Management of severe pneumonia in children at Rabaul Provincial Hospital: systematic use of an audit checklist

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OUTLINE

- Introduction
- Methodology
- Results
- Discussion
- Conclusion
- Recommendation
- Acknowledgment
- References

INTRODUCTION

- Pneumonia is the single largest infectious cause of death in children worldwide.

- Globally, estimated 700,000 children died (14% global child deaths) from pneumonia in 2022[1]

- Papua New Guinea – pneumonia is a common reason for admission estimated 6217, 18.9%; with 1955 severe pneumonia of which 151 died, CFR of 7.7%[7]

- Rabaul Provincial Hospital (RPH) – CFR of 28.6% for severe pneumonia[7]

1. UNICEF (2022); 7. Annual Morbidity and Mortality Report. 2020

STUDY GAP IN PNG

- Reason for high CFR is not clear – delayed presentation, environment, comorbidity, gaps in management of seriously ill children.

- Studies of pneumonia in PNG - epidemiology, aetiology[2], antibiotic treatment[3], oxygen therapy[4] with studies in other countries focused on risk factors[5], and assessment of signs and symptoms[6] but limited studies on quality management clinical audits.

- Unpublished - Small pilot study in 2019 identified gaps in the management of severe pneumonia. Interventions employed to address these gaps.

2. Shann, et al (1984); 3. Duke et al (2002); 4. Duke et al (2001); 5. Eckerle et al. (2022); 6. Khan et al. (2022) 7. Annual Morbidity and Mortality Report. 2020

AIMS/OBJECTIVES

- To assess the quality management of severe pneumonia using standardize audit checklist.

- To identify the risk factors associated with mortality in children with severe pneumonia.

- To identify the outcomes of children with severe pneumonia in Rabaul Provincial Hospital.

METHODOLOGY

CHARACTERISTICS	DETAILS
STUDY DESIGN	Prospective Descriptive Study
LOCATION	RPH. Patients were recruited via the ED, COPD and paediatric ward
PERIOD	January 2021 – January 2022
POPULATION / SAMPLE SIZE	Children ages 1 month (> 28 days) to 59 months. Sample size 46
DATA COLLECTION	Checklist form containing clinical standards and scores, proforma form for demographic and clinical characteristic details of patients and outcome
DATA / STATISTICAL ANALYSIS	Microsoft Excel, STATA v18 Frequency (%), Median (IQR), OR (95% CI), P= <0.05
ETHICAL CLEARANCE	Training & Development & Ethical Committee of RPH

SELECTION CRITERIA

INCLUSION

- Ages 1 month – 59 months
- Severe Pneumonia PNG Classification (WHO = very severe)
  - Hypoxia: SpO2 < 90%
  - Tachycardia > 160 bpm
  - Hepatomegaly: liver span > 2cm below the right subcostal margin
  - Tachypnoea for age (WHO)
  - Lower chest wall indrawing

EXCLUSION

- Diarrhoea with acidotic breathing with no chest signs
- Later diagnosed as pulmonary TB
- Respiratory tract infection other than pneumonia
- Missing Data

PNG Standard Treatment Book (2016); WHO (2013)

STUDY METHOD

- Clinical Standards of managing severe pneumonia by medical practitioners and nursing officers were audited against a scoring system:

- **13 clinical standards**
  - A standard that was:
    - Fully considered/done   = 2 points
    - Partially considered/done   = 1 point
    - Not considered/not done   = 0 point

- Color code – score > 90% (☐green), 71 – 89% (☐ yellow), < 70% (☐red)

- **4 hospital-acquired complications**. Any serious hospital acquired complication resulted in - 2 score

AUDIT CHECKLIST AND SCORES

Audit of severe pneumonia management
Checklist of clinical standards and scoring form

Name:	Sex:	Age (months):

Clinical standards and scoring:
Scores
Fully considered/done = 2
Partially considered/done but not adequate = 1
Not considered/done = 0

No.	CLINICAL STANDARDS	SCORES (2, 1, 0)
1.	**Prompt triage:** • Early detection of danger signs, hypoxia (SpO_2 <90%) and administration of oxygen therapy within 30 minutes of arrival	
	Points lost if danger signs and hypoxia not detected or recorded, O_2 therapy not given within 30minutes of arrival and has hypoxaemia.	
2.	**Proper history and examination (including chest signs and respiratory distress symptoms) + clerking in medical records** • Presence of respiratory distress symptoms (tachypnoea, chest indrawing, cyanosis, grunting, restless, unable to drink) • Presence of chest signs (cough, crepitations, wheeze / rhonchi) • Findings clearly documented in medical records	
	Points lost if no documentation of respiratory distress symptoms and/or chest signs, or chest signs and/or respiratory distress overlooked.	
3.	**Correct classification of pneumonia severity based on clinical signs & symptoms (WHO|STM)** • Tachypnoea, indrawing and cough, plus unable to feed, or cyanosed or restless or heart failure	
	Points lost if incorrect classification of pneumonia based on signs and symptoms	
4.	**Correct antibiotic treatment according to severity classification (WHO|STM). Prompt treatment within 1 hour** Amoxicillin or Benzyl penicillin IV (Flucloxacillin – Staph) and Gentamicin. Treatment initiated within 1 hour of arrival. Change to ceftriaxone only if *persistent high fever*, persistent hypoxia and no improvement in severe respiratory distress after 48H.	
	Points lost if treatment given is not standard and/or given > 1hour following admission	
5.	**Correct use and recording of S_pO_2 and oxygen therapy** Saturation recorded as room air| on oxygen; correct rate and mode of O_2 therapy as per STM	
	Points lost if SpO_2 recorded not identified as with oxygen or in room air No oxygen therapy, shared oxygen,	
6.	**Presence of functioning equipment at bedside** Oxygen cylinder or concentrator, suction machine, pulse oximetry	
	Points lost if equipment are not functioning, unavailable, or faulty	
7.	**Chest x-ray: indicated on day 1 following admission if any of the following:** unilateral chest signs, chronic cough (>2weeks), heart murmur, severe hypoxaemia SpO_2 <80% OR persistent hypoxia (SpO_2 <90%) after 48 hours	

	Points lost if X-ray unavailable when CXR ordered, or X-ray not ordered despite above indications	
8.	**Safe use of intravenous fluids, only if needed – not >50% maintenance fluid IV for 24-48hrs**	
	Points lost if >2/3 maintenance intravenous fluid used for 24-48hrs	
9.	**Early initiation of enteral feeding (breastfeeding, nasogastric feeding)**	
	Points lost if enteral feeds initiated >24-48hrs following admission	
10.	**2-4 hourly monitoring of vital signs by nursing officers plus use of RDS score and appropriate responses**	
	Points lost if vital observations done > 4hrly, abnormal vital signs and or RDS score >12 without prompt response by nurses	
11.	**Assessment by doctors at 4 and 8 hours after admission**	
	Points lost if no assessment by doctors at 4 & 8hrs following admission	
12.	**Review by doctors and care team at least daily on ward rounds**	
	Points lost if no daily reviews by doctors or care team Points gained if twice or more reviews per day	
13.	**Discharge planning, communication and parent education**	
	Points lost if no discharge plan made or documented and or parent education not done/not documented. Points gained if parents familiar with danger signs, when to return, and how to protect against pneumonia (don't expose to smoke, wash hands, exclusive breast feeding, good weaning nutrition).	

Hospital acquired complications

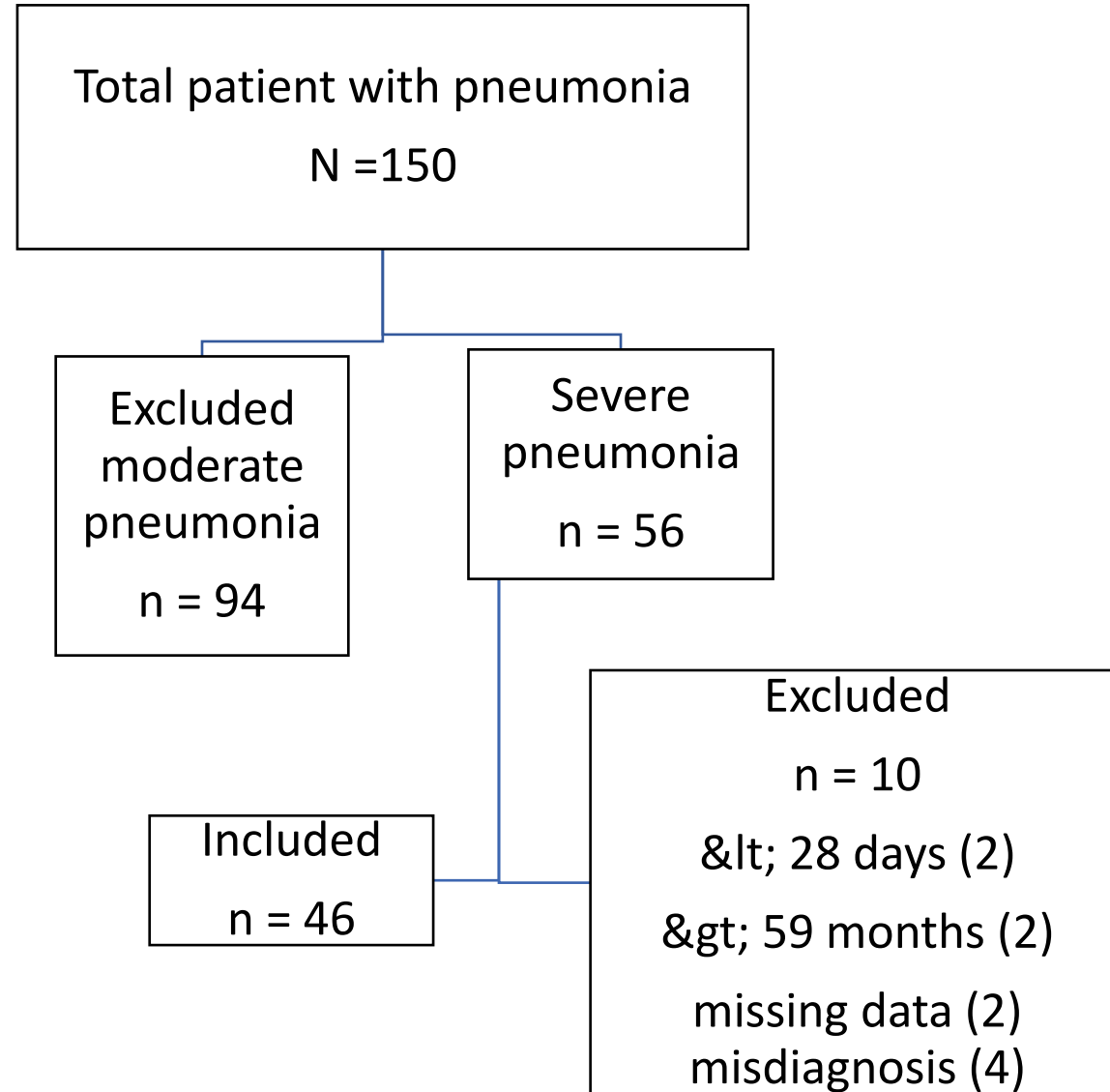|		
1	Development of nosocomial acquired infection	Subtract 2 if present
2.	Intravenous cannula infection/thrombosis/extravasation	Subtract 2 if present
3.	Fluid overload (puffy eyes, facial oedema,)	Subtract 2 if present
4.	Any other complications (drug administration error, aspiration)	Subtract 2 if present
	TOTAL	

RESULTS

Total patient with pneumonia

N =150

Excluded moderate pneumonia

n = 94

Severe pneumonia

n = 56

Included

n = 46

Excluded

n = 10

< 28 days (2)

> 59 months (2)

missing data (2)
misdiagnosis (4)

Table 1. DEMOGRAPHIC CHARACTERISTICS N = 46

| CHARACTERISTICS	RESULTS
Sex (male: female): n (%)	26 : 20 (56:43)
Age (months)	
1 – 11; n (%)	35 (76)
12 – 23; n (%)	6 (13)
24 – 59; n (%)	5 (11)
Median (IQR)	4 (2 – 11)
Residence	
Rural; n (%)	27 (59)
Semirural (<15min from town); n (%)	16 (35)
Urban; n (%)	3 (7)
Referral (referred: non referred); n (%)	16 : 30 (35:65)
Admission	
Days of illness prior to presentation; median (IQR)	4.5 (3 – 6)
Number of admission in a year; median (IQR)	1 (1 – 2)

Table 2. 13 CLINICAL STANDARDS AUDIT RESULTS N=46

CLINICAL STANDARDS • Fully considered/done = 2 • Partially considered/done = 1 • Not considered/done = 0 • Total score each standard 92	Fully Done		Partially Done		Not Done		Total
	n (%)	score	n (%)	score	n (%)	Score	Score
1. Prompt triage: early detection of danger signs, hypoxia (SpO2 <90%), administering oxygen therapy within 30 minutes of arrival	34 (74)	68	8 (17)	8	4 (9)	0	76
2. Proper history and examination including respiratory distress symptoms and documentation	42 (91)	84	4 (9)	4	0	0	88
3. Correct classification of pneumonia severity according to WHO and National criteria	41 (89)	82	4 (9)	4	1 (2)	0	86
4. Correct antibiotics according to pneumonia severity. Prompt treatment with first dose within 1 hour of admission	38 (83)	76	7 (15)	7	1 (2)	0	83
5. Correct use and recording of SpO_2 and oxygen therapy in the wards	43 (93)	86	3 (7)	3	0	0	89
6. Presence of functioning equipment at bedside	44 (96)	88	2 (4)	2	0	0	90

Cont' Table 2. 13 CLINICAL STANDARDS AUDIT RESULTS N=46

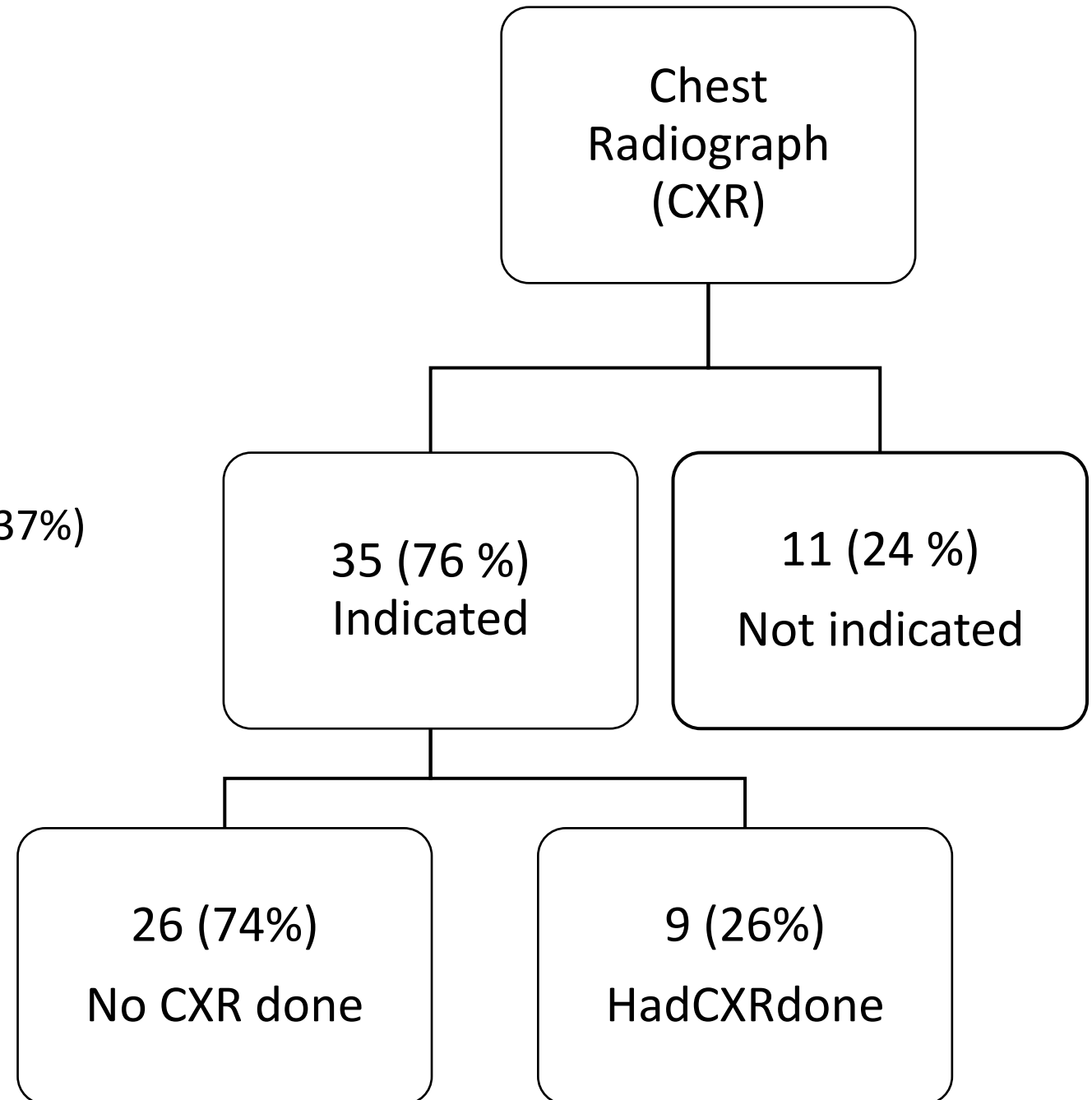|	Fully Done		Partially Done		Not Done		Total
	n (%)	score	n (%)	score	n (%)	Score	Score
7. Chest x-ray: done if indicated on day 1 following admission	18 (39)	36	26 (57)	26	2 (4)	0	62
8. Safe use of intravenous fluids; not > 2/3 of maintenance volume infused	44 (96)	88	2 (4)	2	0 (0)	0	90
9. Early initiation of enteral feeding within 24-48hrs	40 (87)	80	1 (2)	1	5 (11)	0	81
10. 2-4 hourly vital observation with prompt responses by nurse	35 (76)	70	11 (24)	11	0 (0)	0	81
11. Doctors' review within first 4 and 8 hours following admission	8 (17)	16	17 (37)	17	21 (46)	0	33
12. Daily review by care team	44 (96)	88	0 (0)	0	2 (4)	0	88
13. Discharge planning and parental education	19 (56)	38	9 (26)	9	6 (18)	0	59
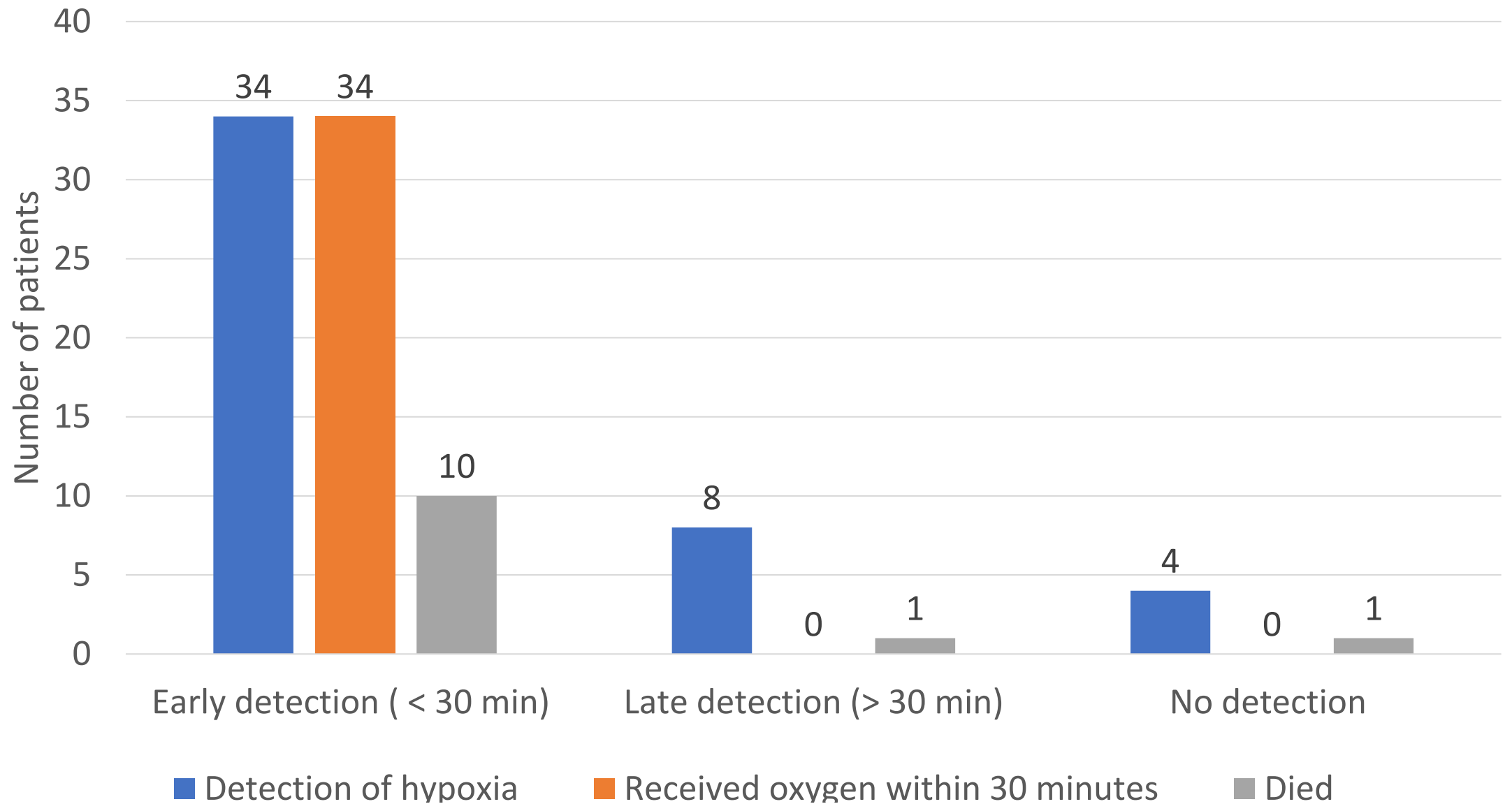
■ 7. Chest radiograph on day 1

Indication:
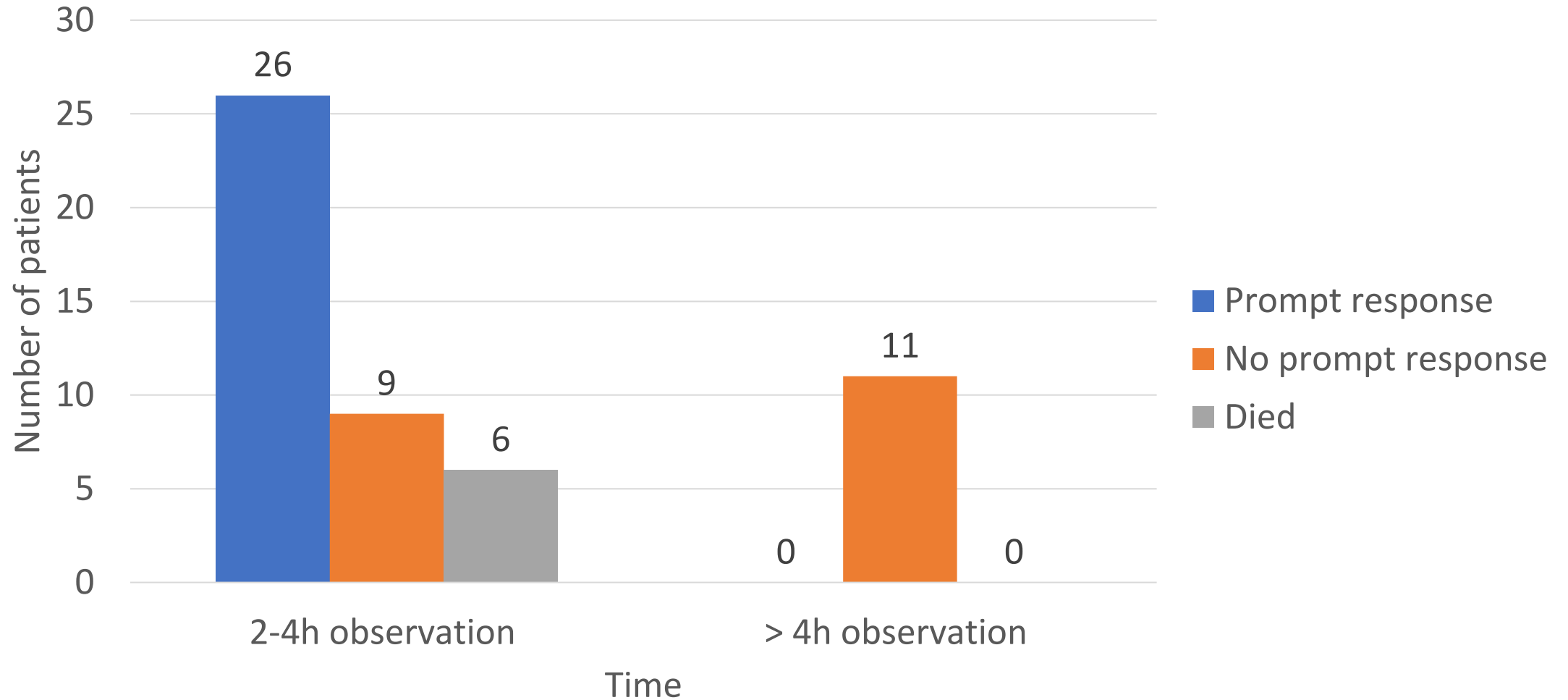- Heart murmur 6 (17%)
- Severe hypoxia (SpO_2 <80%) 13 (37%)
- SpO2 < 90% after 48h 5 (14%)
- Chronic cough 5 (14%)
- Unilateral chest sign 8 (23%)

Findings:
- Lobar consolidations 7 (78%)
- Patchy opacities 2 (22%)
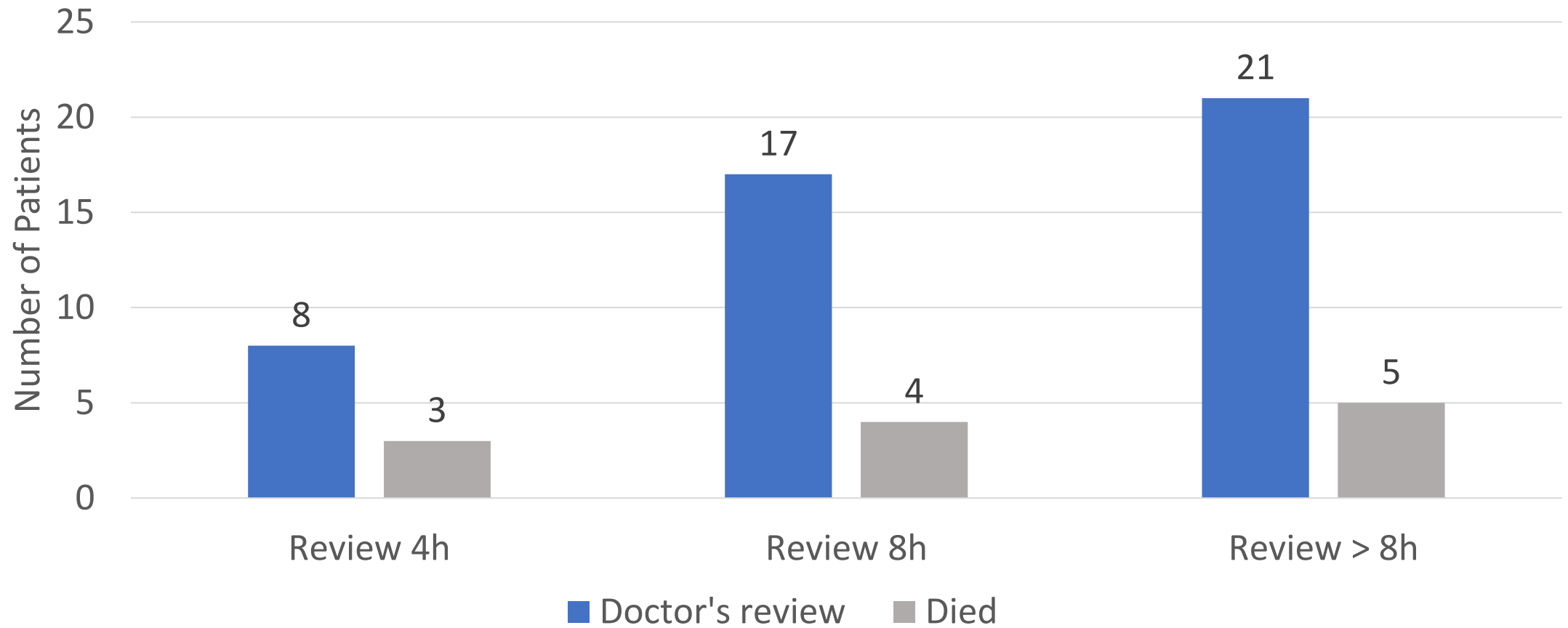- Died: No CXR 9 (26%), CXR 1 (3%)

Chest Radiograph (CXR)

35 (76 %) Indicated

11 (24 %) Not indicated

26 (74%) No CXR done

9 (26%) HadCXRdone

11. DOCTOR'S REVIEW WITHIN 4H AND 8H OF ADMISSION

13. DISCHARGE PLANNING AND PARENTAL EDUCATION

	DISCHARGE PLANS		PARENTAL EDUCATION	
N = 34	Documented	Not documented	Done	Not done / documented
n	28 (82%)	6 (18%)	19 (56%)	15 (44%)

Table 4. Individual Patient Quality Score Distribution

Total Individual composite Score = 26 (2 = fully done, 13 standards)

Ranges	Frequency (%)
0 – 10	1 (2%)
11 – 15	5 (11%)
16 – 20	11 (24%)
21 – 26	29 (63%)

	Median	IQR
Survived to hospital discharge	22.1	21.2 – 23.0
Death	16	13.6 – 18.9

Hospital Acquired Complications

- Nosocomial Infection
- IVF extravasation
- IVC associated thrombophlebitis
- Fluid overload
- Others

6, 19%

8, 26%

14, 45%

2, 7%

1, 3%
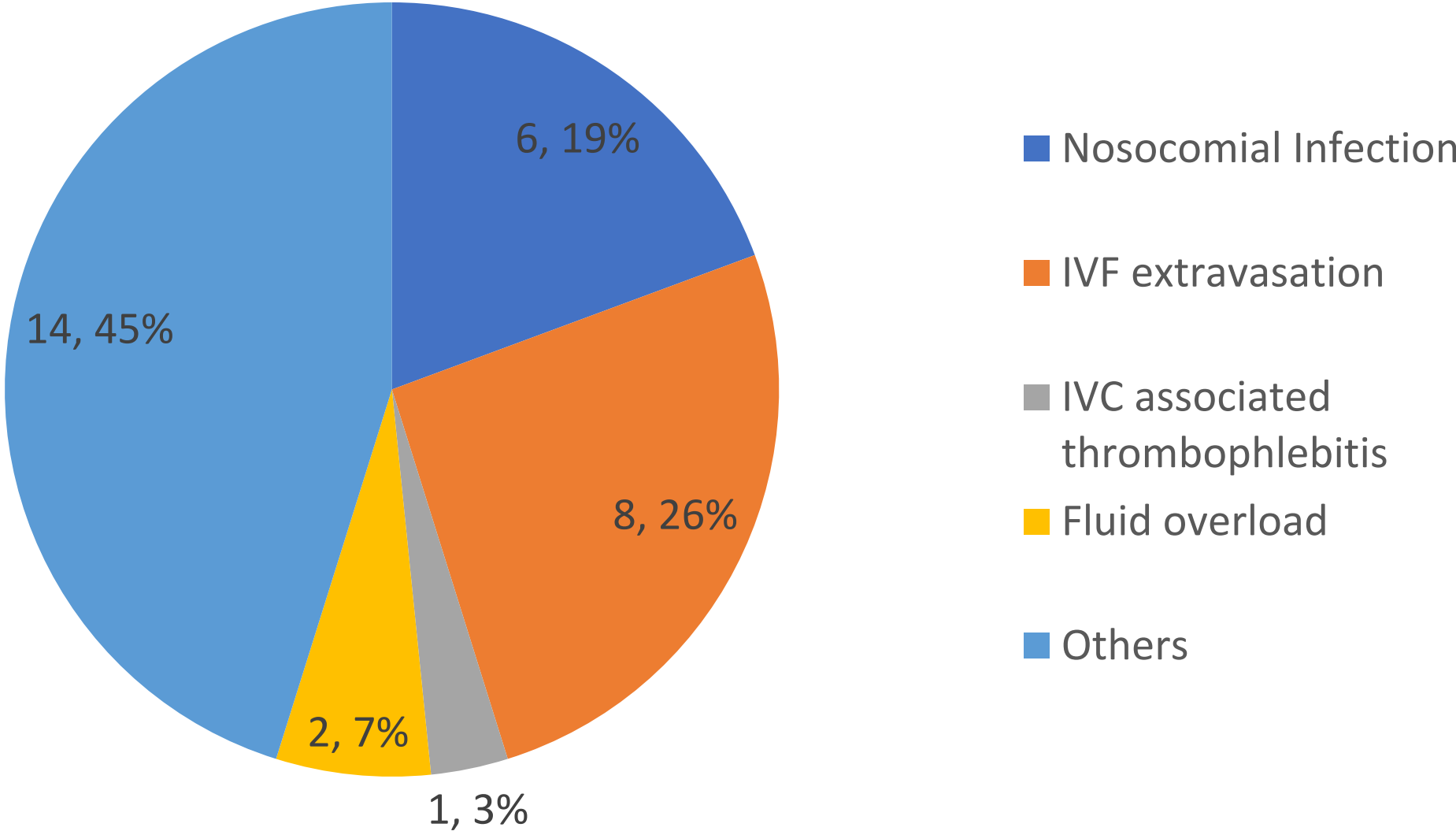
21 children had complications; 11 were those who died

Table 5. Risk factors associated with death in severe pneumonia (univariable)				
Variables	Number n=46 (%)	Odds ratio (OR)	95% Confidence interval	p-value
SpO$_2$ <90% in room air	46 (100)	0.97	0.92 - 1.02	0.3
Central cyanosis	19 (41)	13.8	2.5 - 76	0.002
Starry eyes	15 (32)	15	3.05 - 73.57	0.001
Hypoglycaemia	5 (11)			0.001
Paraldehyde	8 (17)	46.2	4.64 - 459.29	0.001
Audit quality score /26				
Survived (n=34): score 22.1		0.61	0.44 - 0.83	0.002
Died (n=12): score 16				

Receiver Operating Characteristic Curve For 5 Risk Factors

5 risk factors:
1. Central Cyanosis
2. Starry Eyes
3. Hypoglycemia
4. Paraldehyde
5. Audit Quality Score
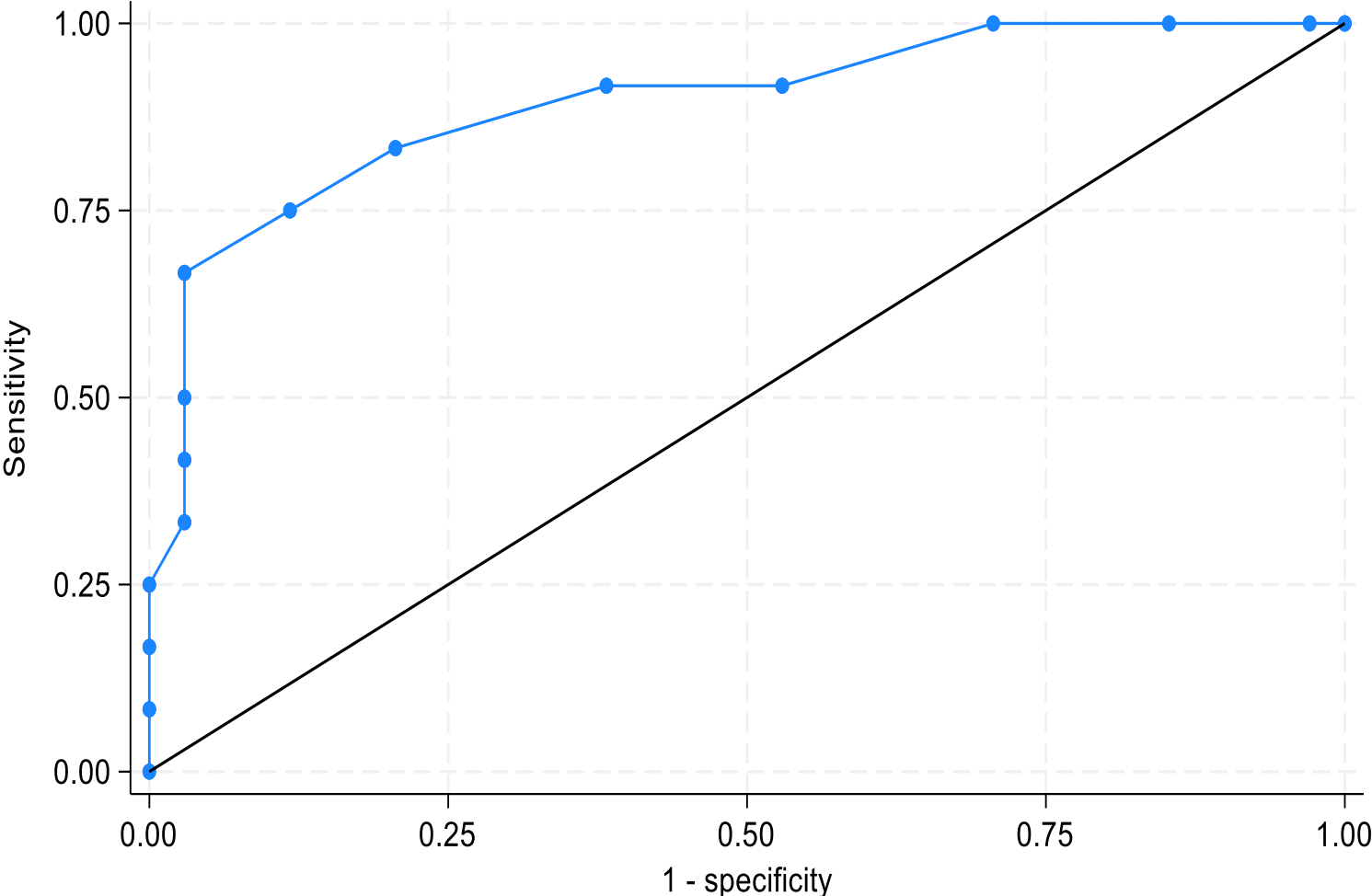
Area under ROC curve = 0.8934

There is 89% chances of patient's survival if the quality standards were optimally done well and risk factors identified earlier. Good prediction

FINAL OUTCOME

DISCHARGED   34 (74%)

DIED   12 (26%)
- Within 24   3 (25%)
- More than 24 hours   9 (75%)

- Length of hospital stay (days); median (IQR)   7 (5 – 14.5)

DISCUSSION – CLINICAL STANDARDS

- Previous study conducted at RPH 2019 – identified gaps in triage and emergency treatment, appropriate oxygen therapy, review of critically ill and communication[7]

- Interventions addressing gaps – WHO pocket book training for NGI 2020, pulse oximeters distributions, installation of oxygen concentrators in RPH and 5 other rural health facilities, development of oxygen plant in ENBP.

- Current study still showed some clinical standards suboptimally done and gaps in management of severe pneumonia in RPH.

- This study is consistent with 2019 study in RPH.

7. Pomat D (2019) [unpublished]

DISCUSSION – RISK FACTORS AND OUTCOME

- Previous study in India showed that head nodding, altered sensorium, and pallor were associated with increase risk of death.[13]

- Mortality is high with or without HIV & Malnutrition[5], hypoxaemia especially in PNG Highlands region.[4]

- In this study significant risk factors were fits or starry eyes, central cyanosis, hypoglycemia and receipt of paraldehyde.

- Intravenous (IV) canula complications were common complication with with extravasation most common, consistent with Zamunu et al study.[14]

- 34 children survived to hospital discharge while 12 died.

5. Eckerle et al. (2022); 4. Duke et al (2001); 13. Tiewsoh (2009); 14. Zamunu et al (2021)

LIMITATIONS

STRENGTHS

- Prospective Observational study

- Clinical checklist for audit was developed before the study

- Data collected in real time

LIMITATION

- Small sample size

- Results from this study might not fully reflect the practices of nursing and medical staff of other hospitals

CONCLUSION

- Children admitted with severe pneumonia in RPH had a high CFR
- Central cyanosis, starry eyes, severe respiratory distress, hypoglycaemia were associated with death
- Children with starry eyes who received paraldehyde were at higher risk of death
- Gaps in management of severe pneumonia
- Optimal use of the clinical standards can reduce CFR of severe pneumonia and improve outcome

RECOMMENDATIONS

- Deaths from severe pneumonia can be audit using a standardize audit checklist to identify gaps in management and improve quality care

- Use of color code charts and respiratory distress score to improve risk assessment and response by nursing and medical team

- Training for all staff both nursing and medical on oxygen therapy, care and monitoring of children with severe pneumonia

- Standardized discharge planning for children with severe pneumonia

- Improving medical and nursing man power

- Appropriate resource distribution

ACKNOWLEDGEMENTS

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Thankyou