



國家衛生研究院



兒童重症轉運 專業教育訓練課程

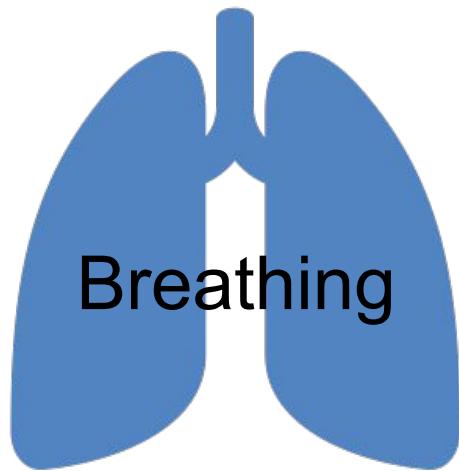
兒童呼吸急重症 個案轉運與特殊處置

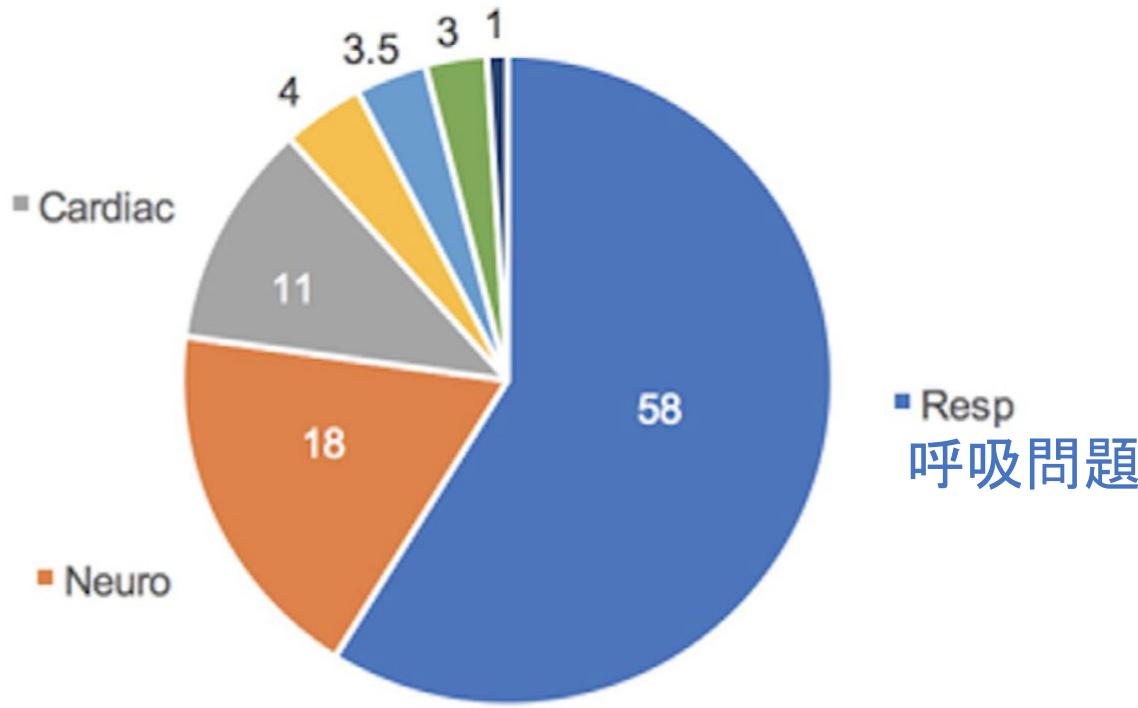
臺大醫院 陳思涵醫師

2023/09/23

Outline

- **臨床照護**
 - 呼吸重症轉運目標
 - 轉院前/ 現場/ 路途 評估處置重點
- **案例個論**
 - 新生兒呼吸窘迫
 - 氣胸
 - 急性呼吸窘迫症候群 ARDS
 - 發紺性先天性心臟病
- **總結**





Riphagen S, Bird R. Ventilatory management of critically ill children in the emergency setting, during transport and retrieval.
Paediatr Anaesth. 2022 Feb;32(2):330-339.

盡量 快

- Administration of standard therapies
- Before, continue, advancing

盡量 安全

- ✗ Risk of deterioration
- ✗ Secondary injury

轉運限制 Limitations

- 擁擠且移動的環境
- 資源有限
- 吵雜環境
- 人員安全

Case 1

- 一天大男嬰，出生後2小時開始喘，給予NIPPV支持未改善
- G1P1, GA: 38+0 weeks, BBW: 2776 gm
- C/S due to elective C/S, Apgar score: 9 to 9
- 規則產檢，無已知異常

外接出勤前資訊收集

生命徵象	SpO2 98%, HR 143, RR 50, BP 66/42
CXR (影像學檢查)	-
Blood gas (檢驗)	pH 7.48, CO2 30, HCO3 21.9, BE -0.6
管路	IV cath x1
呼吸器設定	NIPPV 17/5, RR40, FiO2 50%
鎮靜藥物	-

外接現場評估

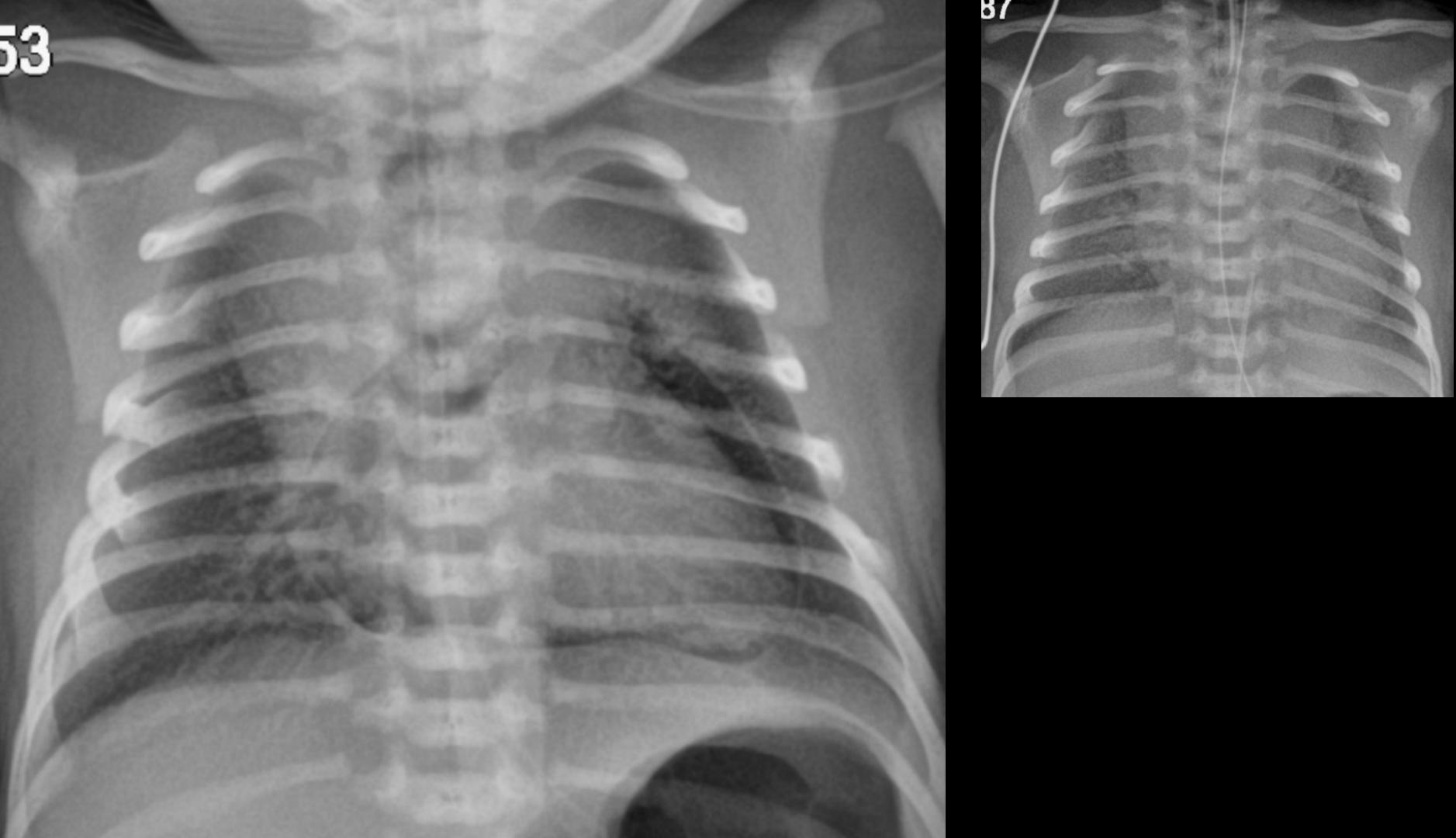
是否需要緊急現場處置?	X
鎮靜深度是否足夠?	-
管路固定是否安全?	-
換床後再次評估	O



外接回程監測

	回程出發		抵達醫院	抵達ICU
	10:31	10:40	10:42	10:47
PR	143	153	138	138
RR	50	39	40	28
BP	66/42	68/48	60/44	80/33
SpO2	98	100	100	97

密集監測生命徵象	O
調升調降呼吸支持?	X
意外事件處置	-
回報接收醫院準備	NICU備床, 備呼吸器



53

87

Noninvasive Ventilation During Transport

- Adults transport-associated NIV reduces mortality and intubation rates
- 0.4% rate of intubation or escalation
- 1–4% in-transport minor adverse event rate
 - use of BVM (1%), desaturation episodes (2%), apnea (4%)

Goodacre S et al: Prehospital noninvasive ventilation for acute respiratory failure: Systematic review, network and individual patient data meta-analysis.

Acad Emerg Med 2014; 21:960–970

Cheema B et al. Noninvasive Ventilation During Pediatric and Neonatal Critical Care Transport: A Systematic Review.

Pediatr Crit Care Med. 2019 Jan;20(1):9-18.

To intubate or not to intubate?

- Indication
 - existing or impending failure of oxygenation, ventilation, neuromuscular respiratory drive, airway protective reflexes
 - patients requiring transport who are at risk for deterioration
- “Elective”
 - prostaglandin E1 (PGE1)
 - apnea, hypotension
 - tube occlusion, displacement, equipment failure

Cuffed Endotracheal Tubes

- Optimal ventilation
- More reliable EtCO₂ capnography
- Replacing an endotracheal tube in the critically ill child is risky
- 213 children, 25.8% with an uncuffed ET tube
 - 43.6% of patients with uncuffed tubes needed replaced on an urgent basis because **ineffective ventilation**
 - 0% cuffed tubes required replacement

Case 2

- 3天大女嬰，呼吸喘經NIPPV支持。今日掉血氧，評估為氣胸，經引流呼吸仍不穩定
- G1P1, GA: 37+0 weeks, BBW: 2830 g
- CS due to cephalopelvic disproportion, Apgar score: 8 to 9
- 規則產檢，無已知異常

外接出勤前資訊收集

生命徵象	SpO2 30%
CXR (影像學檢查)	left pneumothorax
Blood gas	-
管路	IV cath x1
呼吸器設定	NIPPV 10/5, RR 30, FiO2 100%
鎮靜藥物	-

外接現場評估

是否需要緊急現場處置?	是, 左胸drain 70ml air 放置氣管內管3.5#, 照CXR
鎮靜深度是否足夠?	X
管路固定是否安全?	O
換床後再次評估	O

外接現場評估

是否需要緊急現場處置?	是, 左胸drain 70ml air 放置氣管內管3.5#, 照CXR
鎮靜深度是否足夠?	X
管路固定是否安全?	O
換床後再次評估	O

Scene time: 02:08 - 03:25

外接回程監測

	回程出發		抵達醫院	抵達ICU
	03:25	03:40	03:51	03:55
PR	157	146	154	161
RR	49	79	79	74
BP	60/35	58/35	54/35	63/40
SpO2	99	100	99	100

密集監測生命徵象	○
調升調降呼吸支持?	FiO2 100 → 40%
意外事件處置	-
回報接收醫院準備	備呼吸器、胸管



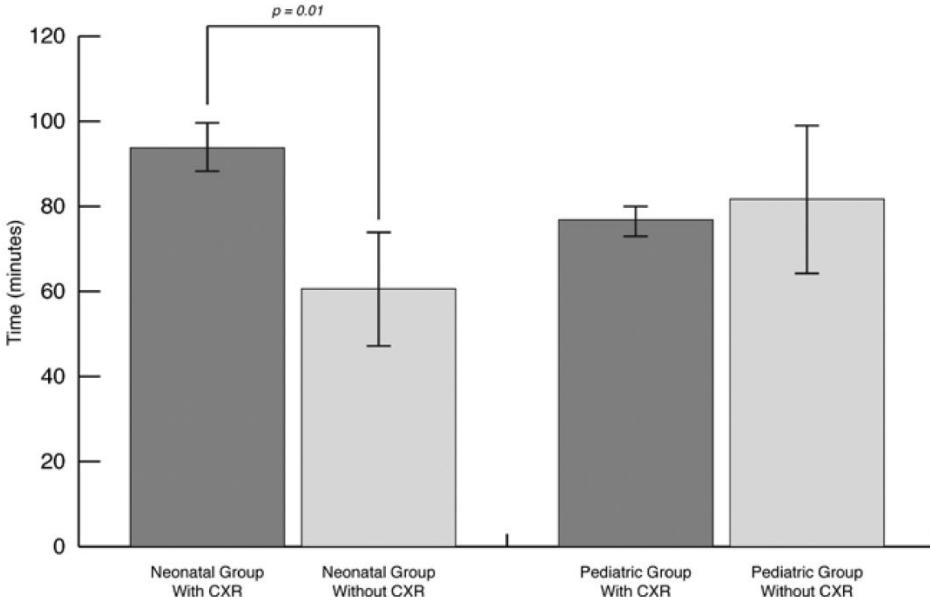
安全

盡量 快

- Provide the **level of care that the patient will receive** at the receiving facility
- At a minimum, must **Maintain the patient's present level of care**

Interfacility transport and stabilization.

Fleisher & Ludwig's Textbook of Pediatric Emergency Medicine 8/E (2021); LWW



	Neonatal (n = 43)	Pediatric (n = 43)	p
Chest radiograph obtained, n (%)	29 (85.3%)	37 (86.0%)	0.93
TTs repositioned based on radiograph, n (%)	15 (51.7%)	16 (43.2%)	0.54
TT determined to be too shallow	6 (40.0%)	10 (62.5%)	0.21
TT determined to be too deep	9 (60.0%)	6 (37.5%)	

快

盡量 安全

教育訓練

- Skills acquisition and refreshers
- Troubleshooting
- Experience in the moving and constrained environment
- Secure the patient
- Case discussions
- Communication skills

Common ventilation issues

Issues occurring	Patient factors	Equipment factors
High airway pressure alarm/ high pressures required	Secretions/ mucus plugs in ETT/ large airways Pneumothorax. Bronchospasm. Abdominal splinting (insert NGT to decompress stomach)	Endobronchial intubation ETT tube or circuit blocked/ Kinked
Increasing ETCO ₂	Inadequate ventilation. Air trapping. Increasing metabolic demand. Rare cause MH secondary to anesthetic drugs.	Ensure ETT and airways lavaged and suctioned. Re-evaluate adequate settings TV/ RR / PEEP. Minimize dead space. Cool and sedate.
Hypoxia	Worsening of underlying condition. Re-examine ABC and treat accordingly	Check O ₂ settings Check cylinder

教育訓練

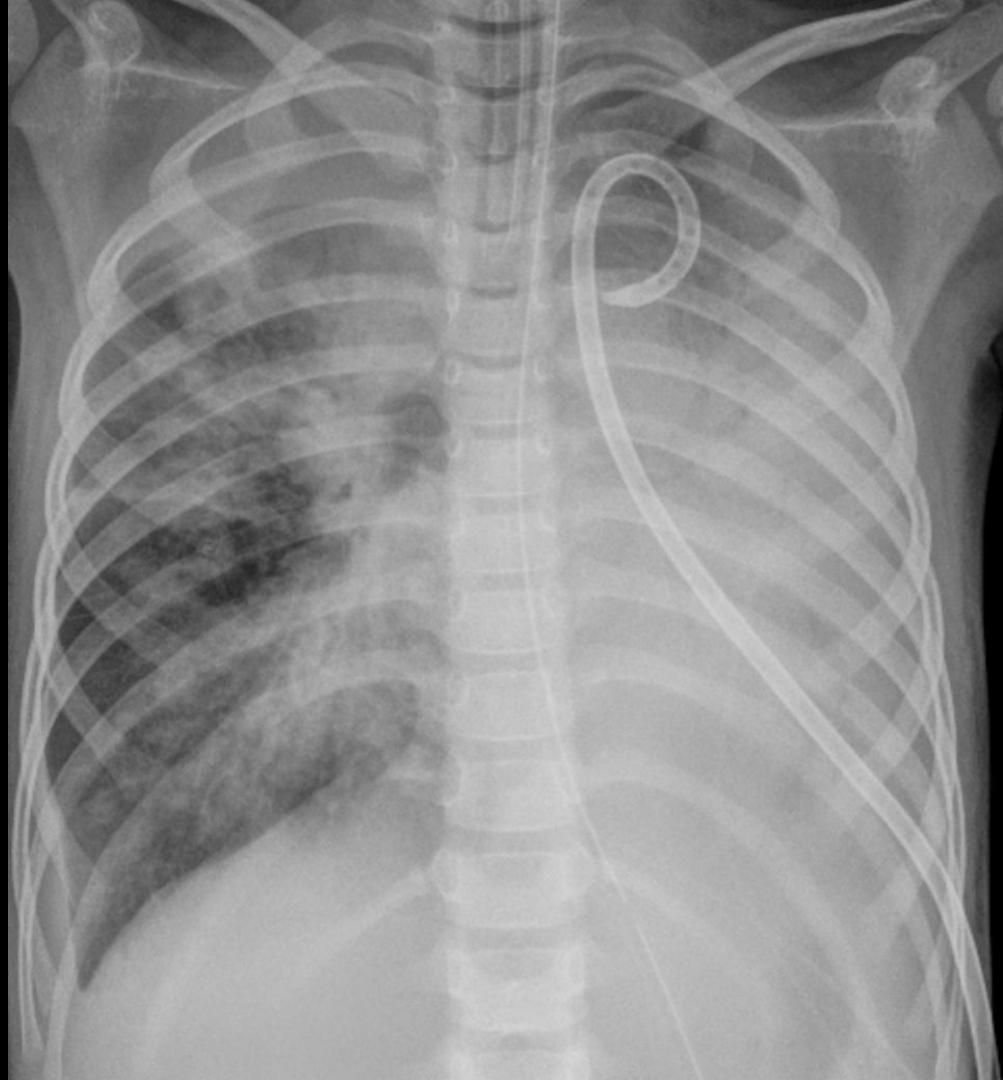
盡量 快

安全

- Knowing limitations
- Simulation
- Quality improvement work

Case 3

- 5歳女童，肺炎合併急性呼吸窘迫症候群。
呼吸器設定非常高但血
氧仍差，需葉克膜支持



外接出勤前資訊收集

生命徵象	SpO2 60~80%
CXR (影像學檢查)	
Blood gas	NA
管路	ETT: 5# cuff(+), fix 15cm Pigtail (L): 14#, 20cm
呼吸器設定	PCV 30/8, R 40, FiO2 100%
鎮靜藥物	Dormicum

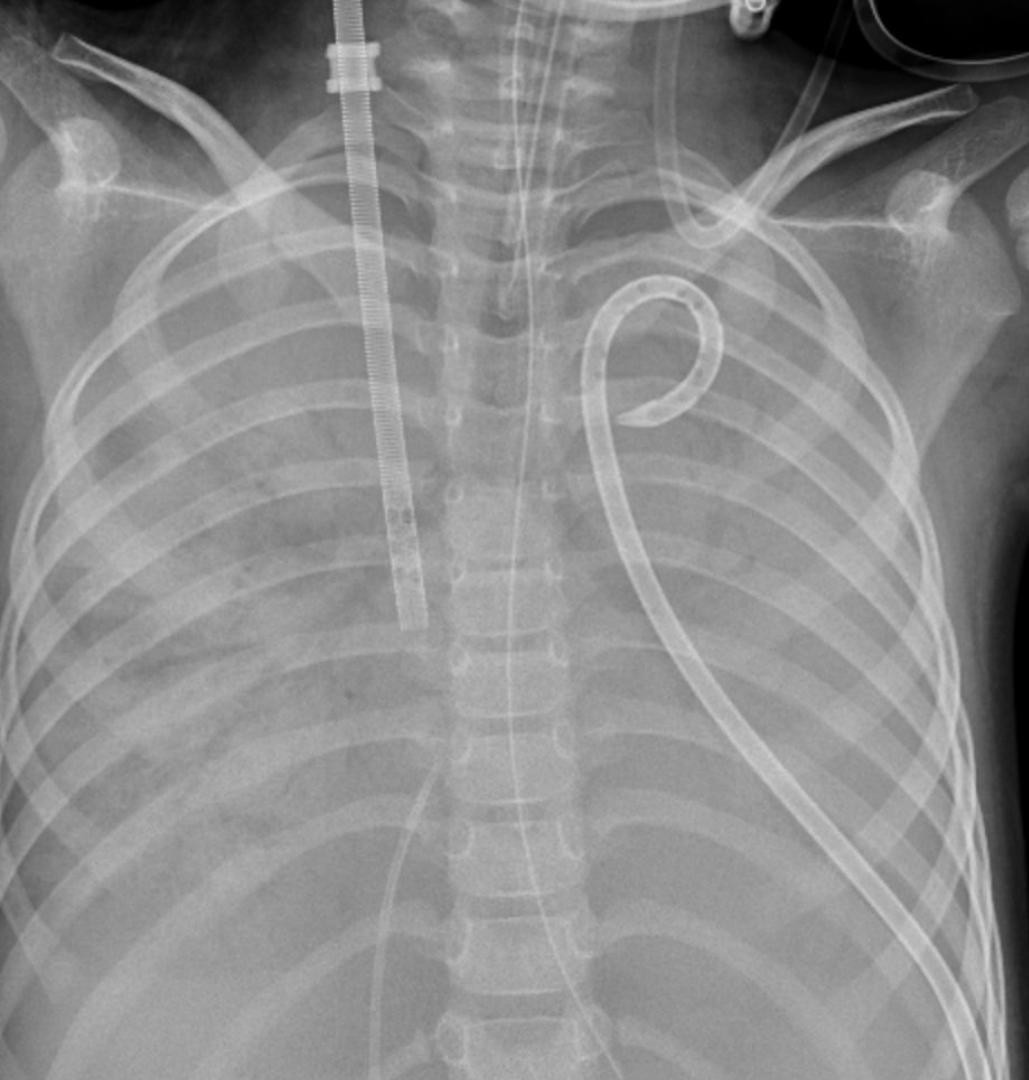
外接現場評估

是否需要緊急現場處置?	X
鎮靜深度是否足夠?	X → Dormicum STAT purge
管路固定是否安全?	O
換床後再次評估	X → Bagging

外接回程監測

	回程出發		抵達醫院	抵達ICU
	10:50	10:55	10:59	11:05
PR	178	171	173	173
RR	38	44	48	55
BP	82/52	71/60	NA	76/48
SpO2	71	67	67	63

密集監測生命徵象	unstable
調升調降呼吸支持?	Bagging
意外事件處置	NS challenge
回報接收醫院準備	ECMO, O2



11:05 抵PICU

11:16 VS評估完畢

11:50 ECMO time out

12:33 ECMO run

快

盡量 安全

- Oxygen delivery systems with limited oxygen supply
- Oxygen capacity and reserve should be calculated for each patient transported
- At least **twice the amount needed** for the expected duration

OXYGEN CALCULATION

Cylinder Oxygen:

(gauge psi in tank - residual pressure)

X cylinder constant

— Total Flow Rate in LPM

Oxygen
Duration
(in minutes)

Tank Size	Cylinder Constant	Residual Pressure (psi)
D	0.16	200
E	0.28	200
M	1.56	200
H	3.14	200

Liquid Oxygen:

$\frac{\text{Total LPM} \times 60 \times \text{Duration of flight in hours}}{804}$ = Amount of liquid oxygen needed

Ventilator	Hamilton
Type of ventilator	Mechanical driven
Modes of Ventilation	ASV PCV VCV PS / VS
Non invasive	Bipap / CPAP
Oxygen	21%-100%
RR	1-80 bpm
Size / Weight	Adult Paediatric Neonatal
TV lower limit	2 mls
TV	2-2000 mls
Inspiratory pressure	0-60 cm H2O
Dimensions (w x h x d)	12.2 x 9.6 x 8.6
Weight	6.5 kg
Battery life	9 h (hot swap battery available for use while running)



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換轉診團隊的呼吸器 10min後抽gas

Beatmungseinstellungen
(Modus, AF, Drücke, VT)
beibehalten. BGA nach 10 min.

Wechsel auf
Transport-
ventilator

S_pO_2 stabil?
 $P_aO_2 > 80 \text{ mmHg}$?
 $pH > 7,1$?

Bei Rekrutierung:
Volumenstatus? Nur „frisches“
ARDS. Pneumothoraxgefahr
beachten

Gasaustausch
ausreichend?

Gasaustausch
unzureichend?

GO !

PEEP erhöhen?
Rekrutierungs-
manöver?

Bauchlage??

Ilomedin
vernebeln?

Ergüsse / Pneu
drainieren?

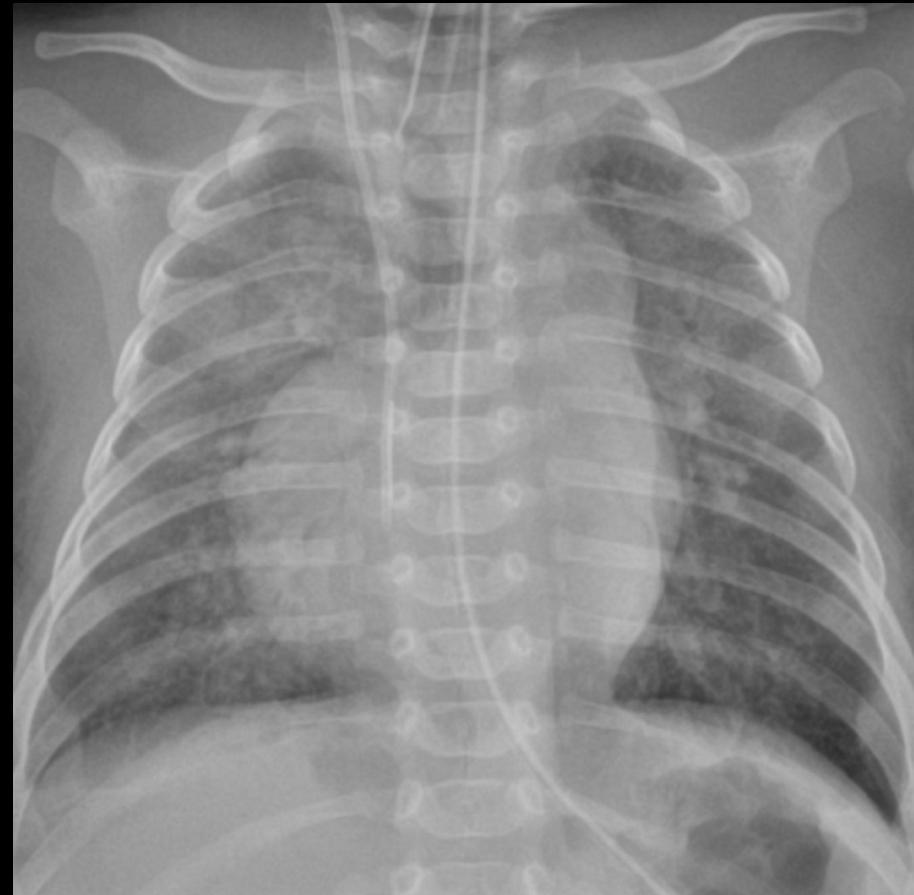
調高PEEP? Prone? iloprost ? Drain水/氣?

High PIP/PEEP...

- Pneumothorax
- Decreased cardiac output
- Ventilator-induced lung injury

Case 4

- 2個月大男嬰，複雜性先天性心臟病，呼吸喘血氧低，評估需要接受心臟手術處置
- d-Transposition of the great arteries with mitral atresia
 - With PT type VSD
 - With severe LV hypoplasia

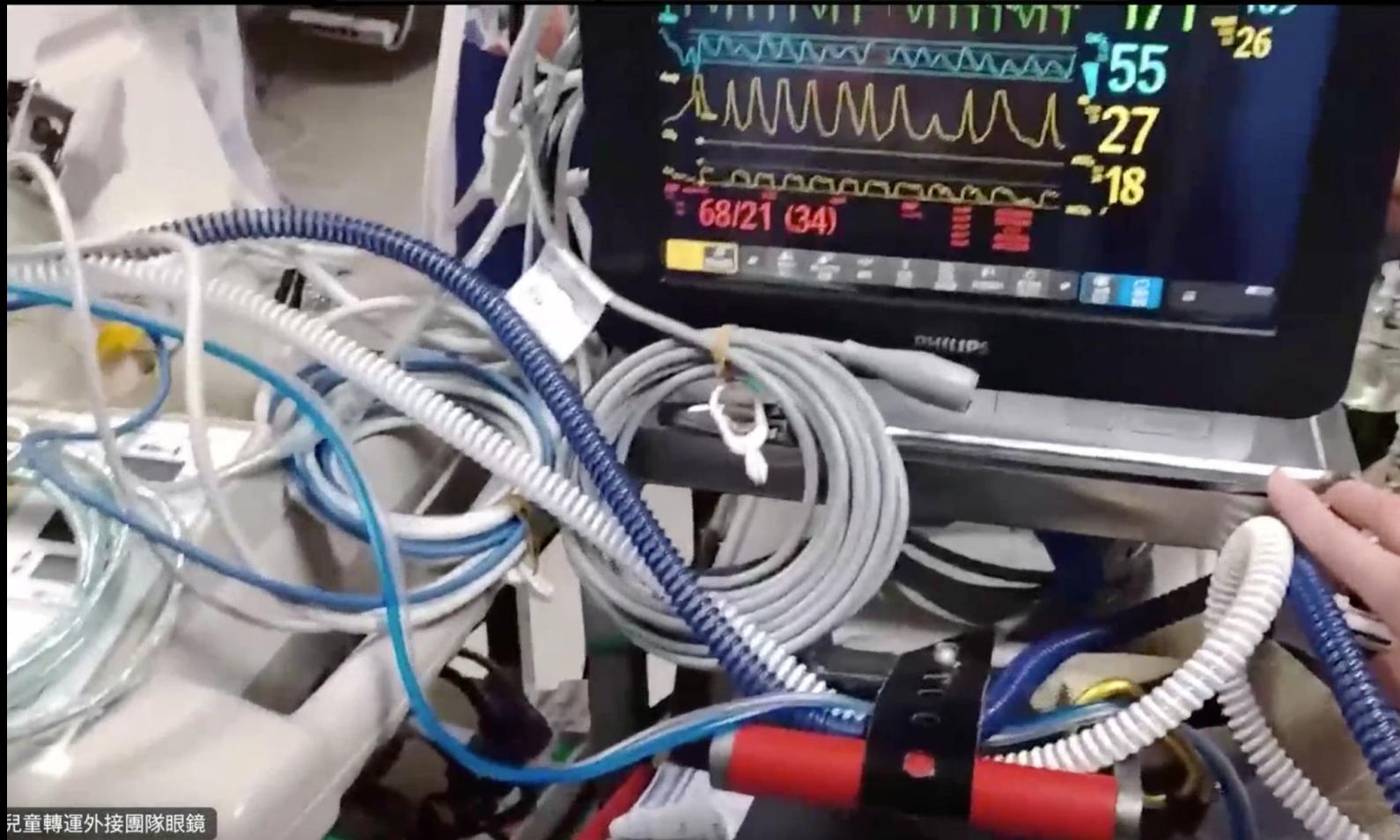


外接出勤前資訊收集

生命徵象	SpO2 70-73%
CXR (影像學檢查)	
Blood gas	
管路	ETT: 4# cuff(-), fix 9.5cm
呼吸器設定	PCAC: 22/6, RR 40, FiO2 100% iNO 20ppm
鎮靜藥物	Dormicum/ Nimbex

外接現場評估

是否需要緊急現場處置?	?
鎮靜深度是否足夠?	O
管路固定是否安全?	O
換床後再次評估	X



外接現場評估

是否需要緊急現場處置?	?
鎮靜深度是否足夠?	O
管路固定是否安全?	O
換床後再次評估	X → 連線後線指導醫師 雙方醫療團隊(PI/ CVS)與家屬溝通風險, 共同決策處置

balloon atrial septectomy (BAS)

外接出勤前資訊收集 - II

生命徵象	SpO2 ~90%
CXR (影像學檢查)	
Blood gas	
管路	ETT: 4# cuff(-), fix 9.5cm
呼吸器設定	PCAC: 22/6, RR 40, FiO2 70% off iNO
鎮靜藥物	Dormicum/ Nimbex

外接現場評估

是否需要緊急現場處置?	X
鎮靜深度是否足夠?	O
管路固定是否安全?	O
換床後再次評估	O

外接回程監測

	回程出發		抵達醫院	抵達ICU
	11:25	12:30	13:09	13:15
PR	167	142	144	140
RR	40	40	40	40
BP	95/61	78/47	70/49	79/50
SpO2	94	85	84	87

密集監測生命徵象	
調升調降呼吸支持?	-
意外事件處置	-
回報接收醫院準備	PICU備床, 照會CVS

危險時刻

During transfer from stretcher to stretcher or vehicle to vehicle

盡量 安全

- Fewest transfers necessary
- Personnel assigned to secure lines and tubes, and the patient movement should be coordinated by a team leader
- Carefully reassessed immediately after each movement (airway, immobilization, tubes/ lines dislodged or disrupted)

快

盡量 安全

後線
支援

- **Medical director**

- specialist in pediatric critical care or emergency medicine
- understand capabilities and limitations in the transport
- actively involved in transport protocols

- **Medical command physician (MCP)**

- participate in every transport
- provide advice as necessary
- knowledgeable about the availability of resources

後線
支援

快

盡量 安全

- Indirect (offline)
 - **guidelines**
 - **save time**
 - reduce the variability of orders
 - Direct (online)
 - real-time supervision
 - review management plan
 - particularly important in tertiary care patient
- * additional reporting time
- * potential decision making inconsistency
- * **technical problems**

盡量 快

- 確認轉診目標
- 病患最佳利益
- 判斷最佳的目的地
與轉診時間點

盡量 安全

- 氣管內管固定
- 有設備與備案
- 氧氣供給穩定
- 持續監測通氣

外接出勤前資訊收集

生命徵象	
CXR (影像學檢查)	
Blood gas (檢驗報告)	
管路	
呼吸器設定	
鎮靜藥物	

外接現場評估

	是否需要緊急現場處置?	
	鎮靜深度是否足夠?	
	管路固定是否安全?	
	換床後再次評估	

快

安全

外接回程監測

密集監測生命徵象

調升調降呼吸支持？

意外事件處置

回報接收醫院準備



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