PREDICTING PNEUMONIA IN PAEDIATRIC ACUTE FEBRILE RESPIRATORY ILLNESS

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INTRODUCTION

- Pneumonia
  - 932 per 100,000 population of 0-5 years old admitted to hospital in HK
  - Kills 1.6 million paediatric patients per year
  - 16% of all deaths in children <5 years old

INTRODUCTION

+

= ?

fever **cough**

URTI ? Pneumonia? Bronchitis?

INTRODUCTION

- To take CXR, or not to take, that is the question.

– Hamlet ver. 2.0, SSEM 2017

PREDICTORS IN THE PAST

- World Health Organization (WHO) 1991
- cough, tachypnea and chest indrawing for pneumonia diagnosis
- Validated in various studies
- poor sensitivity for diagnosing pneumonia in a US-based paediatric emergency department (2012)

PROPOSED PREDICTORS (2004-2011)

	Al-Dabbagh et al (2004)	Lynch et al (2004)	Bilkis prediction rule (2010)	Bilkis simpler rule (2010)	Neuman et al (2011)
Study Design	Case series	Prospective cohort study	Prospective cohort study	Prospective cohort study	Prospective cohort study
Clinical Predictors	nasal flaring, tachypnea, chest indrawing and crackles parallel testing for sensitivity	fever + decreased breath sounds, crackles or tachypnea	Grunting, cough, rales, decreased breath sounds, vomiting	Decreased breath sounds, rales, tachypnea or any combination of the 3	chest pain, focal rales, duration of fever, and oximetry levels at triage
	Temperature >38°C and grunting tested serially for specificity				$SpO_2 \leq 92\%$ strongest predictor of pneumonia in <5 yo

BACKGROUND

- Our aim:
- evaluate independent determinant factors in prediction of pneumonia
- establish a clinical prediction rule for pneumonia in paediatric patients with acute febrile respiratory illness

METHOD

STUDY DESIGN AND SETTING

- Multicentre prospective cohort study
- TMH, PMH, POH
- September 2016 to May 2017
- 1 month to 6 years old

METHOD

INCLUSION CRITERIA

- acute symptom onset within 10 days
- fever ≥38°C within 24 hours at attendance at the A&E
- body temperature in triage, ambulance and self-reported; either oral, rectal or tympanic temperature
- respiratory symptoms (cough, dyspnea, wheezing or added sounds during respiration)

METHOD

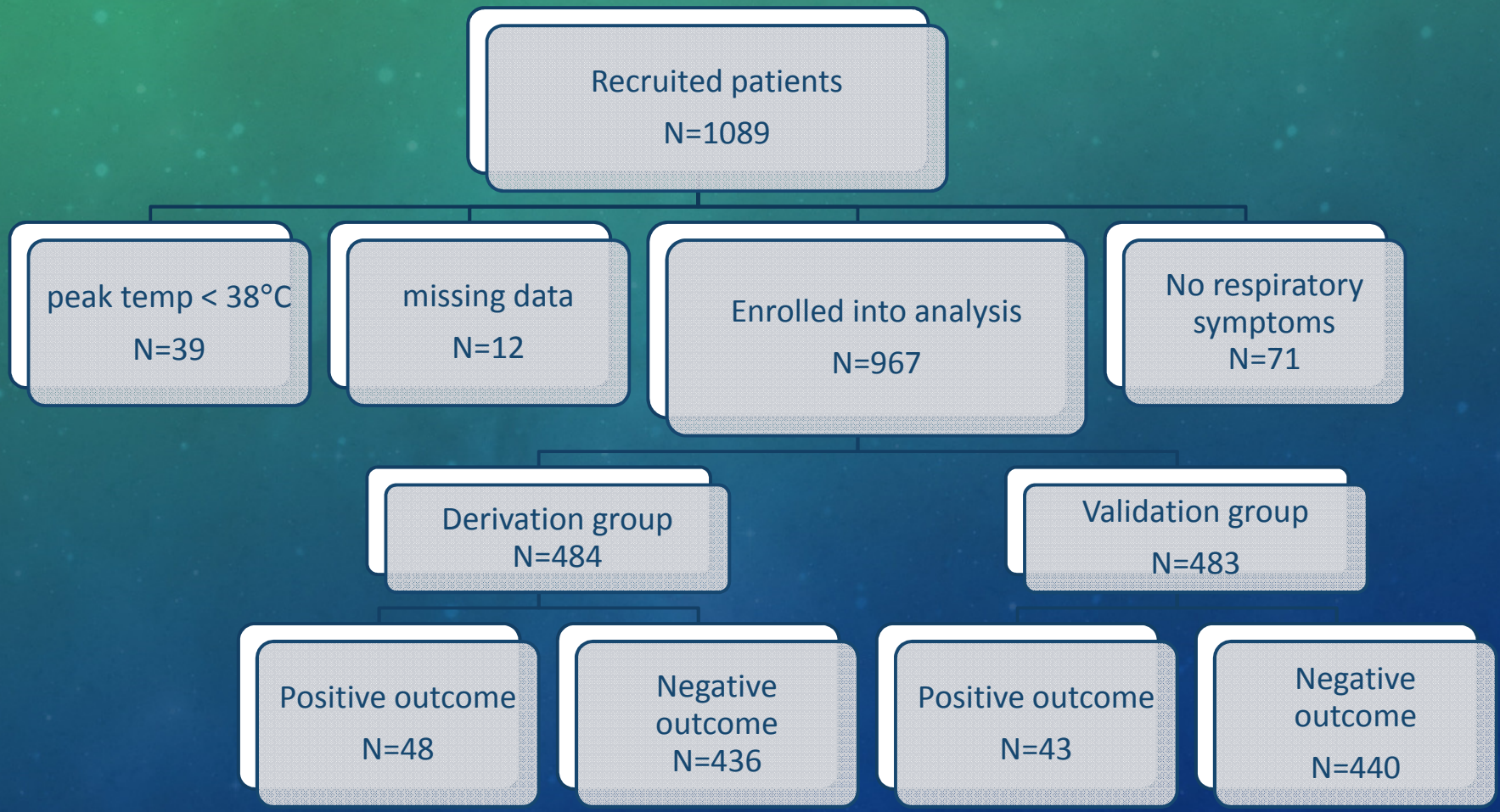
EXCLUSION CRITERIA

- hypoxemic (SpO_2 of ≤ 94%)
- obvious respiratory distress or requiring O_2 supplement
- immunocompromised
- chronic lung disease

OUTCOME

- Pneumonia
- 1. new onset radiological lung infiltrate in chest radiograph
- 2. re-attendance to any emergency departments in Hong Kong within 7 days and diagnosed pneumonia

RESULTS
PATIENT ENROLMENT – SPLIT SAMPLE METHOD



RESULTS
DERIVATION GROUP

- Male predominance
- Median age 26 months

RESULTS

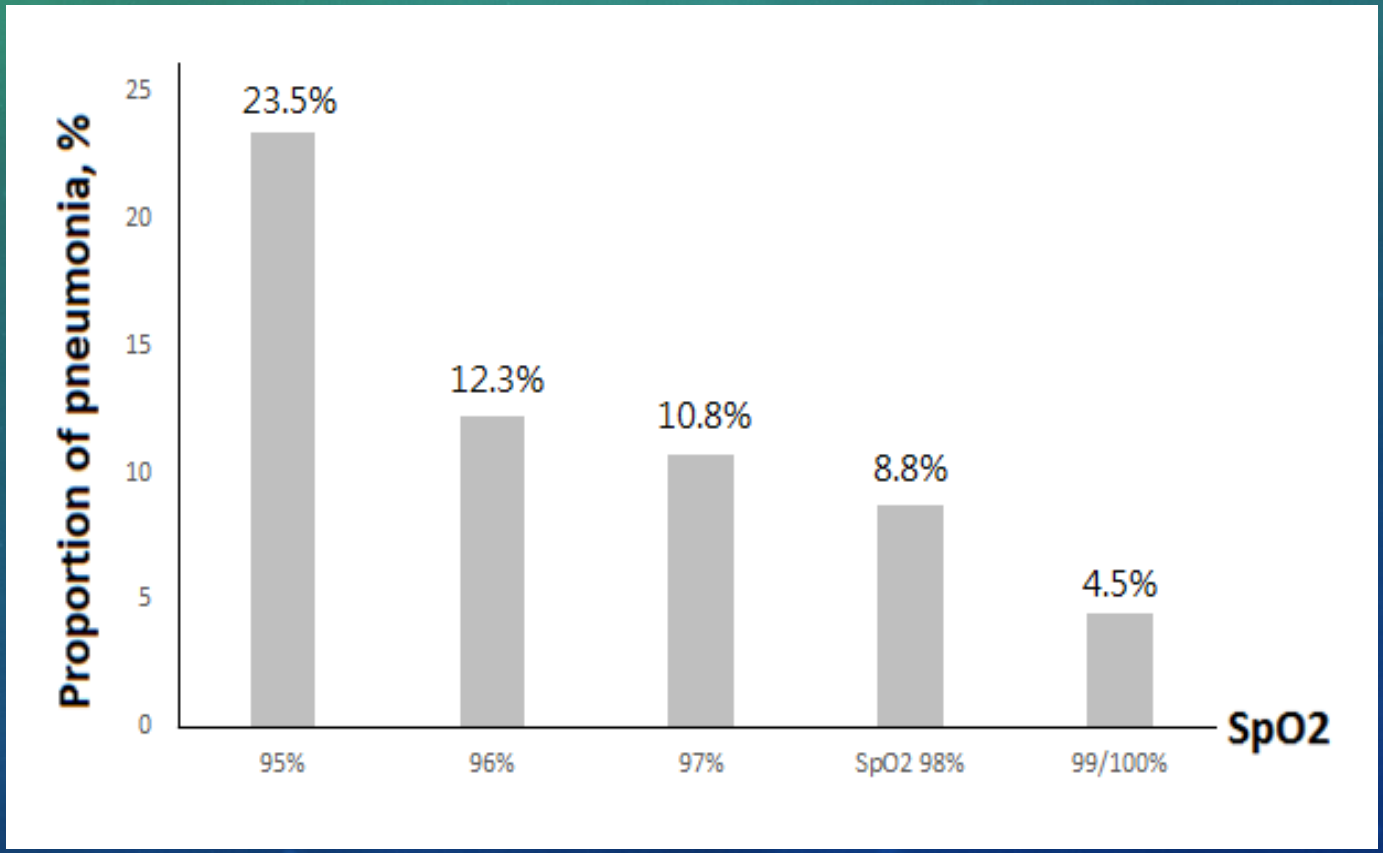
	All (n=484)	Positive outcome (n=48)	Negative outcome (n=436)	p value
Symptoms				
Peak temperature within 24 hours, °C [median ± IQR]	39 (38.5–39.8)	39 (38.7–39.9)	39 (38.5–39.8)	0.923
Peak temperature within 24 hours ≥ 39°C	295 (61.1%)	33 (68.8%)	262 (60.1%)	0.243
Fever duration, days [mean ± SD]	2.3 ± 1.8	3.7 ± 2.7	2.2 ± 1.6	<0.001
Fever duration ≥ 3 days	155 (32.1%)	31 (64.6%)	124 (28.4%)	<0.001
Fever duration ≥ 5 days	53 (11%)	16 (33.3%)	37 (8.5%)	<0.001
Fever duration ≥ 7 days	13 (2.7%)	5 (10.4%)	8 (1.8%)	0.005
Chills	85 (17.6%)	14 (29.2%)	71 (16.3%)	0.026
Cough	477 (98.8%)	46 (95.8%)	431 (98.9%)	0.147
Purulent sputum	23 (4.8%)	0 (0%)	23 (5.3%)	0.152
Noted dyspneic by parents	41 (8.5%)	10 (20.8%)	31 (7.1%)	0.001
Noisy breathing	40 (8.3%)	3 (6.3%)	37 (8.5%)	0.785
Sore throat	132 (27.3%)	13 (27.1%)	119 (27.3%)	0.975
Nasal blockage / discharge	370 (76.6%)	32 (66.7%)	338 (77.5%)	0.093
Poor feeding	134 (27.7%)	13 (27.1%)	121 (27.8%)	0.922
Travel history within 2 weeks	59 (12.2%)	8 (16.7%)	51 (11.7%)	0.318
Hospitalized within 7 days	7 (1.4%)	0 (0%)	7 (1.6%)	1.000

RESULTS

	All (n=484)	Positive outcome (n=48)	Negative outcome (n=436)	p value
Physical examination				
Toxic appearance	10 (2.1%)	3 (6.3%)	7 (1.6%)	0.067
Reduced breath sounds	1 (0.2%)	0 (0%)	1 (0.2%)	1.000
Crackles	16 (3.3%)	5 (10.4%)	11 (2.5%)	0.015
Wheeze on examination	14 (2.9%)	1 (2.1%)	13 (3%)	1.000
Past history				
Past history of pneumonia	49 (10.1%)	4 (8.3%)	45 (10.3%)	0.805
Asthma	18 (3.7%)	4 (8.3%)	14 (3.2%)	0.757
Presenting vital signs				
Pulse rate, beats per min [mean ± SD]	138 ± 26	136 ± 23	139 ± 26	0.186
Tachycardia (99th percentile)	254 (52.6%)	27 (56.3%)	227 (52.1%)	0.582
Tachycardia (99th percentile, adjusted for fever)	139 (28.8%)	15 (31.3%)	124 (28.4%)	0.683
Respiratory rate, breaths per min [median ± IQR]	20 (18–25)	20 (18–24.5)	20 (18–25)	0.967
Tachypnea (99th percentile)	11 (2.3%)	4 (8.3%)	7 (1.6%)	0.017
SpO2, % [median ± IQR]	98 (97–99)	97.5 (96–98)	98 (97–99)	0.007
SpO2 ≤ 96%	92 (19%)	19 (39.6%)	73 (16.7%)	<0.001
Temperature, °C [median ± IQR]	38.1 (37.2–38.8)	38.1 (37.4–38.9)	38.1 (37.2–38.8)	0.489
Temperature ≥ 39°C	82 (17%)	6 (12.5%)	76 (17.4%)	0.387

RESULTS

Association between SpO2 and probability of pneumonia in pediatric patients



PAEDIATRIC AFRI RULE (WITH RESPIRATORY RATE)

	Log OR	Wald	Odds ratio (95% CI)	p value	Weight
Duration of fever		47.37		<0.001	
< 3 days			1		
3-4 days	0.811	7.74	2.25 (1.27 - 3.98)	0.005	2
5-6 days	1.862	32.60	6.44 (3.4 - 12.2)	<0.001	4
≥ 7 days	2.18	25.26	8.84 (3.78 - 20.69)	<0.001	5
Chills	0.696	6.93	2.01 (1.2 - 3.37)	0.008	2
Nasal symptoms	-0.767	9.17	0.46 (0.28 - 0.76)	0.002	-2
Abnormal chest examination	1.183	10.66	3.27 (1.61 - 6.65)	0.001	3
Tachypnea > 99th percentile	1.384	5.22	3.99 (1.22 - 13.1)	0.022	3

Backward stepwise method by likelihood ratio
Hosmer-and-lemeshow goodness-of-fit test p=0.405
AUROC of predicted probabilities 0.762 (95% CI 0.688-0.830)

PAEDIATRIC AFRI RULE (WITH SPO_2)

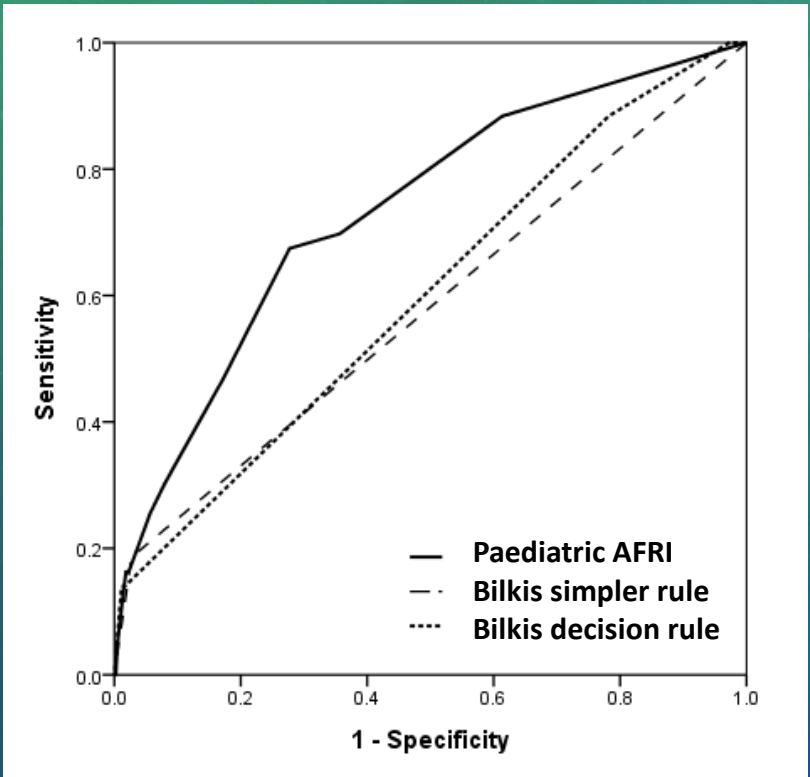
	Log OR	Wald	Odds ratio (95% CI)	p value	Weight
Duration of fever		45.467		<0.001	
< 3 days			1		
3-4 days	0.799	7.562	2.22 (1.26 - 3.93)	0.006	2
5-6 days	1.85	32.416	6.36 (3.36 - 12.02)	<0.001	4
≥ 7 days	2.102	23.027	8.18 (3.47 - 19.3)	<0.001	5
Chills	0.705	7.181	2.03 (1.21 - 3.39)	0.007	2
Nasal symptoms	-0.724	8.279	0.49 (0.3 - 0.79)	0.004	-2
Abnormal chest examination	1.156	9.998	3.18 (1.55 - 6.5)	0.002	3
SpO2 ≤ 96%	0.952	2.961	2.59 (1.94 - 3.69)	0.035	3

Backward stepwise method by likelihood ratio
Hosmer-and-lemeshow goodness-of-fit test p=0.851
AUROC of predicted probabilities 0.761 (95% CI 0.683-0.832)

PROPOSED PAEDIATRIC AFRI (PAFRI) RULE

Predictors	**Weight**
Duration of fever < 3 days 3-4 days 5-6 days ≥ 7 days	 0 2 4 5
Chills (observed chills by parents)	2
Nasal symptoms (nasal discharge, nasal blockage)	-2
Abnormal chest examination (any of reduced breath sound, rales, and wheeze)	3
SpO2 ≤ 96% or tachypnea	3

COMPARISON BETWEEN SCORES



AUROC:
PAFRI 0.733 (95% CI 0.653-0.813; p<0.001),
Bilkis decision rule 0.600 (95% CI 0.510-0.691; p=0.03),
Bilkis simpler rule 0.579 (95% CI 0.481-0.678; p=0.086)

Non-parametric Comparison of AUROC:
PAFRI vs Bilkis decision rule p<0.001;
PAFRI vs Bilkis simpler rule p<0.001.

DIAGNOSTIC CHARACTERISTICS OF PAFRI RULE AT VARIOUS CUT-OFFS (IN DERIVATION DATA SET)

	Outcome	PAFRI ≥ 0	PAFRI ≥ 1	PAFRI ≥ 2	PAFRI ≥ 3	PAFRI ≥ 4	PAFRI ≥ 5
Positive test	Positive	44	37	34	27	17	14
	Negative	269	150	113	68	33	25
Negative test	Positive	4	11	14	21	31	34
	Negative	167	286	323	238	403	411
Sensitivity		91.7 (79.1-97.3)	77.1 (62.3-87.5)	70.8 (55.7-82.6)	56.3 (41.3-70.2)	35.4 (22.6-50.6)	29.2 (17.4-44.3)
Specificity		38.3 (33.7-43.1)	65.6 (60.9-70)	74.1 (69.7-78.1)	77.8 (72.6-82.2)	92.4 (89.4-94.7)	94.3 (91.5-96.2)
PPV		14.1 (10.5-18.5)	19.8 (14.5-26.4)	23.1 (16.8-30.9)	28.4 (19.9-38.7)	34 (21.6-48.9)	35.9 (21.7-52.8)
NPV		97.7 (93.7-99.2)	96.3 (93.3-98)	95.8 (93-97.6)	91.9 (87.7-94.8)	92.9 (89.9-95)	92.4 (89.4-94.6)
PLR		1.49 (1.33-1.66)	2.24 (1.83-2.74)	2.73 (2.15-3.48)	2.53 (1.83-3.51)	4.68 (2.83-7.74)	5.09 (2.84-9.11)
NLR		0.22 (0.08-0.56)	0.35 (0.21-0.59)	0.39 (0.25-0.61)	0.56 (0.41-0.78)	0.7 (0.57-0.86)	0.75 (0.63-0.9)
Youden's J		0.30	0.43	0.45	0.34	0.28	0.24

DISCUSSION

- Tachypnea VS SpO_2? similar accuracy.
- Pulse oximetry more objective, less observer dependent, quickly obtained
- RR not accurate in crying or irritable children in emergency setting.
- Pulse oximetry may not be available in other clinical settings e.g. primary care clinics.

DISCUSSION

- Fever:
  - Duration
  - Temperature at triage 艚
  - Peak Temperature 艚
- Nasal Symptoms VS Sore throat 艚

DISCUSSION – HOW TO USE THE RULE

- Clinical uses of the PAFRI:

- PAFRI ≥1 → assist emergency physicians to consider ordering an CXR/help consider referral for a CXR.

- PAFRI ≥ 4 or above has >90% specificity
- Triage for early assessment with positive prediction by PAFRI
- Consider triage-initiated chest radiograph

LIMITATIONS

- Verification bias – CXR not taken in every patient
- Not done throughout the whole year – flu surge was not taken into account of in the study

CONCLUSION

- A clinical prediction rule for CXR confirmed paediatric pneumonia has been established using clinical history, signs and symptoms.
- The PAFRI rule has achieved satisfactory accuracy in performance in predicting pneumonia compared to other previous studies.
- Different cutoff points can be employed in different settings.
- To be further validated by a primary care population.

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Thank you!