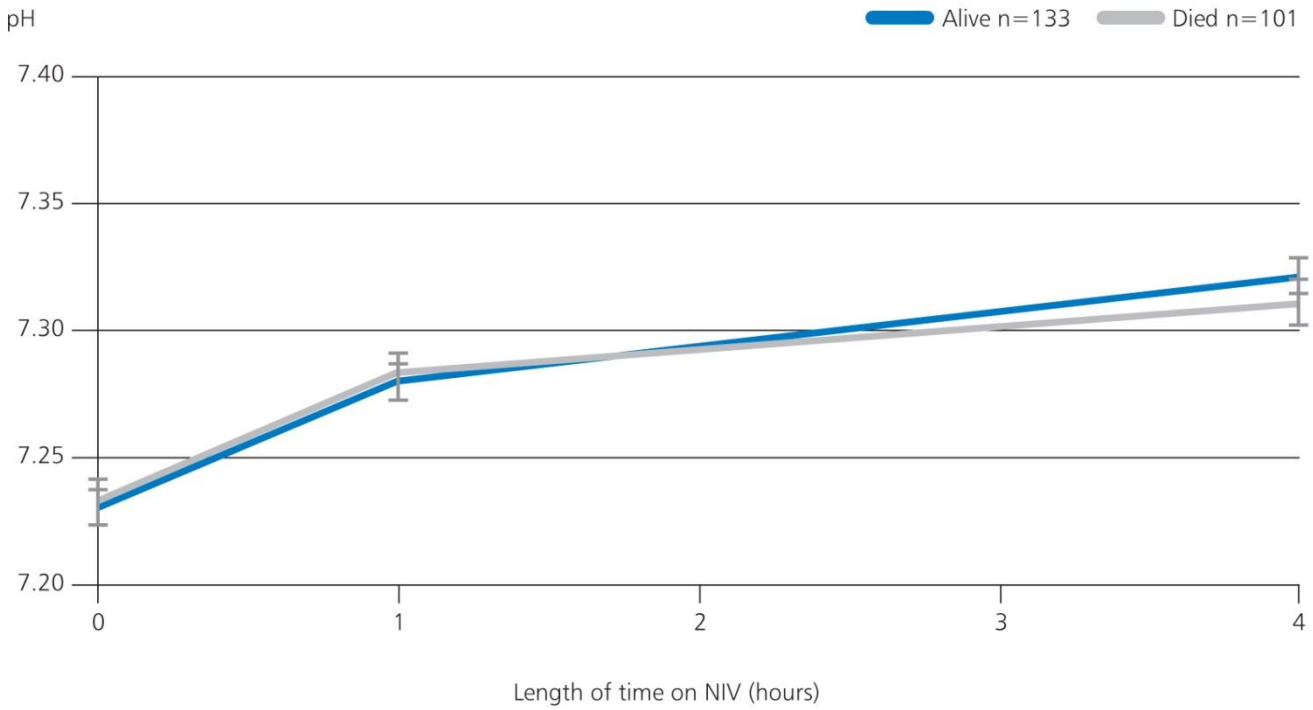


Figure 6.9 pH level at 0, 1 and 4 hours on ventilation (mean and standard error) for patients who survived and those who died (where values recorded at the three time points were available)

Table 6.22 Mean values of pH during NIV episode

	Initiation	1 hour	4 hours
Alive (133 patients)	7.231	7.279	7.321
Died (101 patients)	7.233	7.282	7.311

Clinical response to NIV

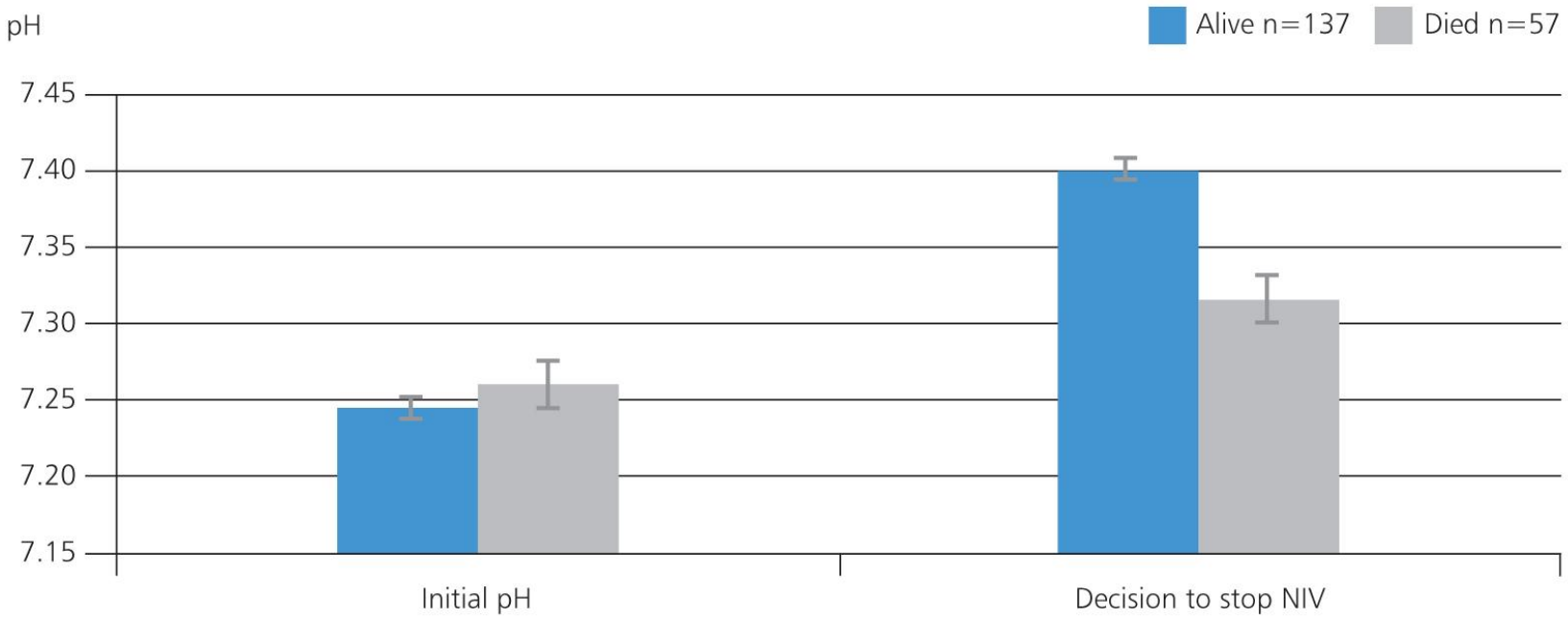


Figure 6.10 pH response to ventilation at initiation and at the end of the ventilation episode

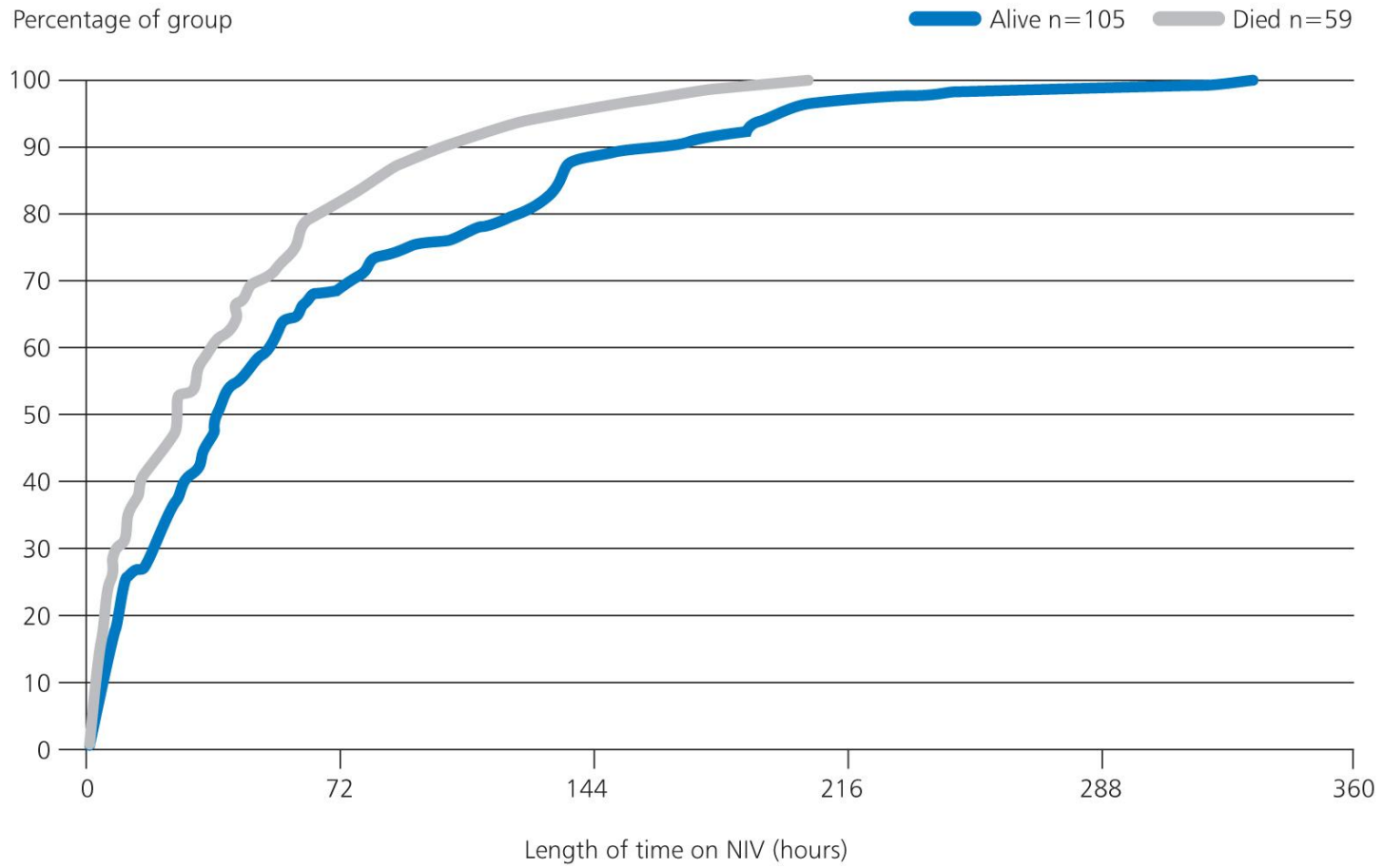


Figure 6.4 Length of time on NIV by outcome; n =164 with documented start and stop times: 105 survivors (blue), 59 deaths (grey) shown as % of each group

Table 6.15 NIV completion within 24, 48 and 72 hours

Number (%) completed NIV episode	24 hours	48 hours	72 hours
Alive (105 patients)	37 (35.2)	60 (57.1)	72 (68.6)
Died (59 patients)	27 (45.8)	41 (69.5)	48 (81.4)

Clinical response to NIV

Table 6.23 Time in hours to correct the acidosis

	Time in hours to normalise pH	Length of time in hours, on NIV
Mean	21:39	79:24
Median	12:17	55:02

Table 6.24 Time to correct acidosis by pH level

	<7.26	≥7.26
Mean	26:54	17:39
Median	18:40	10:52
n=	**63**	**83**

Clinical response to NIV

Table 6.26 NIV discontinued at the appropriate time – reviewers' opinion

	Number of patients	%
Yes	232	72.0
No	90	28.0
Subtotal	**322**	
Unknown	31	
Total	**353**	

Too early:

- Not enough time to correct acidosis

Too late:

- Improvement, NIV only discontinued on senior review

Monitoring: guidelines

2008	2016
Continuous oximetry 12 hours	Continuous oximetry
Continuous ECG 12 hours	ECG if HR >120 / dysrhythmia / cardiomyopathy
pH & CO_2 1,4,12 hours	Intermittent measurement of pH & CO_2
Clinical • 1st hour 15 minutes • 1-4 hours 30 minutes • 4-12 hours hourly	Clinical • No recommendations

Monitoring

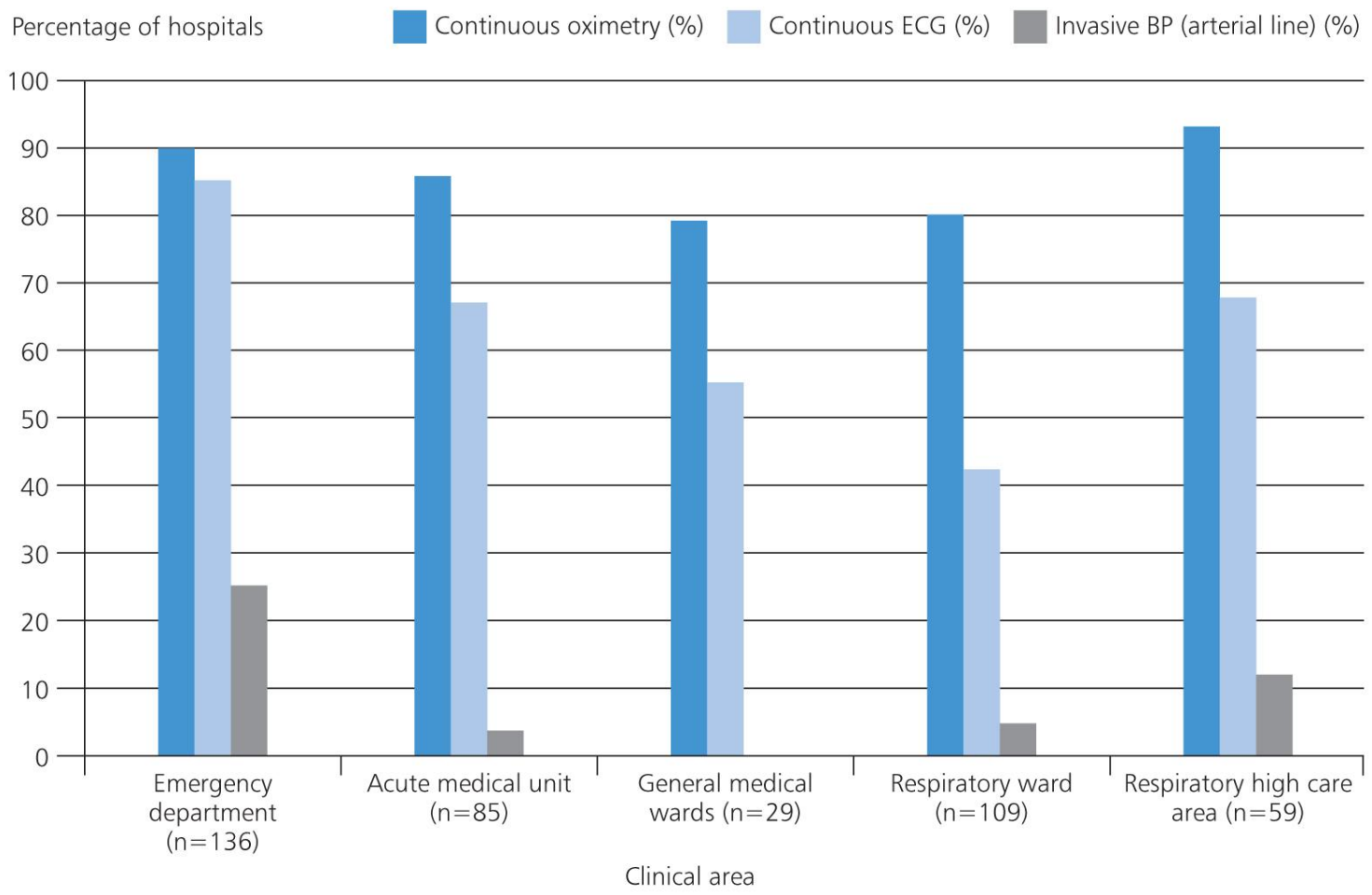


Figure 2.5 Availability of monitoring in different clinical areas

Monitoring

Table 6.11 Patient monitoring could have been improved – reviewers' opinion

	Number of patients	%
Yes	121	45.7
No	144	54.3
Subtotal	**265**	
Unknown	88	
Total	**353**	

Table 6.9 Appropriate frequency of documented observations during NIV – reviewers' opinion

	Number of patients	%
Yes	207	66.6
No	104	33.4
Subtotal	**311**	
Unknown	42	
Total	**353**	

Initial physiological abnormalities

Table 6.8 NEWS categories at start of NIV

NEWS parameter (n)	NEWS 0 (%)	NEWS 1 (%)	NEWS 2 (%)	NEWS 3 (%)
Respiratory rate (254)	72 (28.3) *RR of 12-20*	1 (<1) *RR of 9-11*	54 (21.3) *RR of 21-24*	128 (50.4) *RR of ≤8 or ≥25*
Heart Rate (245)	87 (35.5) *HR of 51-90*	84 (34.3) *HR of 41-50 or 91-110*	58 (23.7) *HR of 111-130*	16 (6.5) *HR of ≤40 or ≥131*
Blood pressure (240)	186 (77.5) *BP of 111-219*	23 (9.6) *BP of 101-110*	18 (7.5) *BP of 91-100*	13 (5.4) *BP of ≤90 or ≥220*
Conscious level* (226)	168 (74.3) *A*			58 (25.7) *V,P or U*
Oxygen saturation (259)	51 (19.7) *O2 of ≥96*	32 (12.4) *O2 of 94-95*	40 (15.4) *O2 of 92-93*	136 (52.5) *O_2 of ≤91*
Oxygen use (432) Clinician Q. data	14 (3.2) *No*		418 (96.8) *Yes*	

**For cases where GCS given for conscious level, GCS 14 or 15 counted as alert on AVPU*

Vital signs response to NIV

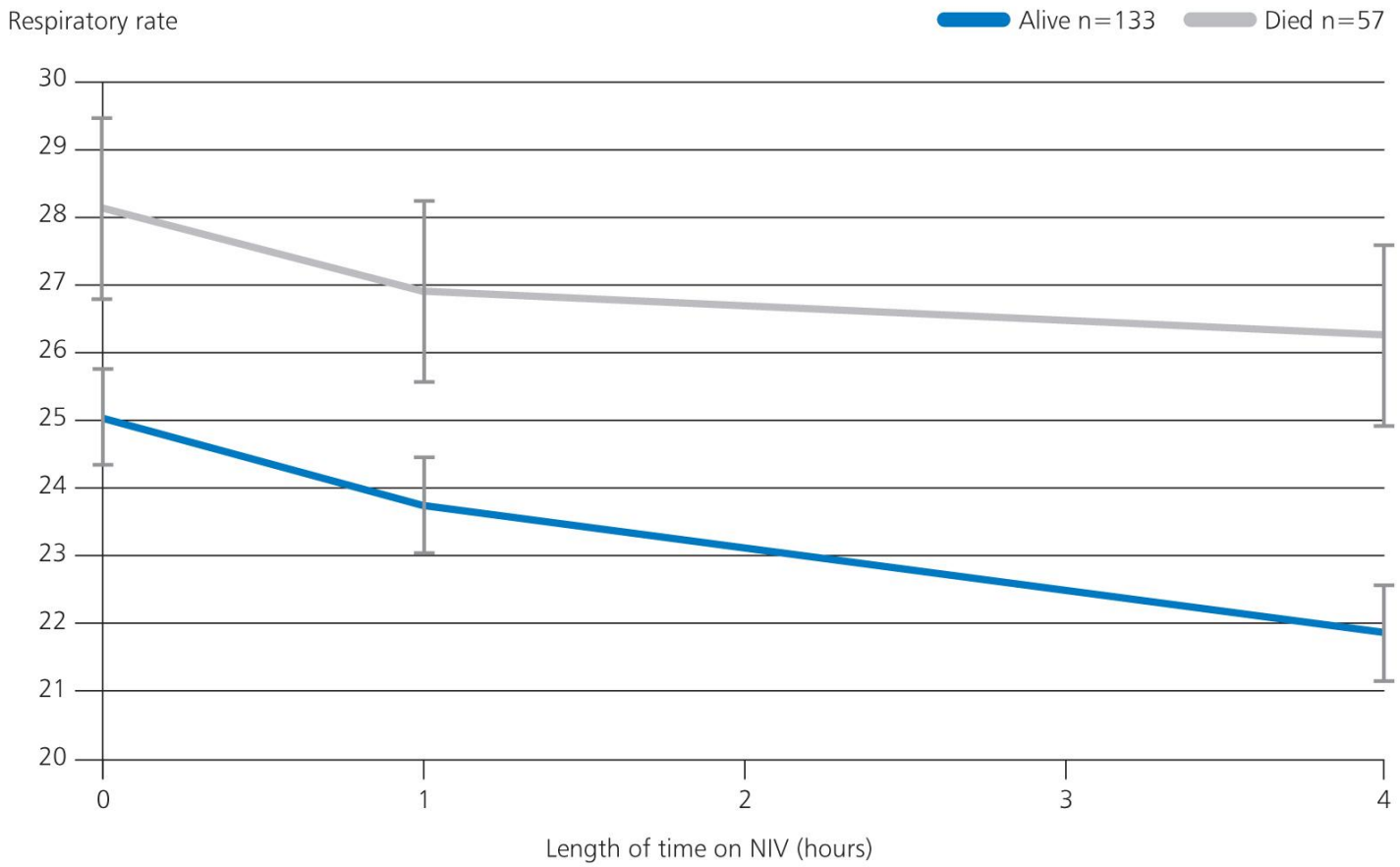


Figure 6.13 Change in respiratory rate on NIV (mean and standard error) for patients who survived and those who died (where values recorded at the three time points were available)

Vital signs response to NIV

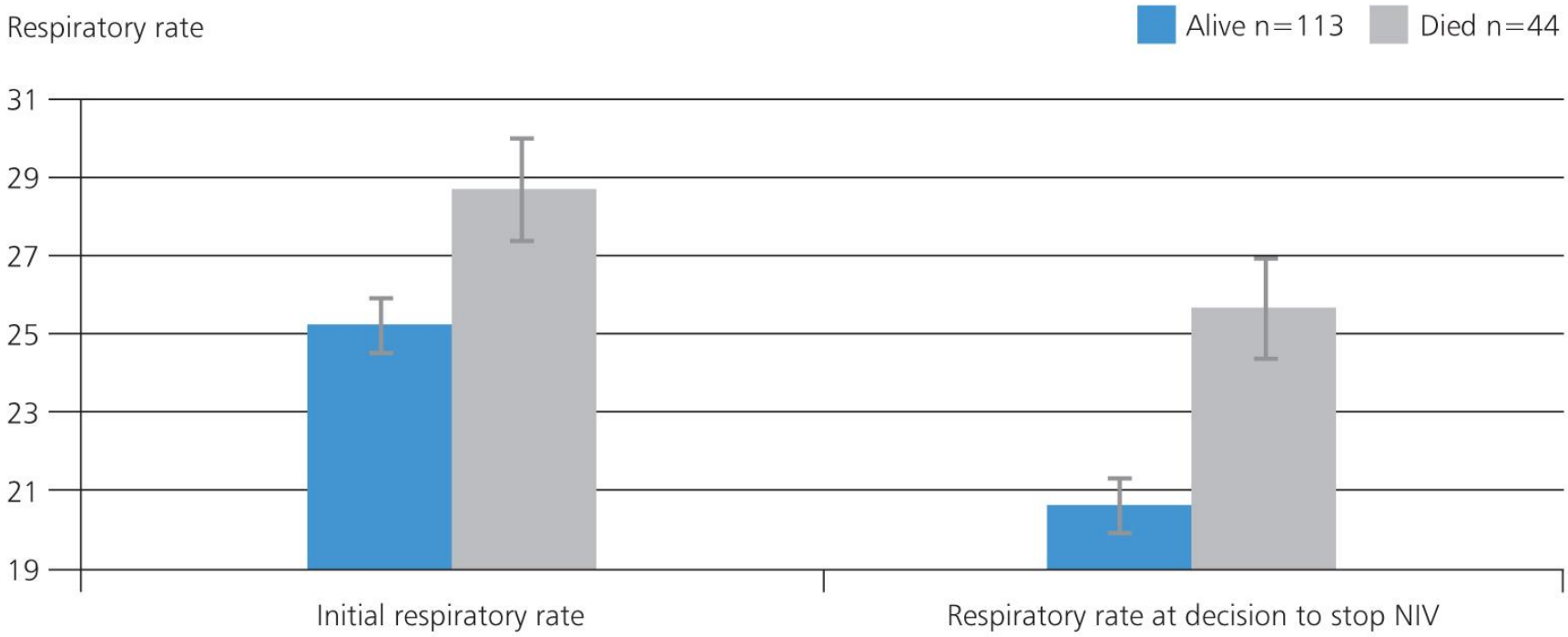


Figure 6.14 Respiratory rate at start and end of ventilation (mean and standard error)

Vital signs response to NIV

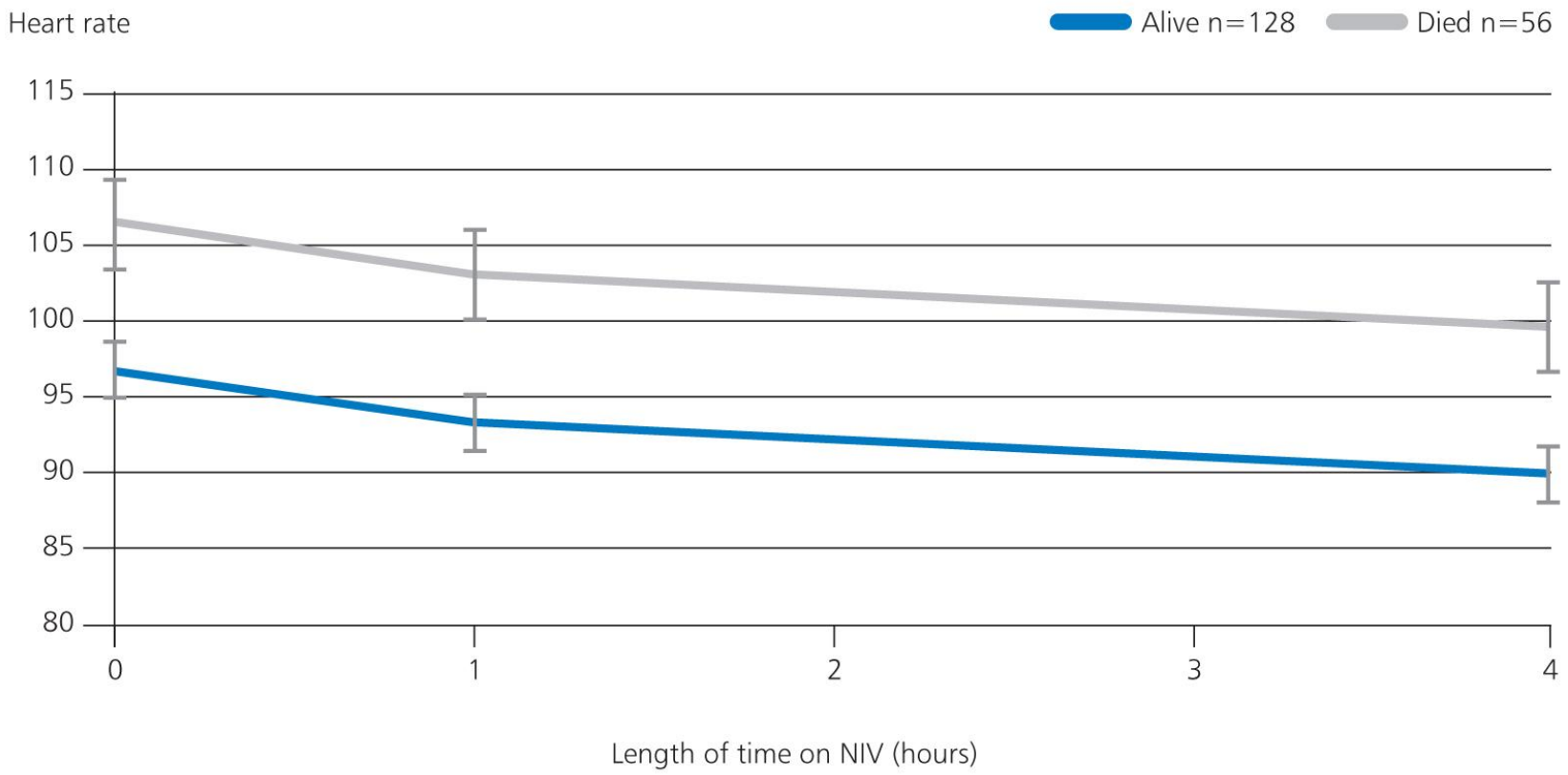


Figure 6.15 Change in heart rate on NIV (mean and standard error) for patients who survived and those who died (where values recorded at the three time points were available)

Vital signs response to NIV

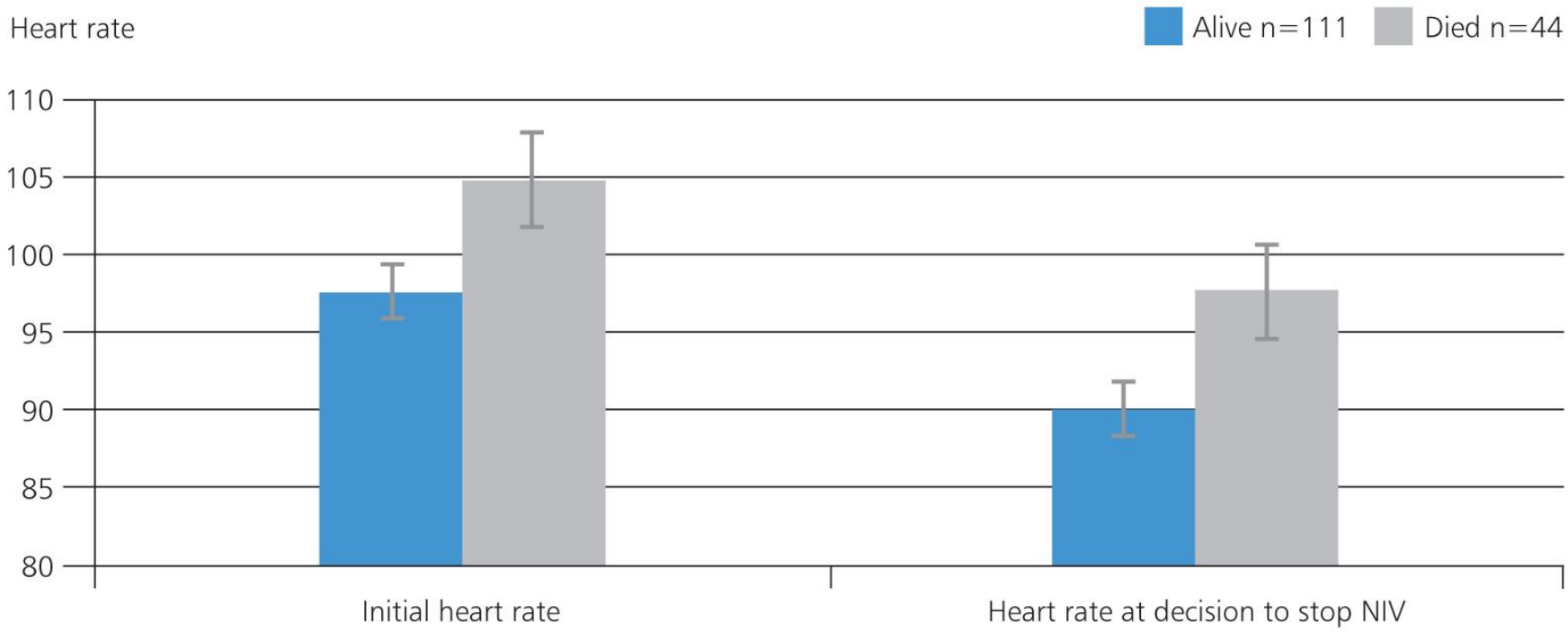


Figure 6.16 Heart rate at start and end of ventilation (mean and standard error)

Deterioration, escalation & critical care

Deterioration on NIV

Table 6.18 Signs of deterioration during NIV – reviewers' opinion

	Number of patients	%
Yes	145	42.0
No	200	58.0
Subtotal	**345**	
Not answered	8	
Total	**353**	

Table 6.19 Specific signs of deterioration

	Number of patients
Rising respiratory rate	39
Worsening acidosis	70
Falling conscious level	39
Agitation/intolerance	53

Answers may be multiple; n=142 (3 not answered)

Action taken in response not appropriate in 33/138 (23.9%)

Critical care referral

Table 6.6 Severity of the initial acidosis suggests immediate intubation would have been more appropriate – reviewers' opinion

	Number of patients	%
Yes	37	10.7
No	308	89.3
Subtotal	**345**	
Not answered	8	
Total	**353**	

Table 7.1 Intubation was appropriate where acidosis was worsening – reviewers' opinion

	Number of patients	%
Yes	20	29.9
No	47	70.1
Subtotal	**67**	
Not answered	3	
Total	**70**	

Critical care referral

156/328 (47.6%) referred to critical care

Table 7.3 Referral to critical care – reviewers' opinion

	Number of patients	%
Appropriate time	119	79.9
Too late	16	10.7
Due to lack of NIV beds	6	4.0
Inappropriate	7	4.7
Too early	1	<1
Subtotal	**149**	
Not answered	7	
Total	**156**	

pH < 7.26	87/184 (47.3%)
pH ≥ 7.26	92/217 (42.4%)

Frailty and critical care

Frailty commonest reason for not admitting

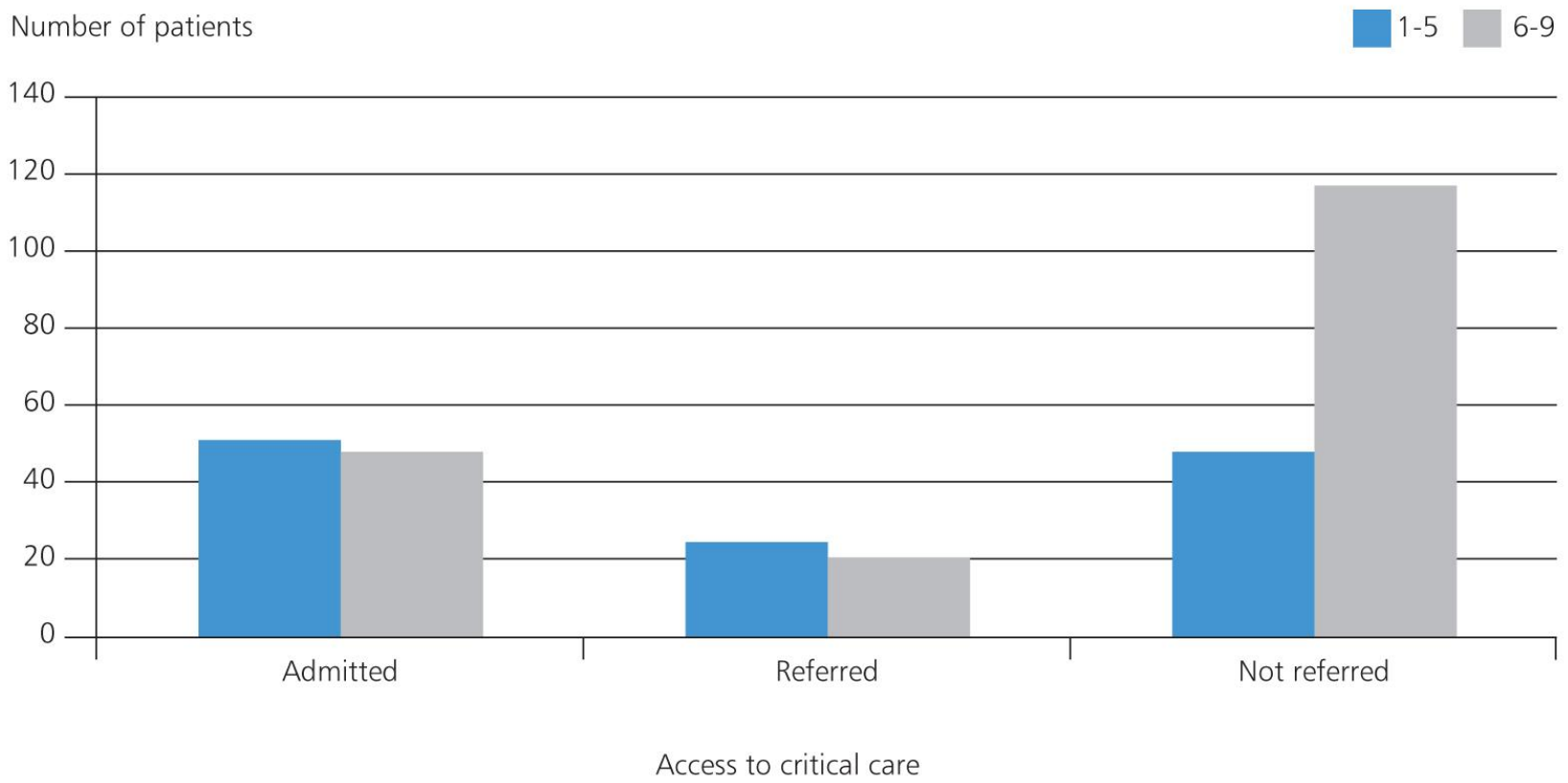


Figure 7.1 Rockwood clinical frailty 1-5 and 6-9 vs group admitted/referred/not referred to critical care

Critical care admission

103/149 (69.1%) patients admitted

6 patients not admitted may have benefited
7 patients not admitted due to lack of beds

Table 7.6 Interventions in critical care

	Number of patients
NIV	91
Arterial line	78
Intubation	18

Answers may be multiple; n=103

Critical care outcome

Table 7.7 Outcome from critical care

	Number of patients
Discharged to ward	63
Discharged home on NIV	3
Died	26
Subtotal	**92**
Not answered	11
Total	**103**

66/92 (71.7%) patients discharged alive

Outcomes & assessment of care

NIV outcome

Table 6.27 Outcome of NIV

	Number of patients	%
Success: (clinical improvement with normalisation of pH to >7.35)	198	57.1
Success: (clinical improvement/ cessation of NIV: no blood gas confirmation)	23	6.6
Failure: (remained acidotic pH<7.35 AND hypercapnic CO_2>6kPa)	22	6.3
Failure: and proceeded to intubation	18	5.2
Failure: treatment withdrawn	86	24.8
Subtotal	**347**	
Not answered	6	
Total	**353**	

Overall success 63.7%

Rockwood score	NIV Success
1-5	74.2%
6-9	55.9%

NIV outcome

Failure predictable in 77/106 (72.6%)

Table 6.29 NIV failure predictable versus appropriateness of NIV as an intervention – reviewers' opinion

	NIV an appropriate intervention				
NIV failure predictable	**Yes**	**No**	**Subtotal**	**Not answered**	**Total**
Yes	35	42	**77**	0	**77**
No	27	1	**28**	1	**29**
Subtotal	**62**	**43**	**105**	**1**	**106**
Unknown	15	4	**19**	1	**20**
Total	**77**	**47**	**124**	**2**	**126**

When NIV failure predictable often appropriate

Assessment of NIV care

Table 6.33 Any aspects of NIV treatment that could have been improved

	Reviewers' opinion		Clinicians' opinion	
	Number of patients	**%**	**Number of patients**	**%**
Yes	232	73.0	162	48.6
No	86	27.0	171	51.4
Subtotal	**318**		**333**	
Unknown	35		99	
Total	**353**		**432**	

Table 6.34 Areas for improvement in NIV care

	Reviewers' opinion	Clinicians' opinion
Documentation	65	39
Pressure titration	49	17
Delay	1	23
Oxygen treatment	6	8
Monitoring (arterial blood gas)	10	5
Senior review	7	2
Inappropriate use	1	10

Answers may be multiple

Room for improvement in ventilator management in 174/288 (60.4%)

Quality of NIV

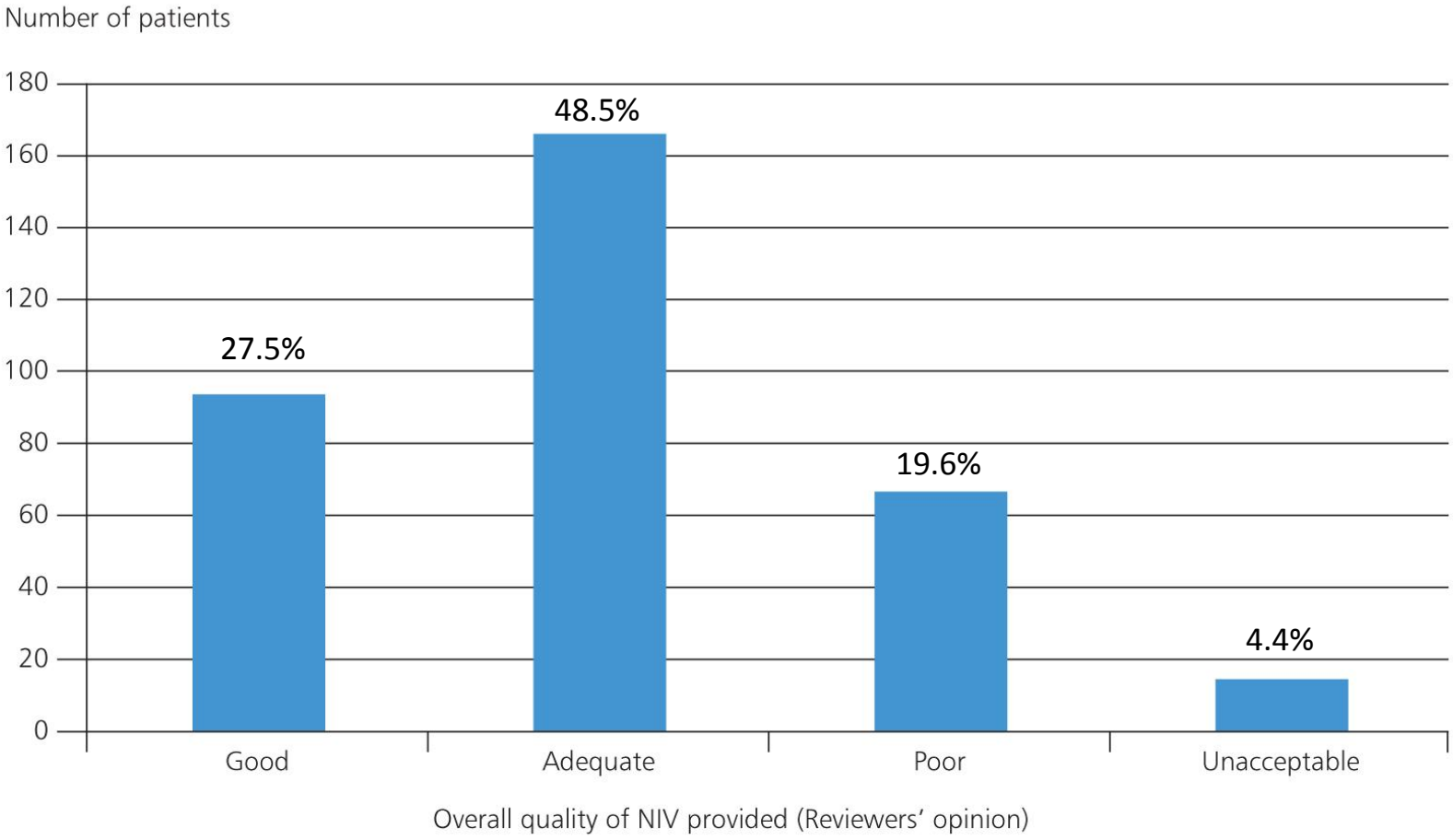


Figure 6.17 Overall quality of NIV provided

For 342 patients

Mortality

Table 9.1 Patient outcome of the peer reviewed cases

	Number of patients	%
Discharged alive	221	65.4
Died in hospital	117	34.6
Subtotal	**338**	
Not answered	15	
Total	**353**	

Table 9.2 Patient outcome of the total number of patients included in the study

	Number of patients	%
Transferred to another hospital	17	4.0
Still an inpatient at 30 days	4	0.9
Discharged home	237	55.8
Died	150	35.3
Other	17	4.0
Subtotal	**425**	
Unknown/not answered	7	
Total	**432**	

Mortality and initial pH

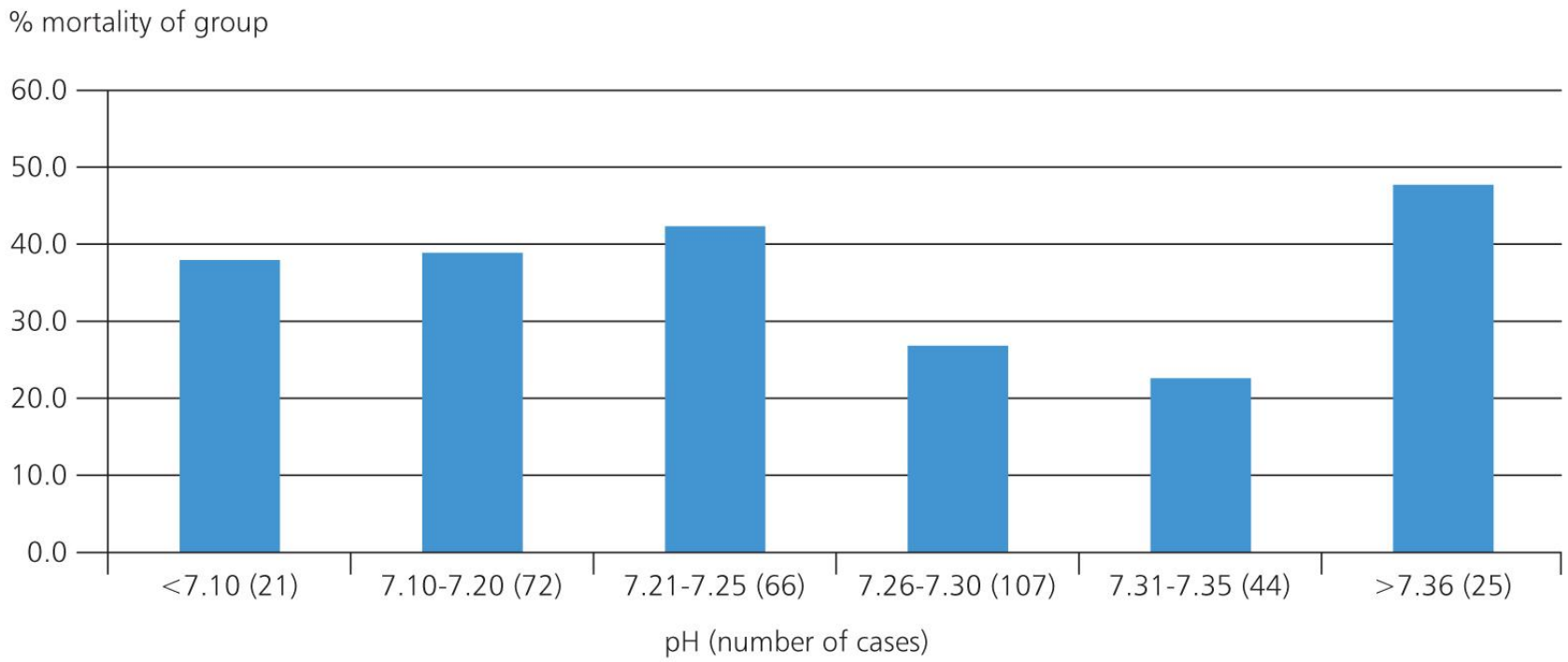


Figure 9.1 pH at initiation of NIV and mortality

Mortality: summary

Table 9.10 Factors associated with mortality in patients treated with NIV

Better prognosis	Mortality (%)	Worse prognosis	Mortality (%)
Early NIV (<24 hrs)	25.1	Late NIV (>24 hrs)	55.4
Started in the emergency department or acute medical unit	27.0	Started in general/respiratory ward	41.7
Chronic obstructive pulmonary disease	25.1	Non-chronic obstructive pulmonary disease	49.0
Initial pH 7.26-7.35	25.8	Initial pH <7.26	40.3
pH ≥7.26 excluding O_2 toxicity	28.5	pH <7.26 excluding O_2 toxicity	45.3
Frailty score 1-5	23.7	Frailty score 6-9	42.3
Respiratory rate <26	23.1	Respiratory rate ≥26+	37.5
Heart rate <100	24.8	Heart rate ≥100+	39.3
No pneumonia	24.8	Pneumonia	44.4
Appropriate NIV	27.0	Inappropriate NIV	63.3
NIV success	5.9	NIV failure	81.7
Previous NIV	23.3	No previous NIV	36.6
Good documentation	29.1	Poor documentation	39.4

Overall quality of care

Overall quality of care

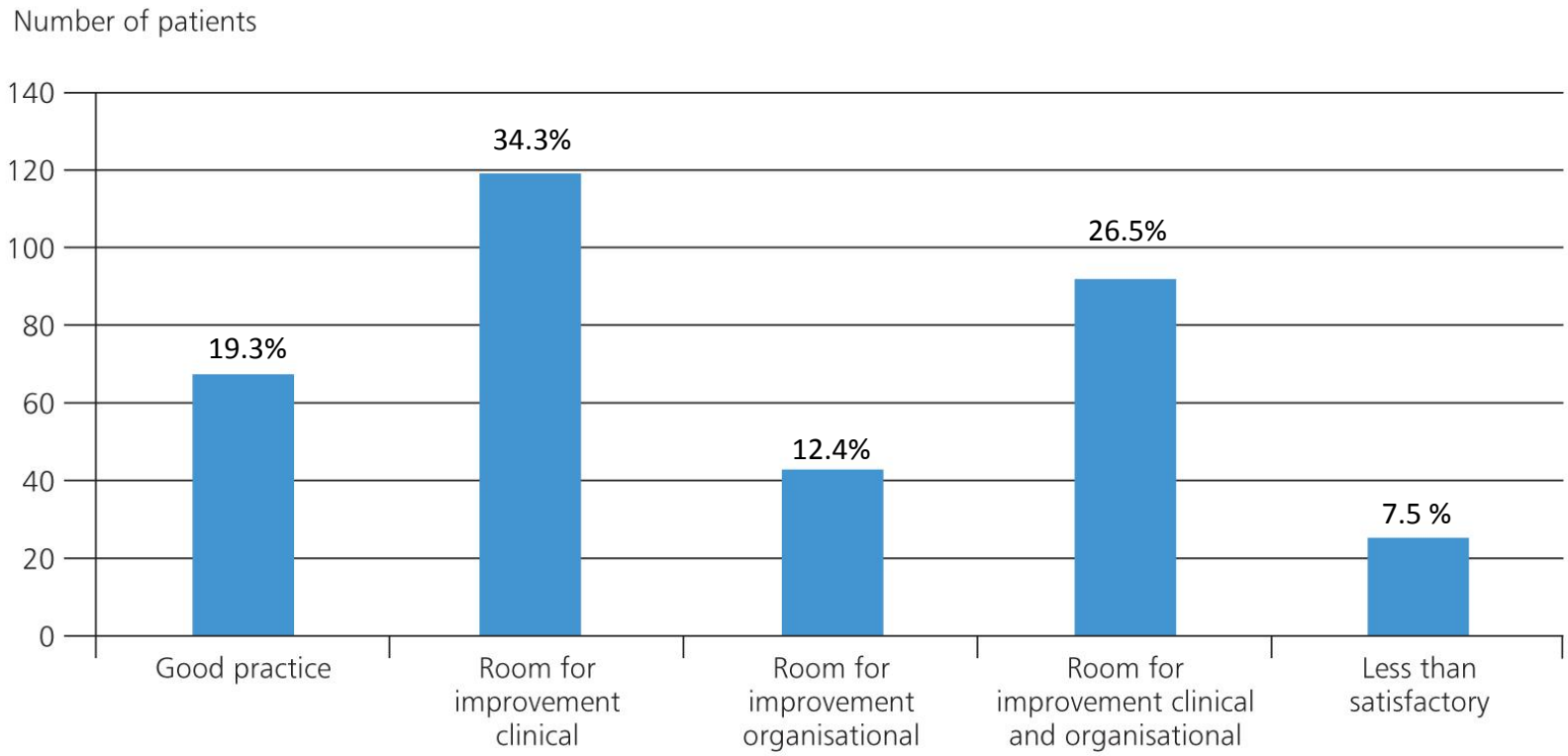


Figure 12.1 Overall quality of care – reviewers' opinion

Summary

- Effective NIV care is more complex than it appears
- In 4 out 5 cases reviewed, care was rated as less than good
- Wide organisational variation (staffing and monitoring)
- Case selection often inappropriate
- Treatment frequently delayed (service organisation, poor recognition)
- Ventilator and non-ventilator management often poor

Recommendations

Principal recommendations

All hospitals should have a clinical lead for their acute NIV service. The clinical lead should have time allocated in their job plan with clear objectives, including audit and governance for this service.

Treatment with acute NIV must be started within a maximum of one hour of the blood gas measurement that identified the need for it, regardless of the patient's location. A service model whereby the NIV machine is taken to the patient to start treatment prior to transfer for ongoing ventilation will improve access to acute NIV.

Principal recommendations

All hospitals where acute NIV is provided must have an operational policy that includes, but is not limited to:

a) Appropriate clinical areas where acute NIV can be provided, and in those areas the minimum safe level of staff competencies;
b) Staff to acute NIV ratios;
c) Escalation of treatment and step down care procedures;
d) Standardised documentation; and
e) Minimum frequency of clinical review, and seniority of reviewing clinician

Compliance with this policy should be part of the annual audit process.

Principal recommendations

All patients treated with acute NIV must have a treatment escalation plan in place prior to starting treatment. This should be considered part of the prescription for acute NIV and include plans in relation to:

a) Escalation to critical care;
b) Appropriateness of invasive ventilation; and
c) Ceilings of treatment

This should take into account:

d) The underlying diagnosis
e) The risk of acute NIV failure; and
f) The overall management plan

Principal recommendations

All patients treated with acute NIV must be discussed with a specialist competent in the management of acute NIV at the time treatment is started or at the earliest opportunity afterwards. Consultant specialist review to plan ongoing treatment should take place within a maximum of 14 hours.

Principal recommendations

All patients treated with acute NIV must have their vital signs recorded at least hourly until the respiratory acidosis has resolved. A standardised approach such as the National Early Warning Score is recommended.

All hospitals should monitor their acute non-invasive ventilation mortality rate and quality of acute NIV care. This should be reported at Board level.

National Confidential Enquiry into Patient Outcome and Death

Inspiring Change

A review of the quality of care provided to patients receiving acute non-invasive ventilation

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