台北榮民總醫院 呼吸治療科 技術評核表
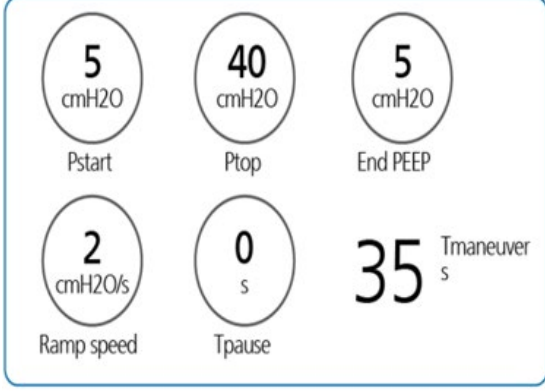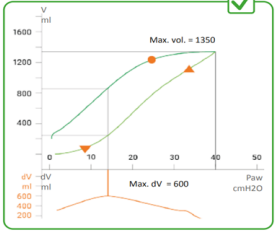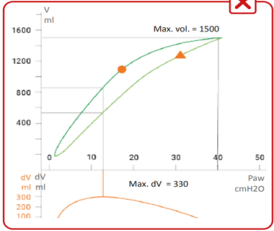# 05_ Lung recruitability assessment and recruitment maneuvers in G5

受評者姓名: 評核日期 (yyyy-mm-dd) : (-   -   )
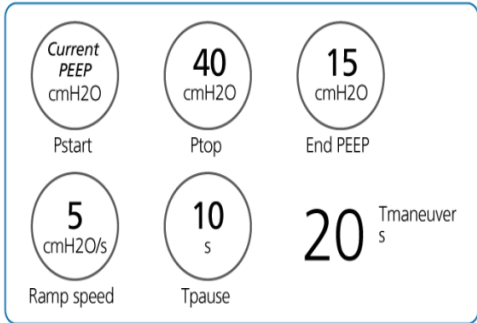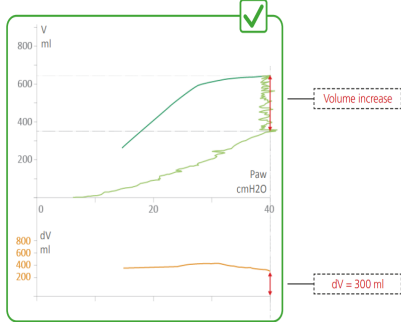
一、 Assess lung recruitability in adult patients.

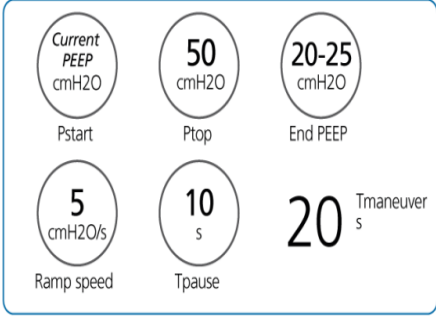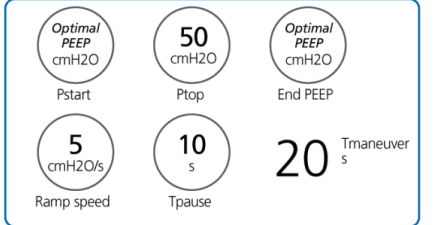| 評估項目	操作過程	狀態	
		通過	未通過
一、 治療前準備：能說出或執行			
1. 適應症	(1)Early in the management of moderate to severe ARDS. (2)As part of an open-lung approach. (3)In the case of impairment with oxygenation after an intervention such as surgery, resuscitation, or similar.		
2. 禁忌症	(1)Air leak (patient and/or breathing circuit) (2)Pregnancy (3)Lung emphysema (COPD 可以做，但 PIP 要設低) (4)Hemodynamic instability. (5)Confirmed or suspected intracranial hypertension (6)Patients who cannot tolerate high intrapulmonary pressure (e.g. right heart failure) (7)Patients vulnerable to baro- or volutrauma (8)Patients who are breathing spontaneously		
二、準備作業:			
1. 確認病人狀態			
(1)For passive patient only Sedation (e.g. Dormicum or Propofol) Paralysis (e.g. Nimbex)			
(2)Hemodynamically stable patients with atelectatic lungs during early ARDS			
(3)Preconditioning : normalize mean arterial pressure (> 65mmHg) or SBP > 90mmHg, and fluid supplement until CVP≥12mmHg, pulse pressure variation < 13%			
2. 執行前置作業			
(1) 洗手			
(2) Run the tightness test: check the breathing circuit is gas tight			
(3) Flow sensor calibration: The flow sensor must perform optimally. P/V Tool Pro is disabled when the Flow			

sensor calibration needed alarm is active.			
(4) Nebulization is deactivated			
(5) Sputum suction			
三. Assess lung recruitability			
1.呼吸器設定步驟			
(1)選擇 Tools 頁面→P/V Tool 分頁。 P/V Tool 資訊視窗會開啟，仔細閱讀後按 ok 繼續。			
(2)設定如下 　✓ Pstart = 0-5 cmH$_2$O 　✓ Ptop = 40cmH$_2$O 　　(COPD:30cmH$_2$O) 　✓ End PEEP = 0-5 cmH$_2$O 　✓ Ramp speed = 2 cmH$_2$O/sec 　✓ T pause = 0 sec NOTE. When prompted whether to change the PEEP setting after the maneuver, touch No			
(3) Start/Stop Maneuver 開始執行			
(4)Assess potential for recruitment 　Calculate the normalized maximum distance (NMD)	$NMD\% = \dfrac{\text{Max. delta volume (dV) between inflation and deflation}}{\text{Maximum volume}}$ 舉例： 		
(5) 判斷適合執行 RM: NMD%≧41% →執行 RM protocol			
(6) 判斷不適合執行 RM: NMD%<41% 　─ Keep PEEP <10 cmH$_2$O 　─ Prone position 　─ Persistent hypoxemia→Consider ECMO			
評 核 者 簽 名:			

二、**Performing a recruitment maneuvers in G5-**

執行第一次 RM (Basic protocol)

評估項目	操作過程	狀態	
		通過	未通過
1.準備作業:			
在執行 RM 之前，先調降 FiO_2 設定使 SpO_2=92% (若 SpO_2>92%，較困難判定 RM 是否有效)			
2.呼吸器設定步驟			
(1)選擇 Tools 頁面→P/V Tool 分頁			
(2)設定如下 ✓ Pstart = Current PEEP ✓ Ptop = 40cmH$_2$O (COPD:30cmH$_2$O) ✓ End PEEP = 15 cmH$_2$O (or current PEEP if current PEEP is above 15 cmH2O) ✓ Ramp speed = 5 cmH$_2$O/sec ✓ T pause = 10 sec NOTE. When prompted whether to change the PEEP setting after the maneuver, touch Yes			
(3)Start/Stop Maneuver 開始執行			
(4)臨床療效觀察 — Volume increase at Ptop was greater than 2.0 ml/kg IBW — SpO$_2$ was above 97% within 5 mins. NOTE. Effective recruitment increases respiratory system compliance, and results in either an increase in tidal volume or a reduction in driving pressure.			
(5)若上述兩點皆符合：重複 Basic protocol (共三次)			
(6)若上述兩點有任一項未符合：考慮 Advanced protocol	*注意：In the event of any hemodynamic impairment, STOP the maneuver immediately.		
評 核 者 簽 名:			

執行第二次 RM (Advanced protocol)

評估項目	操作過程	狀態	
		通過	未通過
1.準備作業:			
<u>Only</u> use the ADVANCED protocol if the first recruitment maneuver (using the BASIC protocol) was well tolerated hemodynamically.			
2.呼吸器設定步驟			
(1)設定如下 ✓ Pstart = Current PEEP ✓ Ptop = 50cmH$_2$O ✓ End PEEP = 20-25 cmH$_2$O ✓ Ramp speed = 5 cmH2O/sec ✓ T pause = 10 sec NOTE. When prompted whether to change the PEEP setting after the maneuver, touch Yes	Current PEEP cmH2O (Pstart) 50 cmH2O (Ptop) 20-25 cmH2O (End PEEP) 5 cmH2O/s (Ramp speed) 10 s (Tpause) 20 s (Tmaneuver)		
(2)Start/Stop Maneuver 開始執行			
(3)臨床療效觀察 — Volume increase at Ptop was greater than 2.0 ml/kg IBW — SpO$_2$ was above 97% within 5 mins.			
(4)若第二次 RM 有效：To perform decremental PEEP titration (找 PEEP)			
3.Performing decremental PEEP titration			
(1)監測 SpO$_2$ 來決定 Optimal PEEP value. 在 PEEP titration 下調過程中 SpO$_2$ 降低 2%，則回到前一個 PEEP 值，將此訂為 Optimal PEEP			
(2)每 3 分鐘降低 PEEP 2 cmH2O			
4. 執行第三次 RM (Specify settings for a recruitment maneuver) (把肺重新打開)			
(1)設定如下 ✓ Pstart = Optimal PEEP ✓ Ptop = 50 cmH$_2$O ✓ End PEEP = Optimal PEEP ✓ Ramp speed = 5 cmH$_2$O/sec ✓ T pause = 10 sec	Optimal PEEP cmH2O (Pstart) 50 cmH2O (Ptop) Optimal PEEP cmH2O (End PEEP) 5 cmH2O/s (Ramp speed) 10 s (Tpause) 20 s (Tmaneuver)		
(2) Start/Stop Maneuver 開始執行			
評 核 者 簽 名:			

撰寫人: RT 王慈珮、施岳廷、陳梅純/VS 柯信國

參考資料:
1. P/V Tool Pro User Guide.
   https://www.hamilton-medical.com/dam/jcr:2be7809a-1f5e-4c4f-93fc-2377d664c087/PV-Tool-user-guide-en-10067117.01.pdf
2. Wei-Chiang Lin, et al. The effect of lung recruitment maneuverer in COVID-19 induced acute respiratory distress syndrome. Respirol Case Rep. 2023 Mar; 11(3): e01107.
3. Chiumello, D., et al. Critical Care Medicine, 48(10) (2020): 1494–1502.
4. Kassis, E., Intensive care medicine 43.8 (2017): 1162-1163.

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1. P/V Tool Pro User Guide.
   https://www.hamilton-medical.com/dam/jcr:2be7809a-1f5e-4c4f-93fc-2377d664c087/PV-Tool-user-guide-en-10067117.01.pdf