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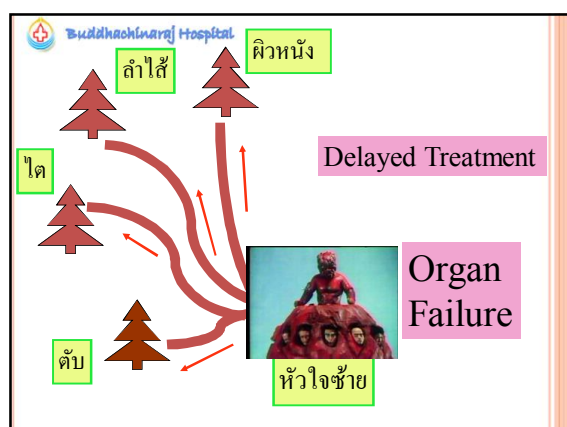
Basic Hemodynamic and Perfusion monitoring in sepsis

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นพ.รัฐภูมิ รามสุขุม
แผนกอายุรกรรม
หน่วยโรคระบบหายใจและเวชบำบัดวิกฤต
รพ.พุทธชินราช พิษณุโลก

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Why monitor ?



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Organ dysfunction variables

- Arterial hypoxemia ($Pao_2/Fio_2 < 300$)
- Acute oliguria (urine output $< 0.5 \text{ mL/kg/hr}$ for at least 2 hrs despite adequate fluid resuscitation)
- Creatinine increase $> 0.5 \text{ mg/dL}$ or $44.2 \text{ } \mu\text{mol/L}$
- Coagulation abnormalities ($INR > 1.5$ or $aPTT > 60 \text{ s}$)
- Ileus (absent bowel sounds)
- Thrombocytopenia (platelet count $< 100,000 \text{ } \mu\text{L}^{-1}$)
- Hyperbilirubinemia (plasma total bilirubin $> 4 \text{ mg/dL}$ or $70 \text{ } \mu\text{mol/L}$)

Crit Care Med. 2013;41:580-637

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Hemodynamic variables

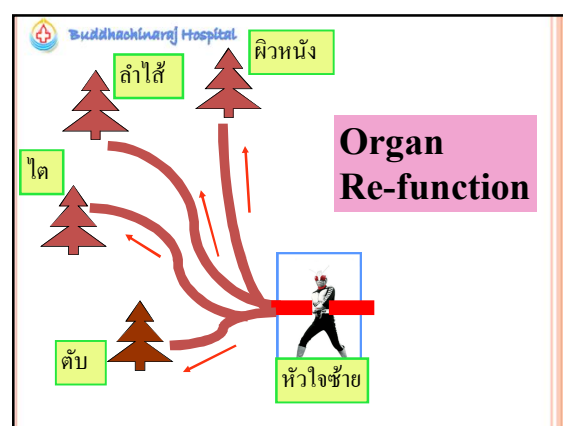
Arterial hypotension

SBP $< 90 \text{ mm Hg}$, MAP $< 70 \text{ mm Hg}$
or an SBP decrease $> 40 \text{ mm Hg}$ in adults
or less than two sd below normal for age

Tissue perfusion variables

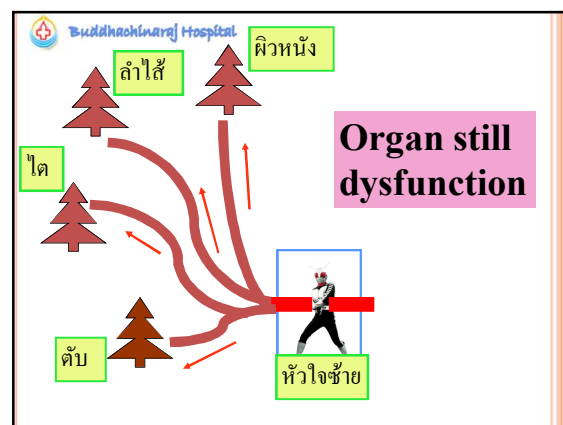
- Hyperlactatemia ($> 1 \text{ mmol/L}$)
- Decreased capillary refill or mottling

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Sign of organ re-function

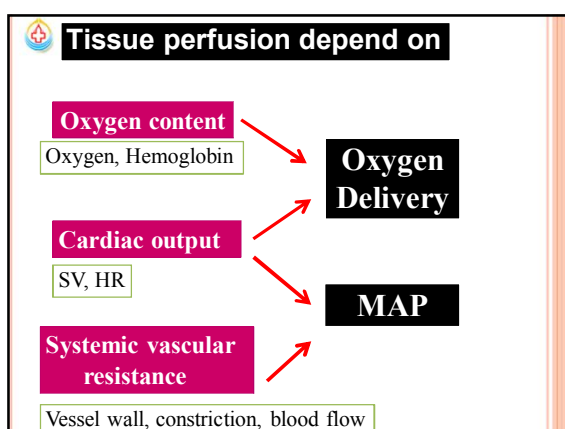
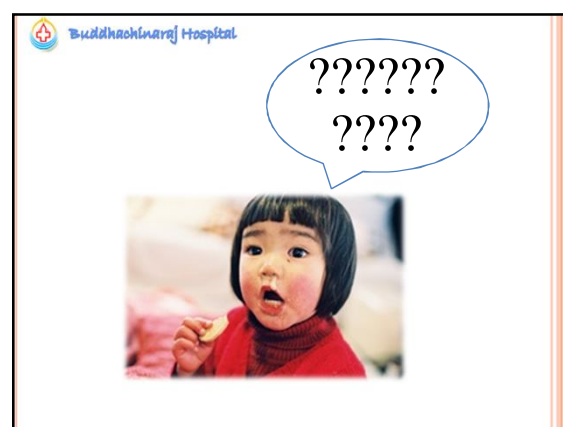
- ความดันโลหิตเพิ่มขึ้น
- รู้สึกตัวดีขึ้น
- ปัสสาวะเริ่มออก
- Capillary refill ดีขึ้น



Adequate Hemodynamic and tissue perfusion

หัวใจซ้าย

Medical Education Center Buddhachinaraj Hospital



Ohm's Law

$$Q \text{ (Blood flow)} = \frac{\Delta P}{R}$$

$$CO = \frac{MAP}{SVR}$$

$$MAP = CO \times SVR$$

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MAP = CO x SVR

$$\begin{aligned} \text{MAP} &= \text{SV} \times \text{HR} \times \text{SVR} \\ &= (\text{EDV} - \text{ESV}) \times \text{HR} \times \text{SVR} \\ &= \frac{(\text{EDV} - \text{ESV})}{\text{EDV}} \times \text{EDV} \times \text{HR} \times \text{SVR} \\ &= \text{EF} \times \text{EDV} \times \text{HR} \times \text{SVR} \end{aligned}$$

MAP = contractility x preload x HR x afterload

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Clinical Questions

- Preload → สารน้ำพอไหม
- Contractility → หัวใจบีบตัวดีไหม
- Afterload → หลอดเลือดหดตัวดีไหม
- Stroke volume → ปริมาณที่บีบตัวต่อครั้ง
- Heart rate → เต้นช้าเร็วเหมาะสมไหม

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Clinical Evaluation

- Preload → JVP
- Contractility → ความดังของ S1, S3
- Afterload → capillary refill time
- Stroke volume → pulse pressure
- Heart rate → maximum HR

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ข้อควรระวังของการใช้ MAP monitor

เพียงอย่างเดียว

การเพิ่มขึ้นของ MAP โดยการเพิ่ม CO และ SVR ก็อาจจะไม่ได้เป็นตัวบ่งบอกถึงการเพิ่ม tissue perfusion เสมอไป




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Tissue perfusion depend on

Oxygen content
Oxygen, Hemoglobin

Cardiac output
SV, HR

Systemic vascular resistance
Vessel wall, constriction, blood flow

Oxygen Delivery

MAP

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Oxygen Delivery

oxygen

Hemoglobin

Cardiac output

Microvascular circulation

Cellular function








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Aims of adequate tissue perfusion

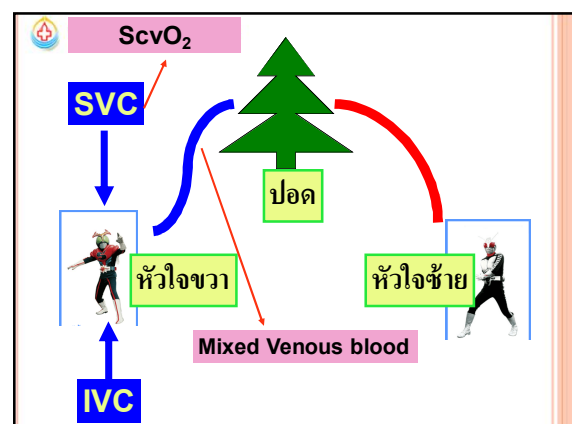
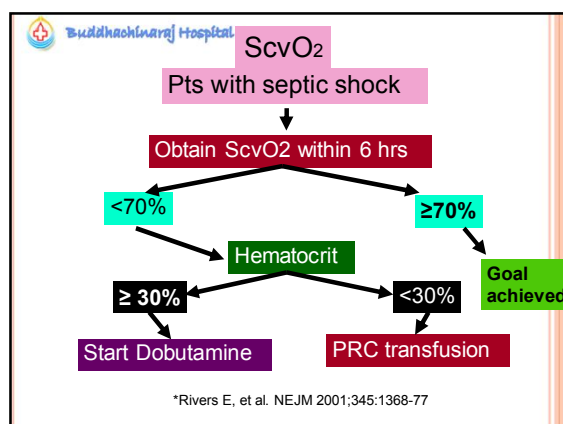
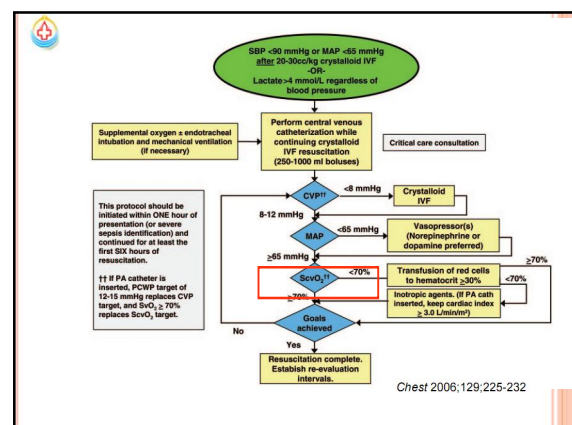
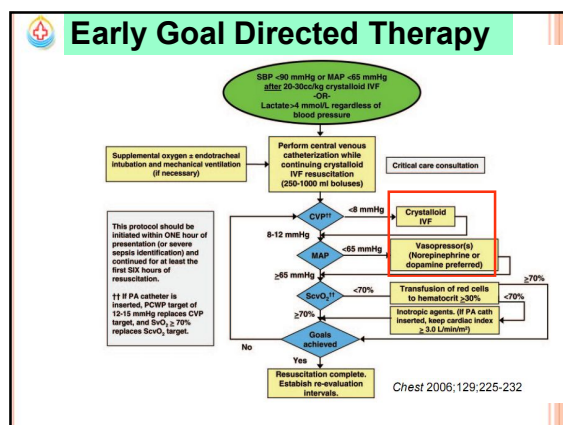
- Organ re-function
- MAP appropriate
balance between CO and SVR
- Adequate oxygen delivery

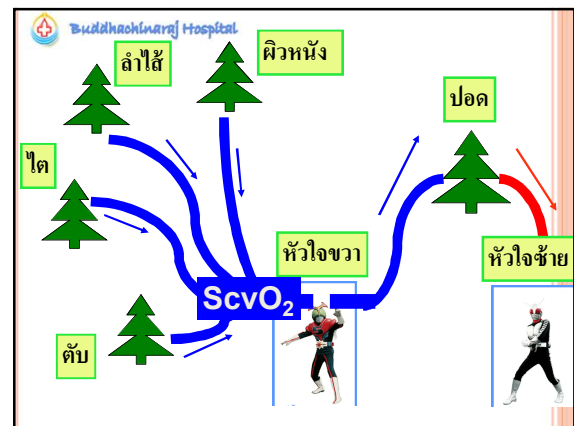
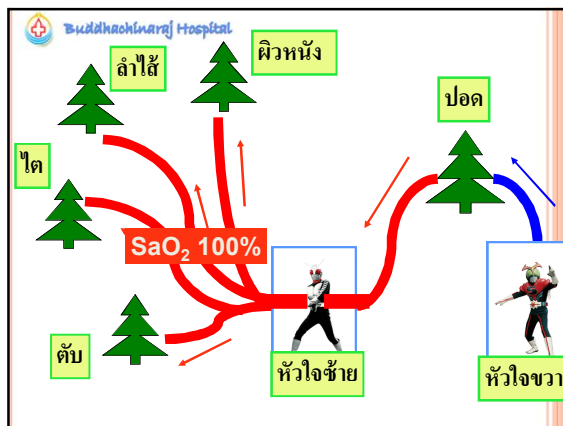
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Early Goal-Directed Therapy in the Treatment of Severe Sepsis and Septic Shock

EMANUEL RIVERS, M.D., M.P.H., BRYANT NGUYEN, M.D., SUZANNE HAVSTAD, M.A., JULIE RESSLER, B.S., ALEXANDRA MUZZIN, B.S., BERNARD KNOBLICH, M.D., EDWARD PETERSON, Ph.D., AND MICHAEL TOMANOVICH, M.D., FOR THE EARLY GOAL-DIRECTED THERAPY COLLABORATIVE GROUP*





Oxygen Delivery

Dobutamine

$DO_2 = CO \times O_2 \text{ content}$

$O_2 \text{ content} = (1.34 \times Hb \times SaO_2) + (0.003 \times PaO_2)$

เติมเลือด

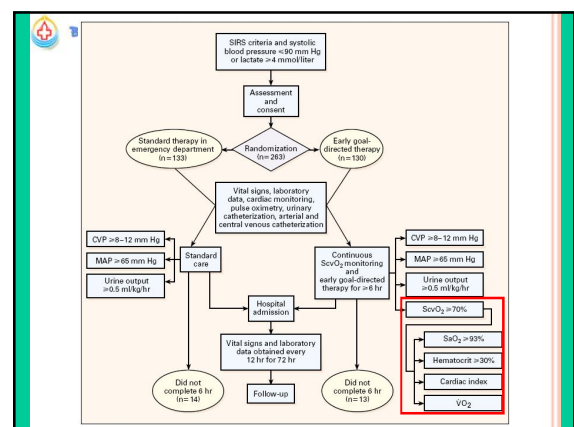
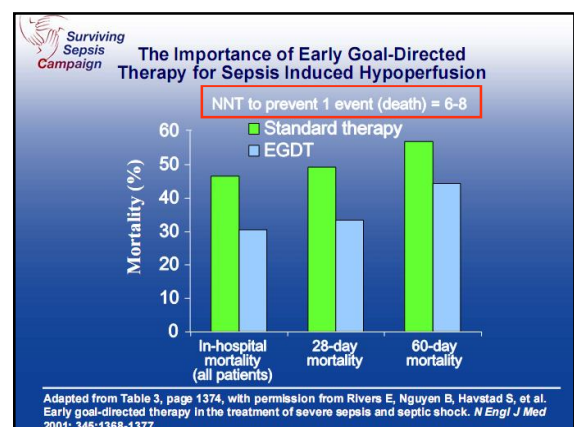


TABLE 3. KAPLAN-MEIER ESTIMATES OF MORTALITY AND CAUSES OF IN-HOSPITAL DEATH.*

VARIABLE	STANDARD THERAPY (N=133)	EARLY GOAL-DIRECTED THERAPY (N=130)	RELATIVE RISK (95% CI)	P VALUE
In-hospital mortality†	59 (46.5)	38 (30.5)	0.58 (0.38–0.87)	0.009
Patients with severe sepsis	19 (30.0)	9 (14.9)	0.46 (0.21–1.03)	0.06
Patients with septic shock	40 (56.8)	29 (42.3)	0.60 (0.36–0.98)	0.04
Patients with sepsis syndrome	44 (45.4)	35 (35.1)	0.66 (0.42–1.04)	0.07
28-Day mortality†	61 (49.2)	40 (33.3)	0.58 (0.39–0.87)	0.01
60-Day mortality†	70 (56.9)	50 (44.3)	0.67 (0.46–0.96)	0.03
Causes of in-hospital death‡				
Sudden cardiovascular collapse	25/119 (21.0)	12/117 (10.3)	—	0.02
Multiorgan failure	26/119 (21.8)	19/117 (16.2)	—	0.27

*CI denotes confidence interval. Dashes indicate that the relative risk is not applicable.
 †Percentages were calculated by the Kaplan-Meier product-limit method.
 ‡The denominators indicate the numbers of patients in each group who completed the initial six-hour study period.

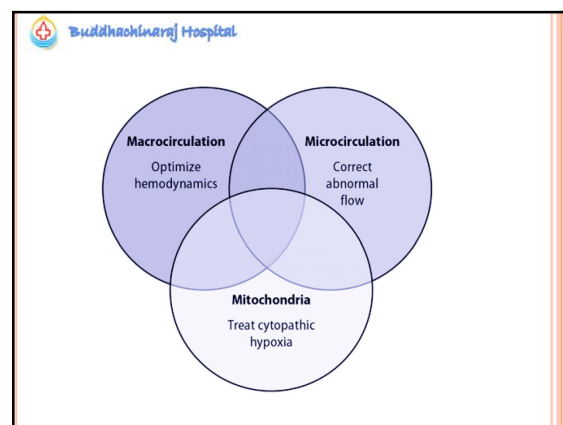
16% absolute risk reduction → largest in sepsis RCT



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Monitor hemodynamic and perfusion for sepsis

- Appropriate preload (volume)
- Appropriate afterload (vasopressor)
- Appropriate pumping (inotrope)
- Appropriate oxygen delivery (recheck)



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Put the Right patient to the Right place, Right time and Right therapy



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ด้วยความขอบคุณโรงพยาบาลชุมชนทุกแห่งในจังหวัดพิษณุโลก
แผนกอุบัติเหตุและฉุกเฉิน
และแผนกอายุรกรรมโรงพยาบาลพุทธชินราช
ที่ร่วมกันดูแลผู้ป่วย Sepsis ให้มีประสิทธิผลมากยิ่งขึ้น



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