

尊重生命 · 人本醫療

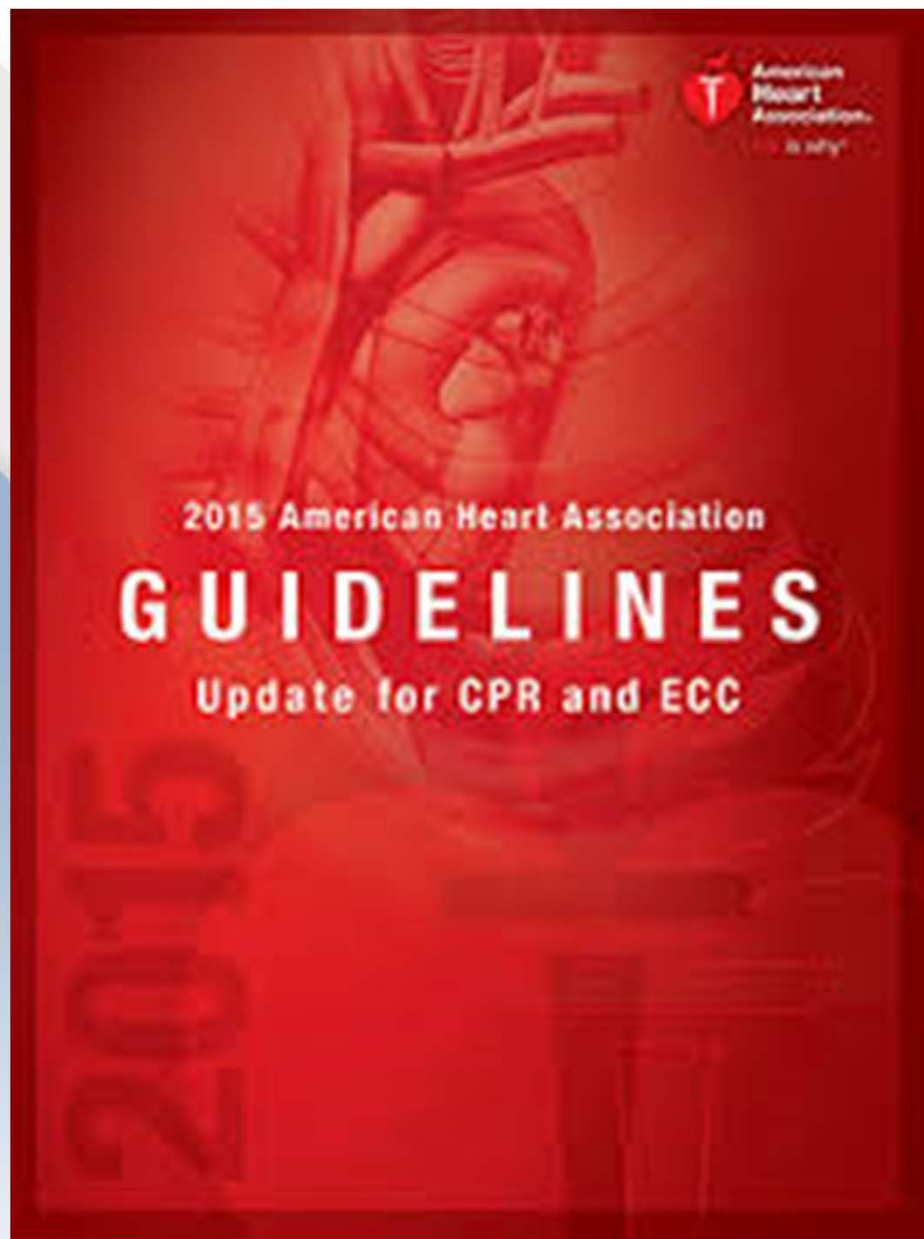
佛教大林慈濟綜合醫院 
Buddhist Da Lin Tzu Chi General Hospital

2015 AHA /ECC updates for BLS:

Compression rate and depth - how to perform and monitor

范文林醫師

2016/04/10



Reinforced

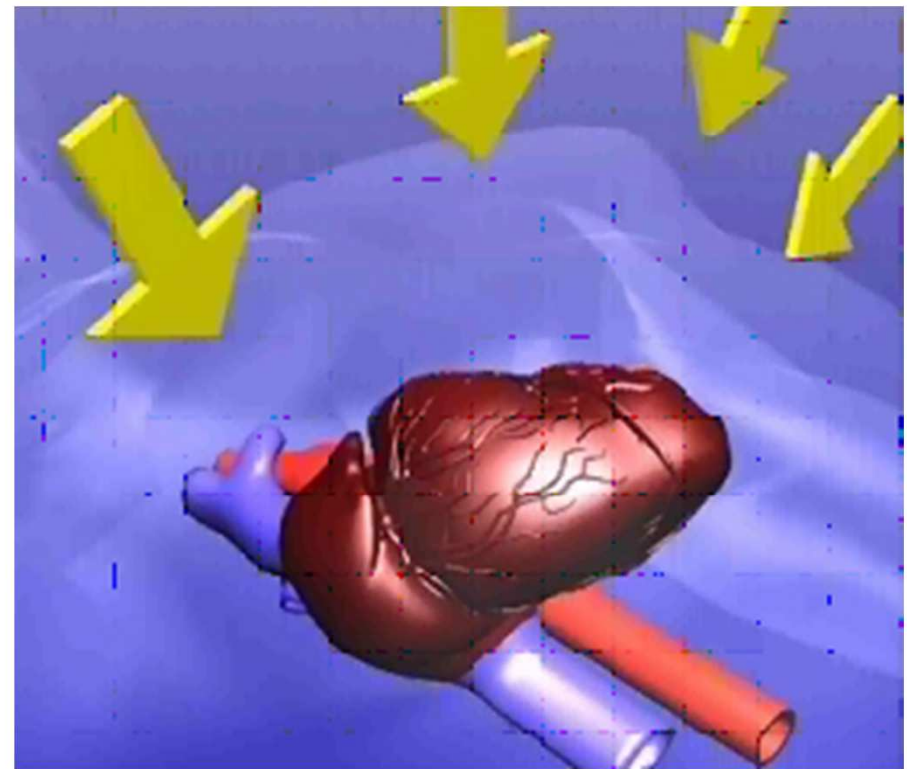
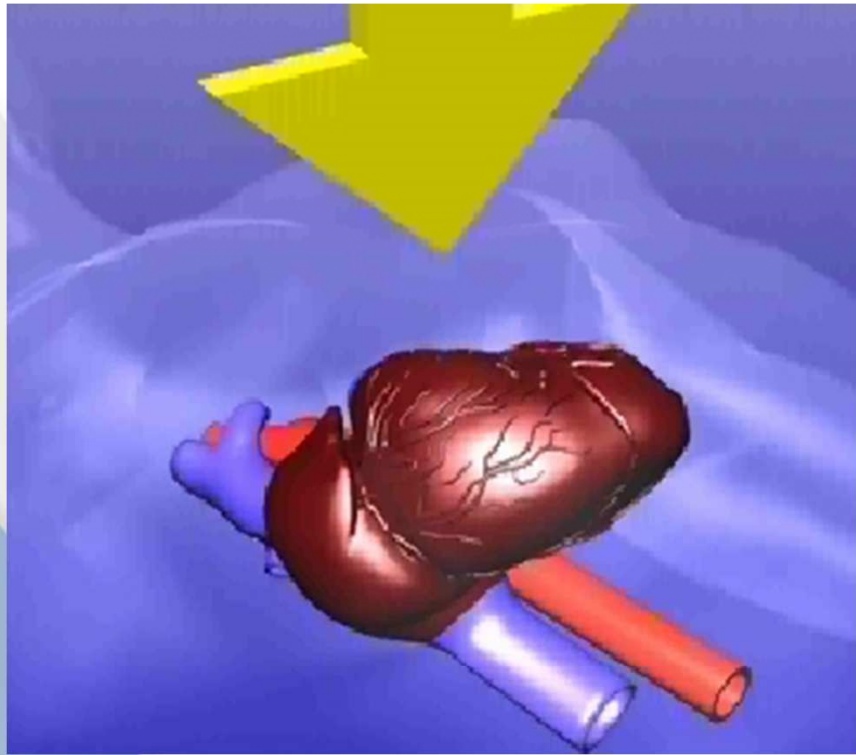
- Chest compressions are the key component of effective CPR.
- Characteristics of chest compressions include their rate, depth, and degree of recoil.
- The quality of CPR can also be characterized by the frequency and duration of interruptions (chest compression fraction), and avoid excessive ventilation.



High quality CPR

- Ensuring chest compressions of adequate rate
- Ensuring chest compressions of adequate depth
- Allowing full chest recoil between compressions
- Minimizing interruptions in chest compressions
- Avoiding excessive ventilation





Reinforced

- These CPR elements affect intra-thoracic pressure, coronary perfusion pressure, cardiac output, and in turn, clinical outcome.
- More data are available showing that high-quality CPR improves survival from cardiac arrest.



CPR Quality Overview

- Other important aspects of CPR quality:
 - Resuscitation team dynamics
 - System performance
 - Quality monitoring



Reinforced CPR cycle remains C-A-B

- Emphasis placed on trained rescuers performing ventilations and non-trained perform chest compression only.



Reinforced Hand Position During Compressions

- Consistent with the 2010 Guidelines, it is reasonable to position hands for chest compressions on the lower half of the sternum in adults with cardiac arrest (Class IIa, LOE C-LD).



Reinforced Hand Position During Compressions

- Different rescuer hand positions alter the mechanics of chest compressions and may, in turn, influence their quality and effectiveness.
- A few human studies have not provided conclusive or consistent results about the effects of hand placement on resuscitation outcome.



It's importance about rate and depth during CPR!

**Not too fast;
Not too hard**



**100-120/min
5-6cm deep**



Updated Chest Compression Rate

- In adult victims of cardiac arrest, it is reasonable for rescuers to perform chest compressions at a rate of 100/min to 120/min (Class IIa, LOE C-LD)
- In the 2010 Guidelines, the recommended rate was at least 100/min.



Updated Chest Compression Rate

- Chest compression rate is defined as the actual rate used during each continuous period of chest compressions.
- The rate differs from the number of chest compressions delivered per unit of time, which takes into account any interruptions in chest compressions.



Chest Compression Rate

2015 summary of evidence

- Human studies that evaluate the relationship between compression rate and outcomes including survival to hospital discharge, ROSC, and various physiologic measures, such as BP and ET-CO₂.
- An optimal zone for the compression rate – between 100 - 120/min – that on average is associated with improved survival.

[Circulation.2012;125:3004-3012](#)



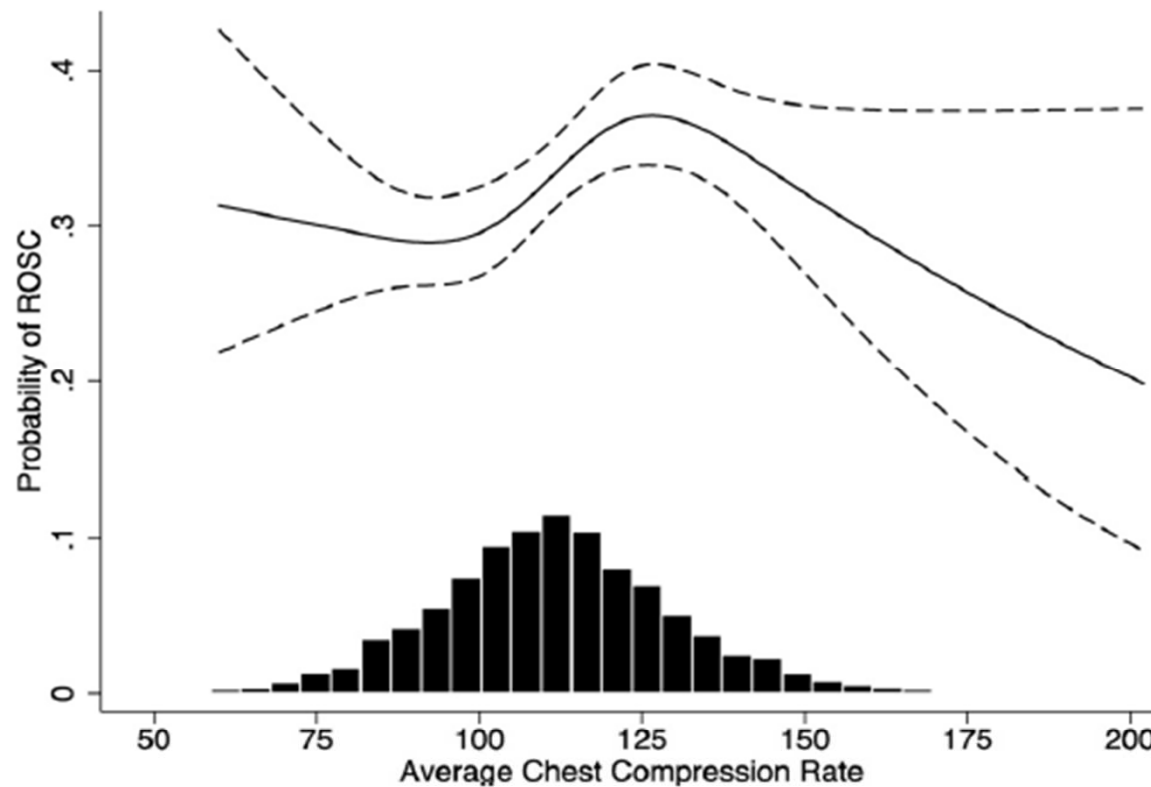


Figure 3. Adjusted cubic spline of the relationship between chest compression rates and the probability of return of spontaneous circulation (ROSC). The adjusted model includes sex, age, bystander-witnessed arrest, emergency medical services-witnessed arrest, first known emergency medical services rhythm, attempted bystander cardiopulmonary resuscitation, public location, and site location (y axis). Probability of ROSC vs average chest compression rate when other covariates are equal to the population average is shown. We used a global test that tested the null hypothesis that the spline curve is a horizontal line ($P=0.012$). A histogram of the compression rates and numbers of patients is included. Dashed lines show 95% confidence intervals.

[Circulation 2012;125:3004-3012](#)



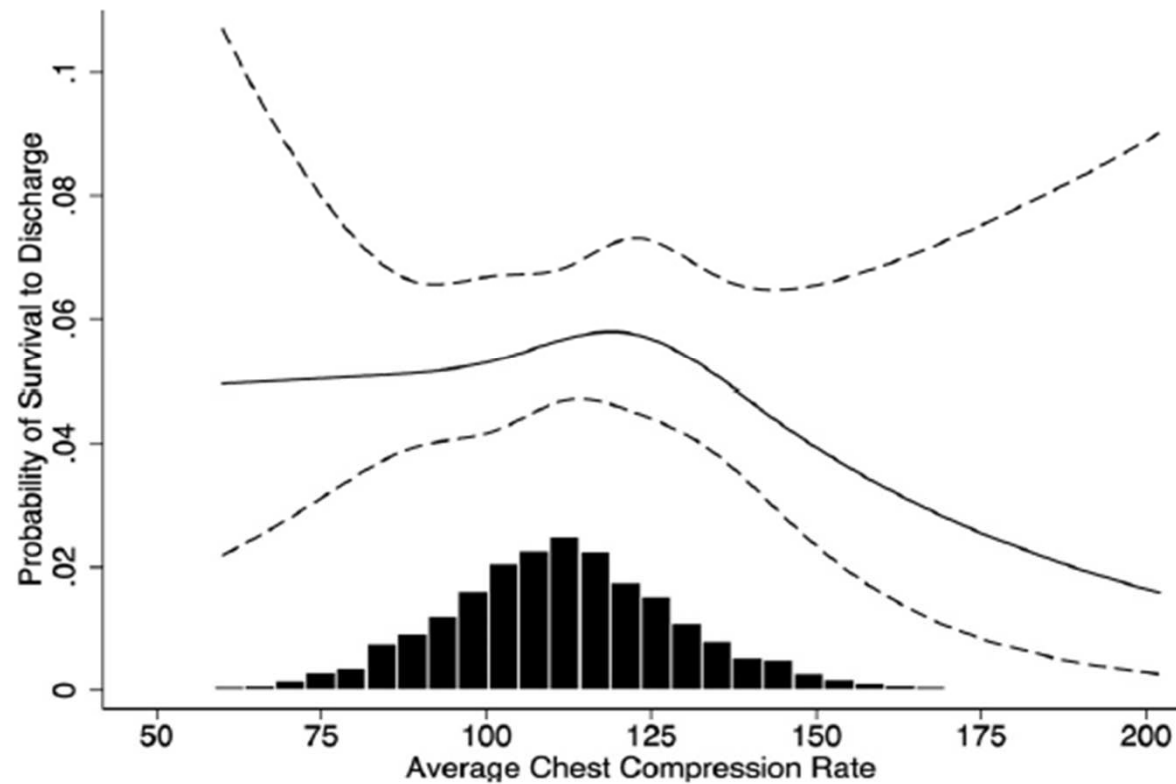


Figure 4. Adjusted cubic spline of the relationship between chest compression rates and the probability of survival to hospital discharge. The adjusted model includes sex, age, bystander-witnessed arrest, emergency medical services-witnessed arrest, first known emergency medical services rhythm, attempted bystander cardiopulmonary resuscitation, public location, and site location (y axis). Probability of survival vs average chest compression rate when other covariates are equal to the population average is shown. We used a global test that tested the null hypothesis that the spline curve is a horizontal line ($P=0.63$). A histogram of the compression rates and numbers of patients is included. Dashed lines show 95% confidence intervals.

Circulation 2012;125:3004-3012



Chest Compression Rate

2015 summary of evidence

- An interdependent relationship between compression rate and depth.
- As rate increases to greater than 120/min, depth decreases in a dose-dependent manner.
- The proportion of compressions less than 3.8 cm (1.5 inches) was about 35% for a rate of 100 to 119/min, but increased to 50% for a rate of 120 to 139/min, and 70% for a rate of greater than 140/min.

Crit Care Med.2015;43:840-848



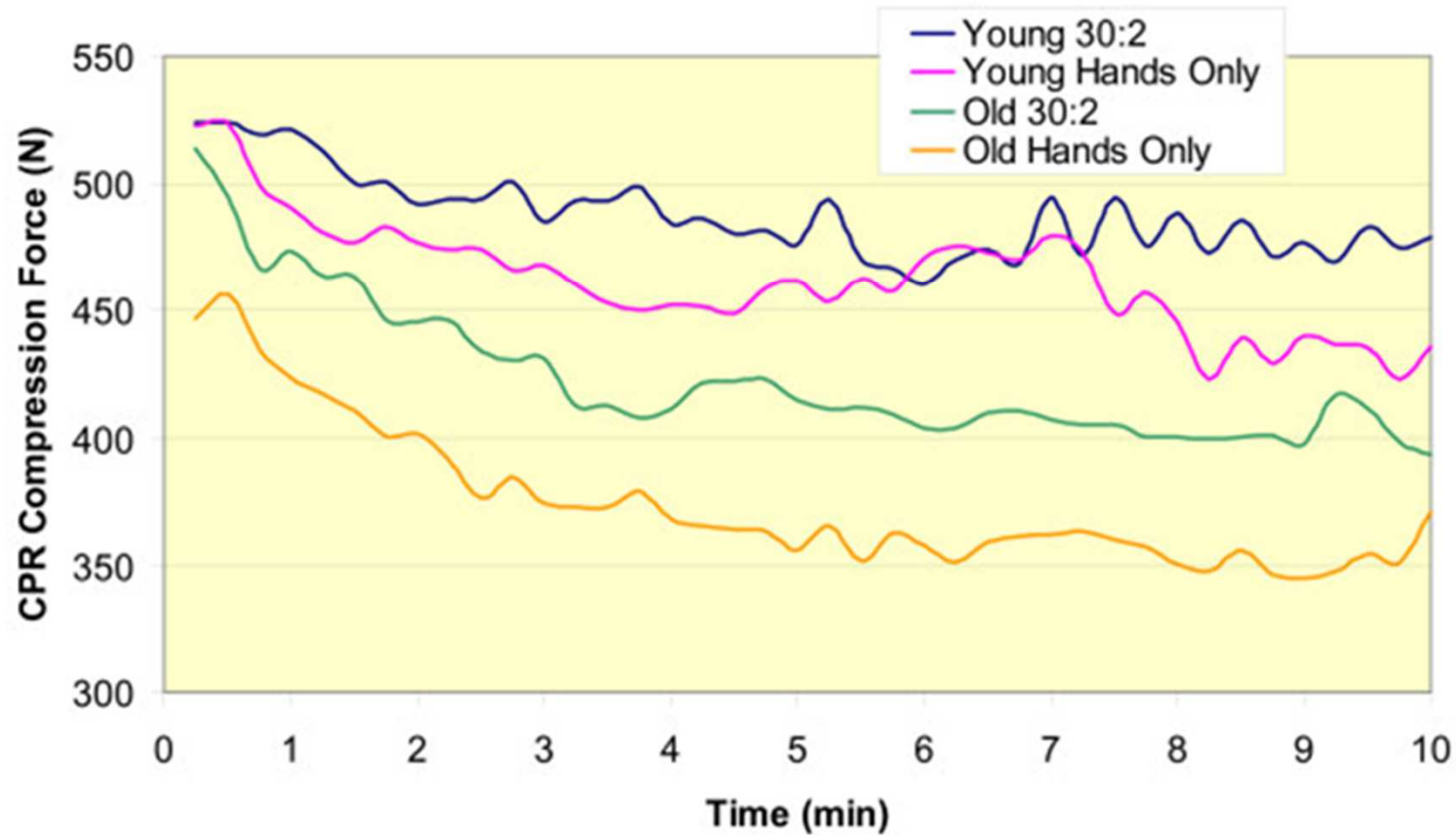


Figure 4

Average compression forces across time for younger and older subjects performing Hands-Only and 30:2 CPR.



Updated

Chest compression depth

- The compression depth can affect the relative increase in intrathoracic pressure and , in turn, influence forward blood flow from the heart and great vessels to the systemic circulation.



Updated

Chest compression depth

- During manual CPR, rescuers should perform chest compressions to a depth of at least 2 inches or 5 cm for an average adult, while avoiding excessive chest compression depths (greater than 2.4 inches or 6 cm).
(Class I, LOE C-LD)
- In the 2010 Guidelines, the recommended depth was at least 2 inches (5 cm).



Chest Compression Depth

2015 summary of evidence

- Human studies that evaluate the relationship between compression depth and outcomes including survival with favorable neurologic outcome, survival to hospital discharge, and ROSC.
- Classify depth differently, using distinct categories of depth or using an average depth for a portion of the resuscitation.



Chest Compression Depth

2015 summary of evidence

- There is consistent evidence that achieving depth of approximately 5 cm is associated with greater favorable outcome compared with shallower compressions.
- In the largest study to date (n= 9136), the optimal depth regard to survival occurred within the range of 4.1 to 5.5 cm (1.61 to 2.2 inches).

[Circulation. 2014;130:1962-1970](#)



Chest Compression Depth

2015 summary of evidence

- Less evidence is available about whether there is an upper threshold beyond which compressions may be too deep.
- Injuries are more common when depth is greater than 6 cm (2.4 inches) than when it is between 5 to 6 cm.
[Resuscitation.2013;84:257-262.](#)
- Chest compressions performed by professional rescuers are more likely to be too shallow (< 4 cm) and less likely to exceed 5.5 cm.

[Circulation. 2014;130:1962-1970](#)



Updated Infant /Child Compression rate

- For simplicity in CPR training, in the absence of sufficient pediatric evidence, it is reasonable to use the adult BLS-recommended chest compression rate of 100/min to 120/min for infants and children.



Reinforced

Infant / Child compression depth

- It is reasonable that for pediatric patients (birth to the onset of puberty) rescuers provide chest compressions that depress the chest at least one third the anterior-posterior diameter of the chest.
- This equates to approximately 1.5 inches (4 cm) infants to 2 inches (5 cm) in children (Class IIa, LOE C-LD).
- Once children have reached puberty, the recommended adult compression depth of at least 5 cm, but no more than 6 cm, is used for the adolescent of average adult size.



表 2

BLS 實施人員之高品質 CPR 要素摘要

要素	成人與青少年	兒童 (1 歲至青春期)	嬰兒 (不滿 1 歲，新生兒除外)
沒有高級呼吸道裝置時的按壓通氣比率	1 或 2 名施救者 30:2	1 位施救者 30:2 2 名以上的施救者 15:2	
有高級呼吸道裝置時的按壓通氣比率	持續按壓，速率為 100-120 次 / 分鐘 每 6 秒吹氣 1 次 (10 次呼吸 / 分鐘)		
按壓速率	100-120 次 / 分鐘		
按壓深度	至少 2 英吋 (5 cm)*	至少胸部前後徑尺寸的三分之一 約 2 英吋 (5 cm)	至少胸部前後徑尺寸的三分之一 約 1½ 英吋 (4 cm)
手部放置位置	將雙手放在胸骨下半部	將雙手或單手 (年幼的兒童適用 放在胸骨下半部)	1 位施救者 將 2 根手指擺放在胸部正中央， 略低於乳頭連線處 2 名以上的施救者 雙手姆指環繞手法置於胸部正 中央，略低於乳頭連線處
胸部回彈	每次按壓後讓胸部完全回彈；每次按壓後切勿依靠在胸部上		
減少中斷	盡量讓胸部按壓的中斷時間少於 10 秒		

Reinforced Chest Wall Recoil

- It is reasonable to avoid leaning on the chest between compressions to allow full chest wall recoil for adults in cardiac arrest. (Class IIa, LOE C-LD)
- Full chest wall recoil occurs when the sternum returns to its natural or neutral position during the decompression phase of CPR.



Reinforced Chest Wall Recoil

- Chest wall recoil creates a relative negative intra-thoracic pressure that promotes venous return and cardiopulmonary blood flow.
- Leaning on the chest wall between compressions precludes full chest wall recoil.
- Incomplete recoil could increase intra-thoracic pressure and reduce venous return, coronary perfusion pressure, and myocardial blood flow and potentially influence outcome.

[Crit Care Med.2010;38:1141-1146](#)



Chest Wall Recoil

2015 summary of evidence

- Observational studies indicate that leaning is common during CPR.
[Resuscitation.2011;82:1019-1024.](#)
- There are no human studies reporting the relationship between chest wall recoil and clinical outcome.
- 2 animal studies and a pediatric study of pts not in cardiac arrest. In all 3 studies, an increased force of leaning was associated with a dose-dependent decrease in CPP, but the relationship between leaning and cardiac output was inconsistent.
[Crit Care Med.2010;38:1141-1146](#)



Minimizing Interruptions in Chest Compressions

- Interruptions in chest compressions can be intended as part of
 - required care (ie, rhythm analysis and ventilation)
 - unintended (ie, rescuer distraction).



Table 1. Compression Pause Requirements for Resuscitation Tasks

Pause Requirement	Task
Generally required	Defibrillation Rhythm analysis Rotation of compressors Backboard placement Transition to mechanical CPR or ECMO
Sometimes required	Complicated advanced airway placement in patients who cannot be ventilated effectively by bag-valve-mask Assessment for return of spontaneous circulation
Generally not required	Application of defibrillator pads Uncomplicated advanced airway placement IV/IO placement

CPR indicates cardiopulmonary resuscitation; ECMO, extracorporeal membrane oxygenation; and IV/IO, intravenous/intraosseous.

[Circulation 2013;128:417-435](#)



Reinforced Minimizing Interruptions in Chest Compression during AED use

- In adult cardiac arrest, total preshock and postshock pauses in chest compressions should be as short as possible.(Class IIa, LOE C-LD).
- It may be reasonable to immediately resume chest compressions after shock delivery for adults in cardiac arrest in any setting.



Reinforced Minimizing Interruptions in Chest Compression during breaths.

- For adults in cardiac arrest receiving CPR without an advanced airway, it is reasonable to pause compressions for less than 10 seconds to deliver 2 breaths. (Class IIa, LOE C-LD)



Reinforced Minimizing Interruptions in Chest Compressions

- In adult cardiac arrest with an unprotected airway, it may be reasonable to perform CPR with the goal of a CCF (chest compression fraction) as high as possible, with a target of at least 60%. (Class IIb, LOE C-LD)



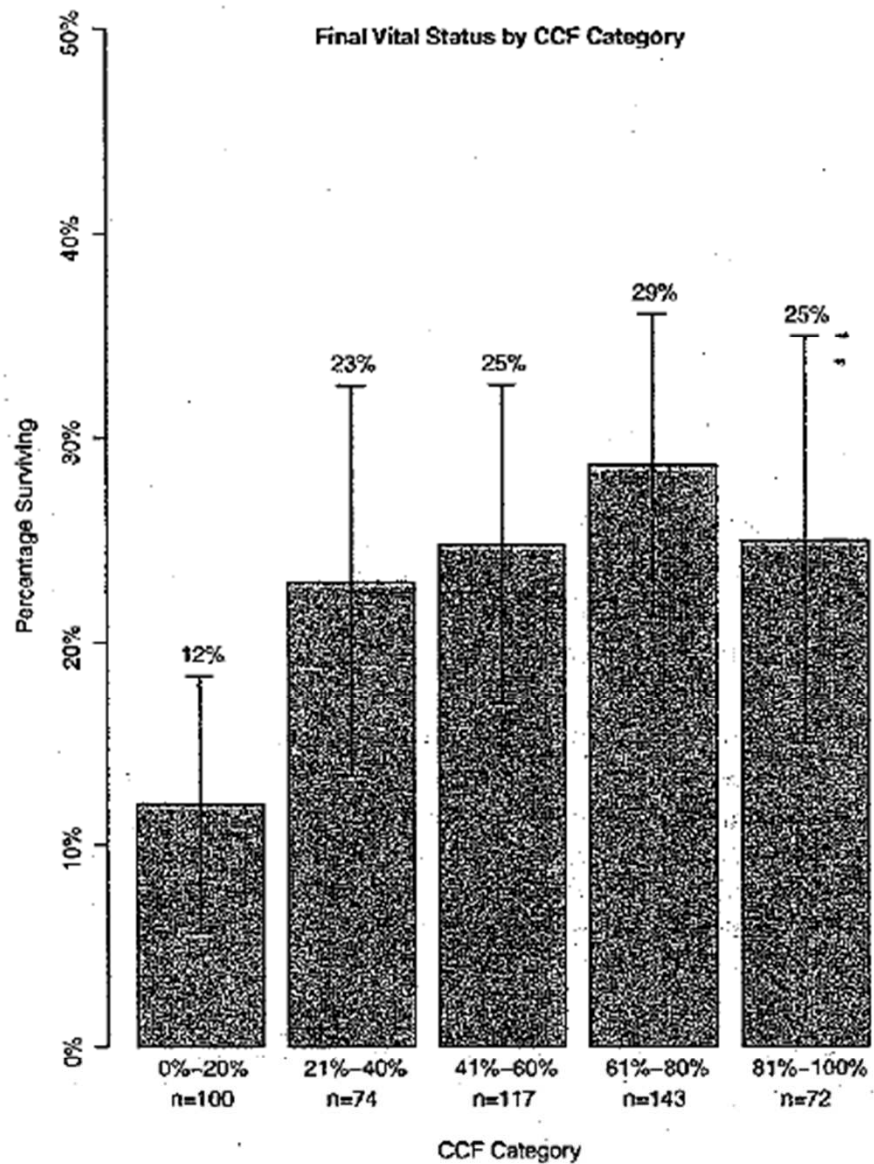


Figure 2. Survival to discharge for each category of chest compression fraction.

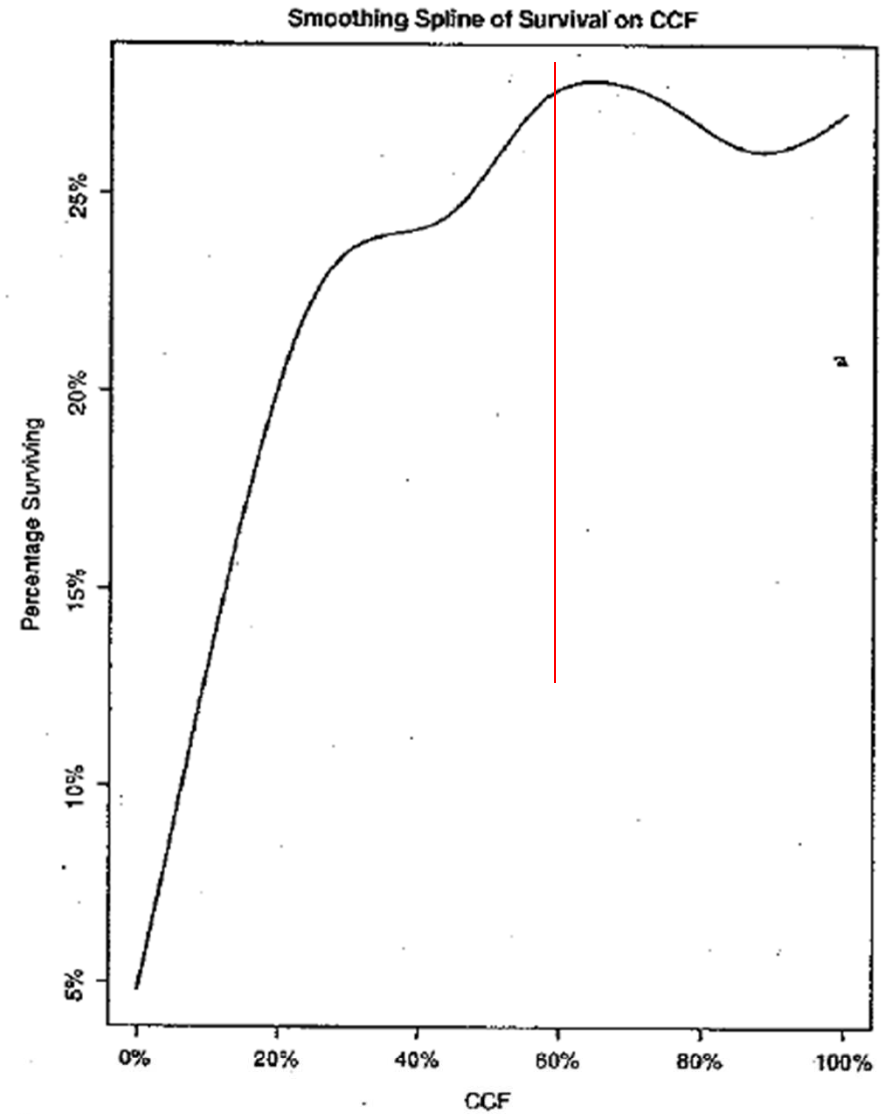


Figure 3. Smoothing spline representing the incremental probability of survival corresponding to a linear increase in chest compression fraction.



Minimizing Interruptions in Chest Compressions

- Compression fraction is a measurement of the proportion of time that compressions are performed during a cardiac arrest.
- An increase in fraction can be achieved by minimizing pauses in compressions.
- The AHA expert consensus is that a compression fraction of 80% is achievable in a variety of settings.

[Circulation 2013;128:417-435](#)



Minimizing Interruptions in Chest Compressions

2015 summary of evidence

- Observational studies demonstrate an association between a shorter duration of interruption for the peri-shock period and a greater shock success, ROSC, and survival to hospital discharge.
- An association between higher chest compression fraction and likelihood of survival among pts with shockable rhythms, and ROSC among patients with non-shockable rhythms.

[Circulation.2009;120:1241-1247](#)

[Resuscitation.2011;82:1501-1507](#)



實施的按壓次數 會受按壓 速率以及中斷的影響

復甦期間進行的按壓總次數是病患發生心臟停止後存活的重要決定因素。

- 執行的按壓次數會受到按壓速率 (每分鐘的胸部按壓頻率)，和按壓時間段 (按壓期間的總 CPR 時間) 影響。增加按壓速率和按壓時間段，會增加給予的總按壓數，減少按壓中斷的次數和時間長度，就能增進按壓時間段。
- 在行車方面可以找到類似的原理。駕車出外時，一天內所開的里程數不僅會受到開車速度 (行駛速率) 的影響，也會受到停車次數和停車時間 (行駛中斷) 的影響。毫不中斷以 60 mph 的速率行駛，換算成實際行駛距離為一小時行駛 60 哩。以 60 mph 的速率行駛但中途休息 10 分鐘，換算成實際行駛距離則為一小時行駛 50 哩。休息次數愈多、時間愈長，實際行駛距離就愈短。
- 在 CPR 期間，施救者必須以適當的速度 (100 至 120 次 / 分鐘) 和深度進行有效的按壓，同時盡量減少胸部按壓中斷次數和時間。高品質 CPR 的其他要素，包括每次按壓後確保胸部完全回彈，以及避免過度通氣。



表 1**成人高品質 CPR 的 BLS 守則**

施救者應該	施救者不應該
執行胸部按壓，速率為 100-120 次 / 分鐘	按壓速率低於 100 次 / 分鐘或高於 120 次 / 分鐘
按壓深度至少 2 英吋 (5 cm)	按壓深度不足 2 英吋 (5 cm) 或超過 2.4 英吋 (6 cm)
確保每次按壓後胸部完全回彈	在按壓之間依靠在胸部
盡量避免按壓中斷	中斷按壓超過 10 秒
適當通氣 (30 次按壓後施予 2 次人工呼吸，每次吹氣時間超過 1 秒並使病患胸部升起)	過度通氣 (亦即吹氣太多次或太用力)



CPR Quality, Accountability, and Healthcare Systems

- Few healthcare organizations consistently apply strategies of systematically monitoring CPR quality.

JEMS.2011;36:50-63

- There is an unacceptable disparity in the quality of resuscitation care and outcome.

Crit Care Med. 2012;40:1192-1198



CPR Quality, Accountability, and Healthcare Systems

- The use of a relatively simple, iterative continuous quality improvement approach to CPR can dramatically improve CPR quality and optimize outcome.
[Circ Cardiovasc Qual Outcomes.2012;5:423-428.](#)
- Similar to successful approaches toward mitigating medical errors, programs aimed at system-wide CPR data collection, implementation of best practices, and continuous feedback on performance have been shown to be effective.
[Circulation 2013;218:417-435.](#)



Chest Compression Feedback

- Metronome
- Resusci. Anne Skill-Guide manikins
- Nursing Anne (SimPad Capable)
- MegaCode Kelly Advanced (SimPad Capable)
- High-fidelity patient simulator
- Audiovisual feedback devices

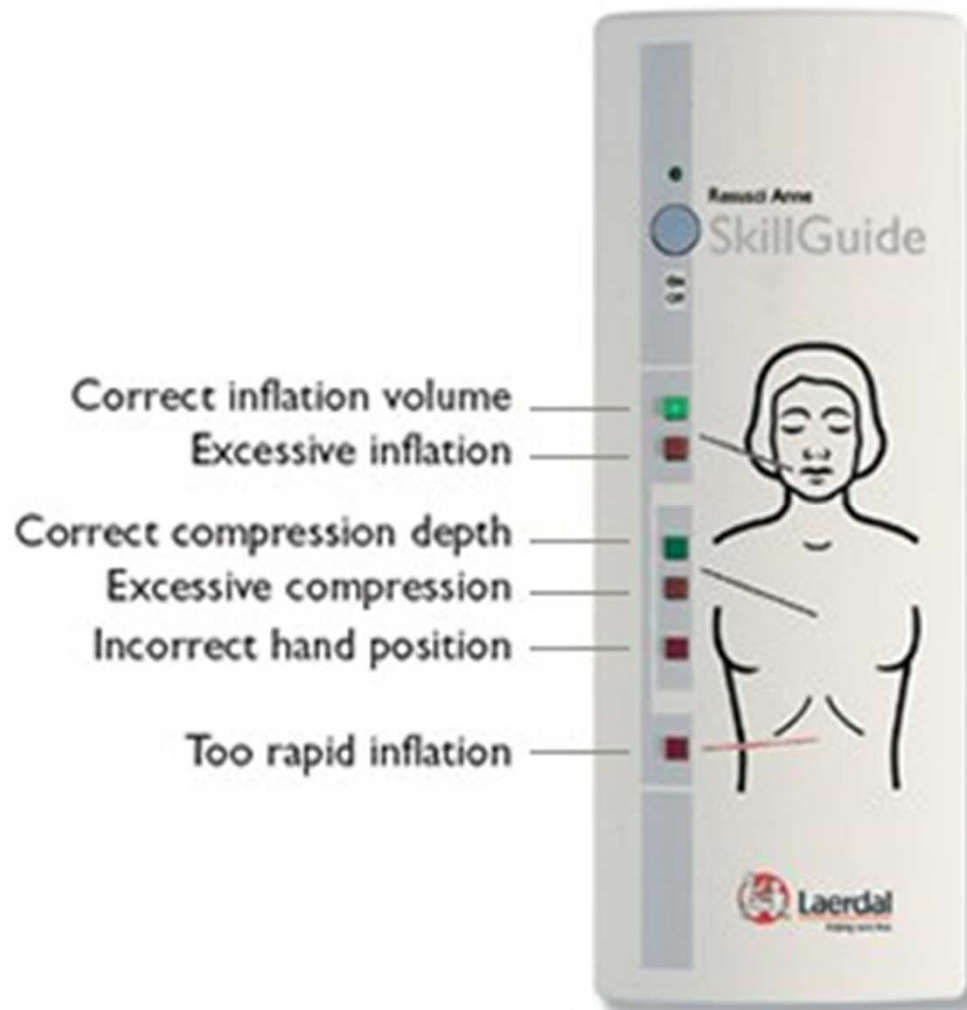


Chest Compression Feedback Metronome



Chest Compression Feedback

Resusci. Anne Skill-Guide manikins



Chest Compression Feedback

SimPad



The SimPad™ System includes:

SimPad: Operator's remote control

Simulation Software: Manual/Automatic Mode as well as the log viewer application and SimStore access

Link Box: Connects to and controls the patient simulator

Lithium-ion battery: Battery power for Link Box

AC Adapter: Power and charger for SimPad and Link Box

Manikin Strap: Attaches Link Box and battery to patient simulator

USB Cable: Attaches SimPad to PC for updates and downloads

Ethernet Cable

SimPad Wrist Strap

SimPad Sleeve: Protective case for SimPad

Headset/Microphone for two-way communication



Chest Compression Feedback

High-fidelity patient simulator



Using simulation situations can be re-run to explore outcome with different treatments

Mission critical tasks can be performed by learners without putting patients at risk



Updated Chest Compression Feedback

- It may be reasonable to use audiovisual feedback devices during CPR for real-time optimization of CPR performance (Class IIb, LOE B-R).

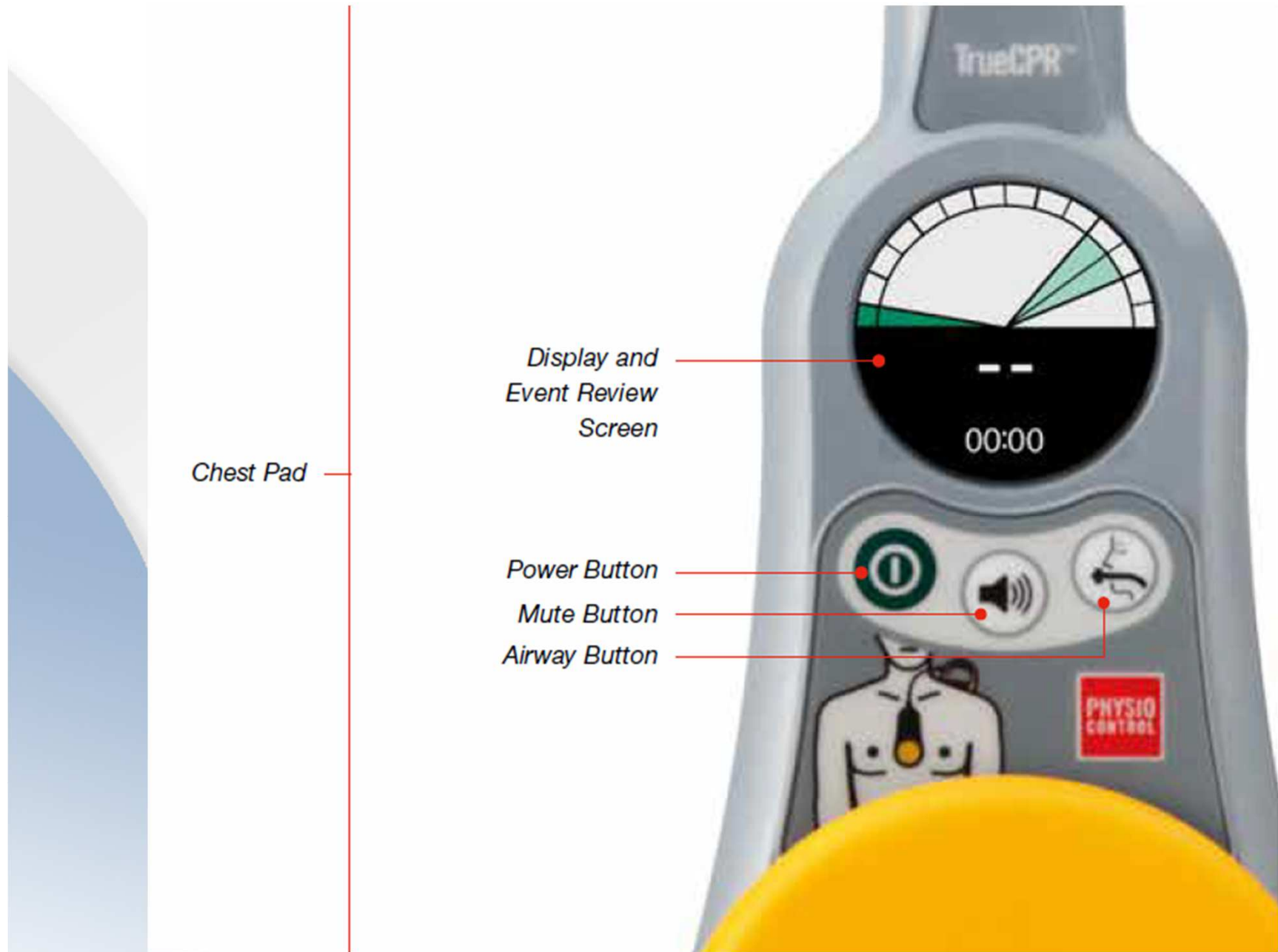


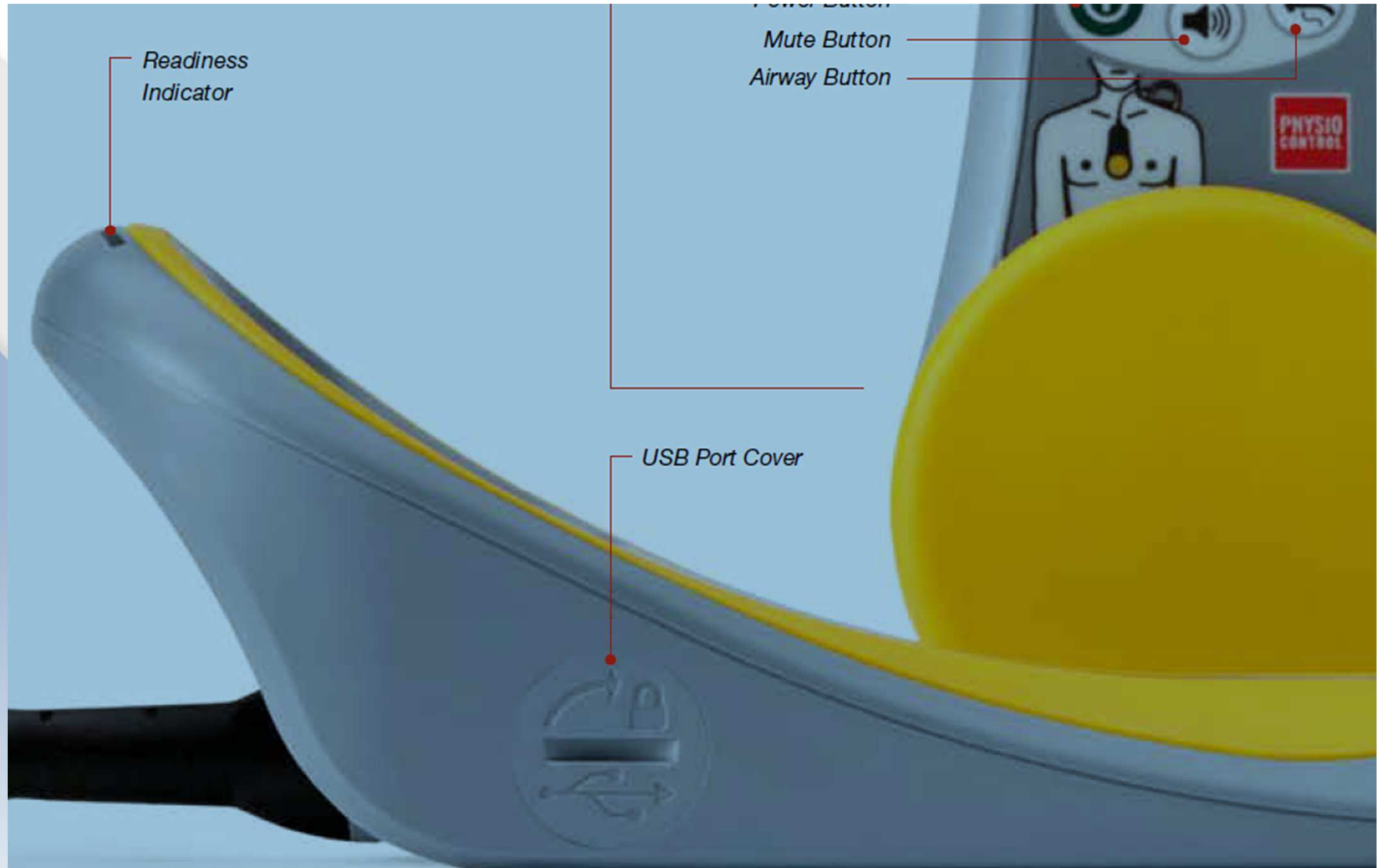
TrueCPR™
COACHING DEVICE



Audiovisual feedback device







Readiness Indicator

Power Button
Mute Button
Airway Button

USB Port Cover

PHYSIO CONTROL





3 Levels of CPR Feedback (Coaching Device)

- Real-Time → During resuscitation
- Post-Event → Summary on data
- Post-Event → Analysis and Review



Updated Chest Compression Feedback

- Real-time monitoring, recording, and feedback about CPR quality, including both physiologic patient parameters and rescuer performance metrics.
- This data can be used in:
 - Real time during resuscitation
 - For debriefing after resuscitation
 - For system-wide quality improvement program





Audiovisual Feedback Devices during CPR



During chest compressions

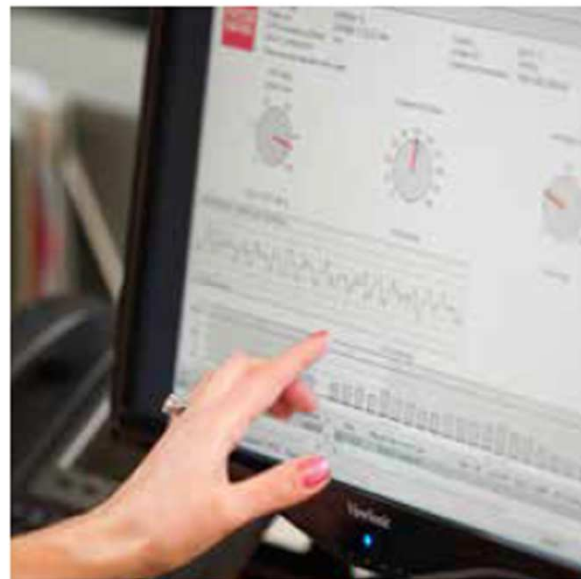
TrueCPR shows a CPR provider exactly how they're doing, right where they are looking—at the patient's chest. Compression depth, rate and recoil are displayed in real time on a highly visible dial. In addition, a CPR metronome and ventilation prompts help guide responders to provide CPR per Guidelines' recommended rates.

Immediately after an event

Important summary statistics such as average rate, percentage of compressions at the correct depth and recoil, hands-on time and total event time are displayed on the easy-to-read TrueCPR dial and provide a snapshot of event performance.

Post-event review and debriefing

TrueCPR captures up to 180 minutes of CPR information, which can easily be assessed with Physio-Control data review software to help evaluate overall performance and establish a critical team feedback loop for continuous CPR improvement.



Updated

Chest Compression Feedback

- Feedback devices may be effective in modifying chest compression rates, decreases the leaning force during compressions.
*Ann Emerg Med.2013;62:47-56
Resuscitation. 2009;80:553-557*
- Feedback devices has not been shown to significantly improve performance of compression depth, fraction and ventilation rate.
- Studies to date have not demonstrated a significant improvement in favorable neurologic outcome or survival to hospital discharge related to the use of feedback devices during actual cardiac arrest events.





- Life saving quality CPR is dependent on several coordinated factors as in the Quality Circle:
 - Therapy - audiovisual feedback during resuscitation with the HeartStart MRx with Q-CPR technology.
 - Training - initial and maintenance training with the Resusci. Anne Q-CPR/D training system.
 - self-directed training and certification with Anne Skills Station.
 - Evaluation - post event debriefing of the training and therapy with Event Review Pro and Q-CPR Review.



A Report Card: general checklist

Event number / date	No / Intermediate / Yes		
<i>V0131 3-9-12</i>			
Was the team leader clearly identified?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Was the scene orderly and quiet?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Was the defibrillator applied quickly?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Was CPR started promptly?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Were pauses in CPR delivery minimized?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Was CPR of subjectively high quality?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Were peri-shock pauses minimized?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Was an airway secured efficiently?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Comments	<i>Great team leadership, good effort by all, but remember to MINIMIZE pauses in CPR, esp. before/after shocks</i>		

B Report Card: CPR quality analysis

Event number / date			
<i>V0131 3-9-12</i>			
Compression fraction	92%		
Mean compression rate	102		
Mean compression depth (mm)	49		
Compressions without leaning	75%		
Mean ventilation rate	9		
Comments	<i>Great rate and hands on time; remember to keep Pre-shock and post-shock pauses short to improve shock success</i>		

Figure 1. Illustration of proposed resuscitation “report cards.” Routine use of a brief tool to document resuscitation quality would assist debriefing efforts and quality improvement efforts for hospital and emergency medical services systems. **A**, General checklist. Example of a general checklist report card that could be completed by a trained observer to a resuscitation event. **B**, CPR quality analysis. Example of a report card that relies on objective recording of CPR metrics. Ideally, both observational (**A**) and objective (**B**) reports could be used together in a combined report. CPR indicates cardiopulmonary resuscitation.

Circulation 2013;128:417-435



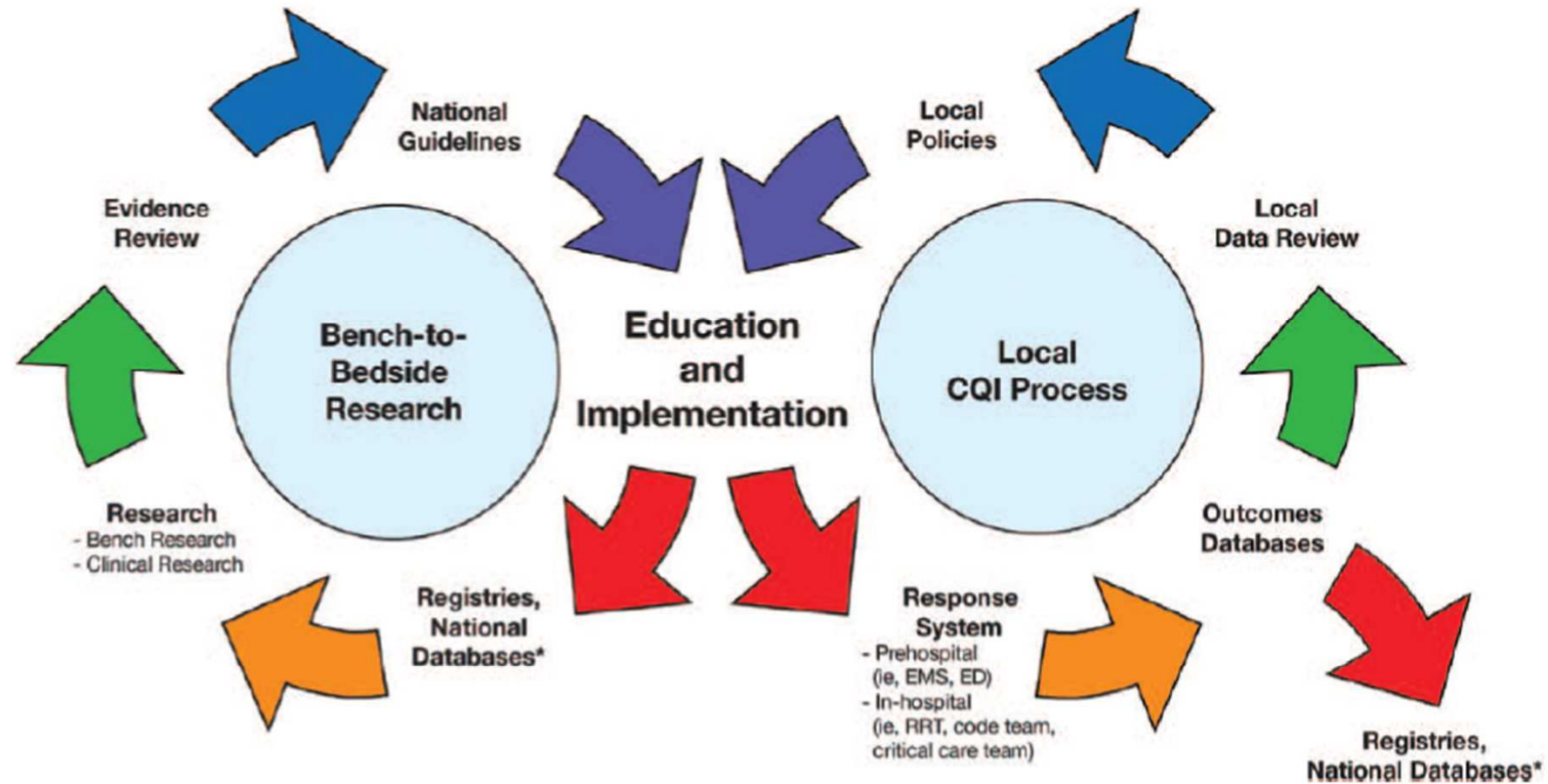


Figure 2. A continuous process evaluates and improves clinical care and generates new guidelines and therapy. Outcome data from cardiac arrest and periarrest periods are reviewed in a continuous quality-improvement (CQI) process. Research and clinical initiatives are reviewed periodically in an evidence-based process. Experts then evaluate new therapy and make clinical and educational recommendations for patient care. The process is repeated, and continual progress and care improvements are generated. ED indicates emergency department; EMS, emergency medical services; and RRT, rapid response team. *This is an overlap point in the cycle. That is, data come from outcomes databases (shown on the right) and go into registries and national databases (shown on the left).

Circulation 2013;128:417-435



Future Directions Need to Improve CPR Quality: Research

- To determine the optimal targets for CPR characteristics (CCF, compression rate and depth, lean, and ventilation), as well as their relative importance to patient outcome
- To determine the effect of a victim's age and cause of arrest on optimal CPR characteristics (especially initiation and method of ventilation)
- To further characterize the relationships between individual CPR characteristics
- To further characterize which CPR characteristics and relationships between them are time dependent
- To determine the impact of the variability during the arrest of CPR characteristics (especially CCF and depth) on patient outcome
- To clarify whether ventilation characteristics (time-, pressure-, volume-based parameters) during CPR impact patient outcome
- To determine optimal titration of hemodynamic and ETCO₂ monitoring during human CPR
- To determine whether ETCO₂ monitoring of a noninvasive airway is a reliable and useful monitor of CPR quality
- To determine optimal relationship between preshock CPR characteristics (ie, depth, pause) and ROSC/survival
- To determine the optimal number of rescuers and the effect of rescuer characteristics on CPR quality and patient outcome
- To further characterize the impact of provider fatigue and recovery on patient outcome
- To determine the impact of work environment, training environment, and provider characteristics on CPR performance and patient survival
- To clarify methods of integration of CPR training into advanced courses and continuing maintenance of competency
- To determine the method of education, as well as its timing and location, at a system level to ensure optimal CPR performance and patient outcome
- To develop a global CPR metric that can be used to measure and optimize educational and systems improvement processes



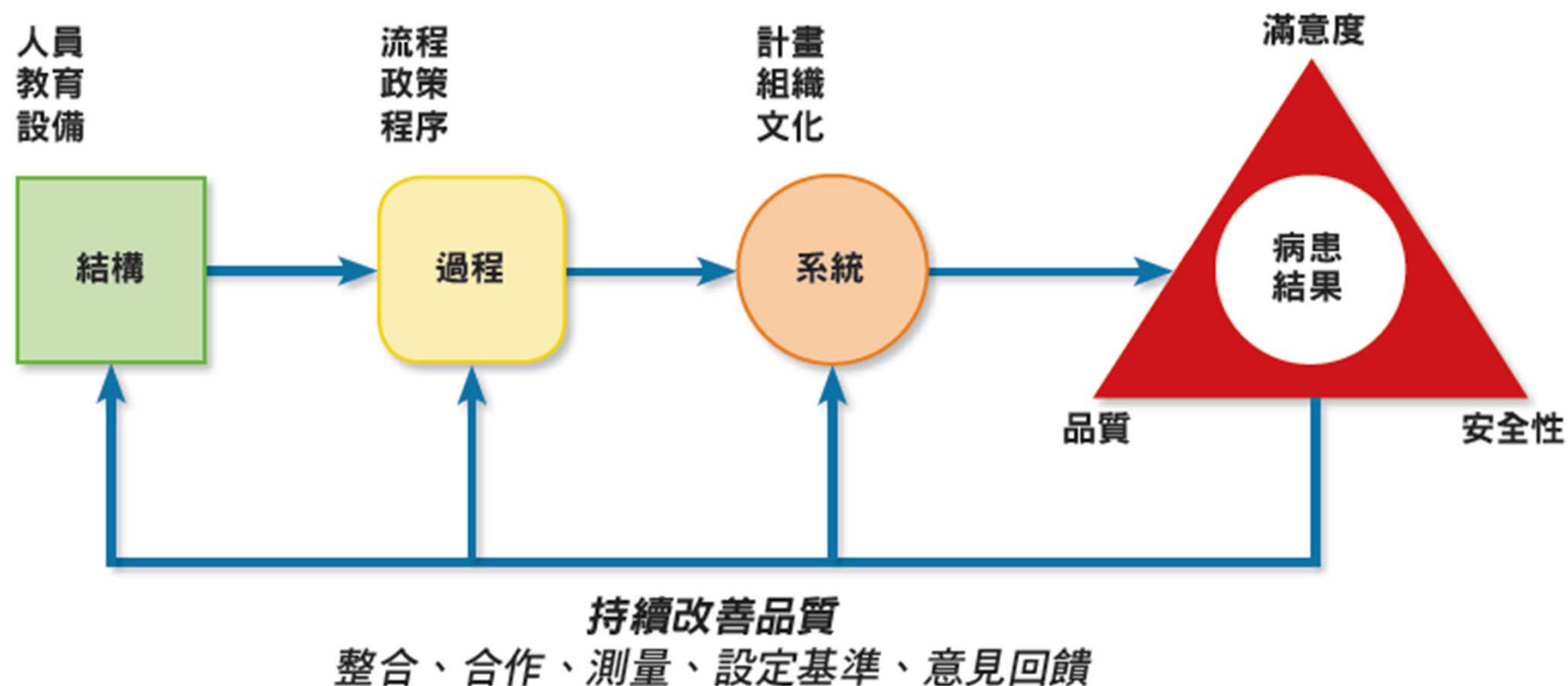
Future Directions Need to Improve CPR Quality: Development

- To standardize the reporting of CPR quality and the integration of these data with existing systems improvement processes and registries
- To develop a device with the ability to measure and monitor CPR quality during training and delivered in real events and integrate it with existing quality improvement and registries
- To develop optimal CPR systems improvement processes that provide reliable, automated reporting of CPR quality parameters with the capacity for continuous CPR quality monitoring in all healthcare systems
- To develop feedback technology that prioritizes feedback in an optimal manner (eg, correct weighting and prioritization of the CPR characteristics themselves)
- To develop a more reliable, inexpensive, noninvasive physiological monitor that will increase our ability to optimize CPR for individual victims of cardiac arrest
- To develop training equipment that provides rescuers with robust skills to readily and reliably provide quality CPR
- To develop improved mechanical systems of monitoring CPR, including consistent and reliable capture of ventilation rate, tidal volume, inspiratory pressure, and duration, as well as complete chest recoil



照護系統分類：結構過程系統結果 (SPSO)

結構過程系統結果



感恩聆聽

