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Basic Hemodynamic and Perfusion monitoring in sepsis

www.sepsiseasy.com

นพ.รัฐภูมิ ชามพูนท
แผนกอายุรกรรม
หน่วยโรคระบบหายใจและเวชบำบัดวิกฤต
รพ.พุทธชินราช พิษณุโลก

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Why monitor ?

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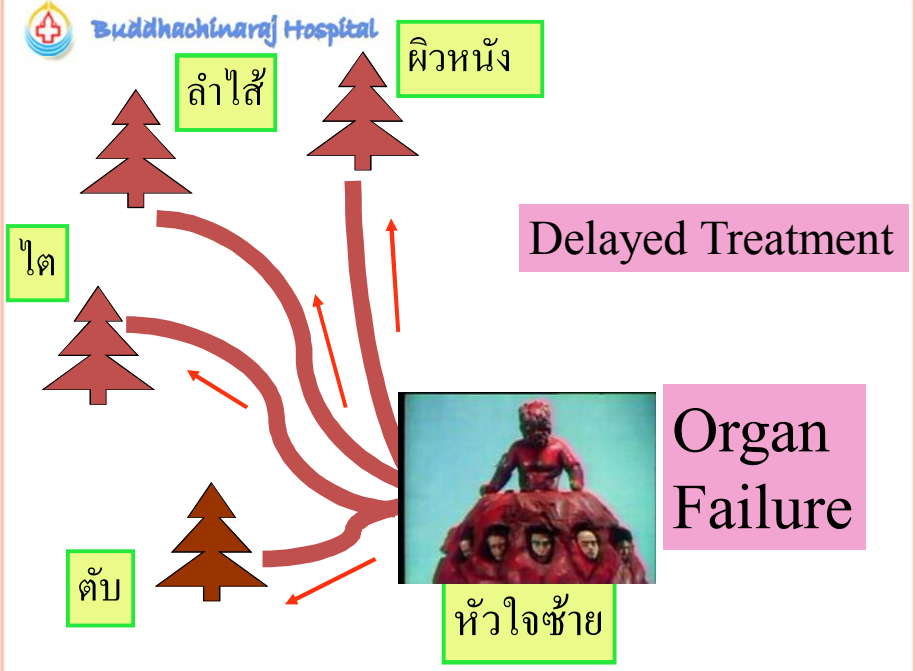

Delayed Treatment

Organ Failure

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Organ dysfunction variables

- Arterial hypoxemia (Pao2/Fio2 < 300)
- Acute oliguria (urine output < 0.5 mL/kg/hr for at least 2 hrs despite adequate fluid resuscitation)
- Creatinine increase > 0.5 mg/dL or 44.2 µmol/L
- Coagulation abnormalities (INR > 1.5 or aPTT > 60 s)
- Ileus (absent bowel sounds)
- Thrombocytopenia (platelet count < 100,000 µL–1)
- Hyperbilirubinemia (plasma total bilirubin > 4 mg/dL or 70 µmol/L

Crit Care Med. 2013;41:580-637

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Hemodynamic variables

Arterial hypotension

SBP < 90 mm Hg, MAP < 70 mm Hg

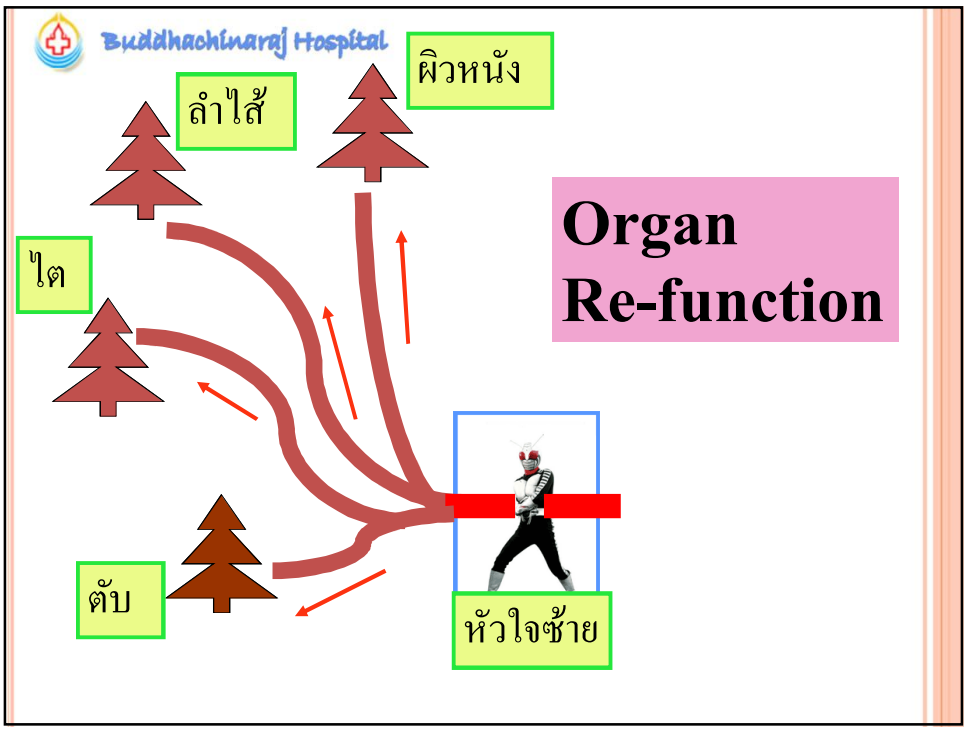
or an SBP decrease > 40 mm Hg in adults

or less than two sd below normal for age

Tissue perfusion variables

- Hyperlactatemia (> 1 mmol/L)
- Decreased capillary refill or mottling

Crit Care Med. 2013;41:580-637



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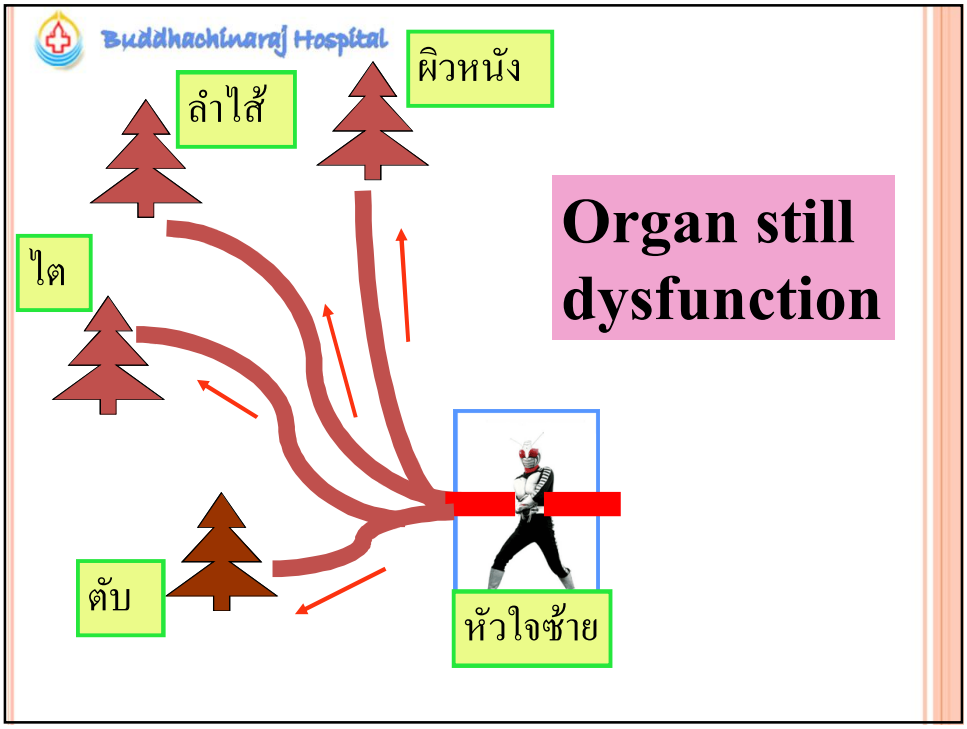
Sign of organ re-function

- ความดันโลหิตเพิ่มขึ้น
- รู้สึกตัวดีขึ้น
- ปัสสาวะเริ่มออก
- Capillary refill ดีขึ้น



Adequate Hemodynamic and tissue perfusion

หัวใจซ้าย

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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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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

MAP= SV X HR X SVR

= (EDV-ESV) X HR X SVR

= (EDV-ESV) EDV X HR X SVR

EDV

MAP = EF X EDV X HR X SVR

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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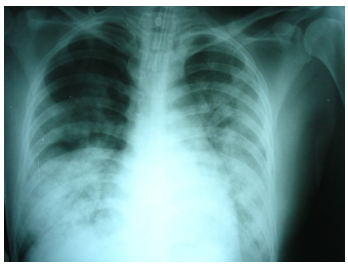
Clinical Evaluation

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

ข้อควรระวังของการใช้ MAP monitor เพียงอย่างเดียว

การเพิ่มขึ้นของ MAP โดยการเพิ่ม CO และ SVR ก็อาจจะไม่ได้เป็นตัวบ่งบอกถึงการเพิ่ม tissue perfusion เสมอไป



Tissue perfusion depend on

Oxygen content

Oxygen, Hemoglobin

Cardiac output

SV, HR

Systemic vascular resistance

Vessel wall, constriction, blood flow

→ **Oxygen Delivery**

→ **MAP**

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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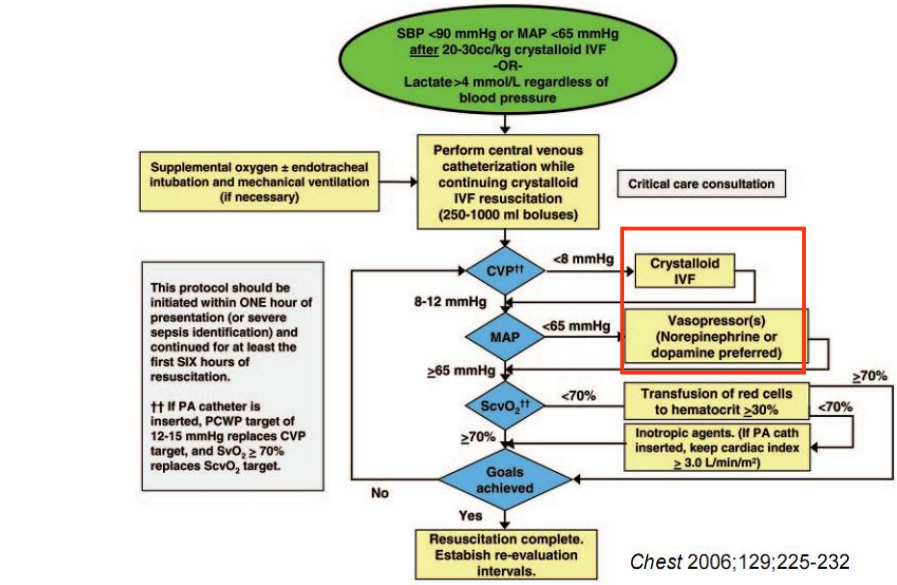
The NEW ENGLAND JOURNAL of MEDICINE
N Engl J Med, Vol. 345, No. 19 · November 8, 2001

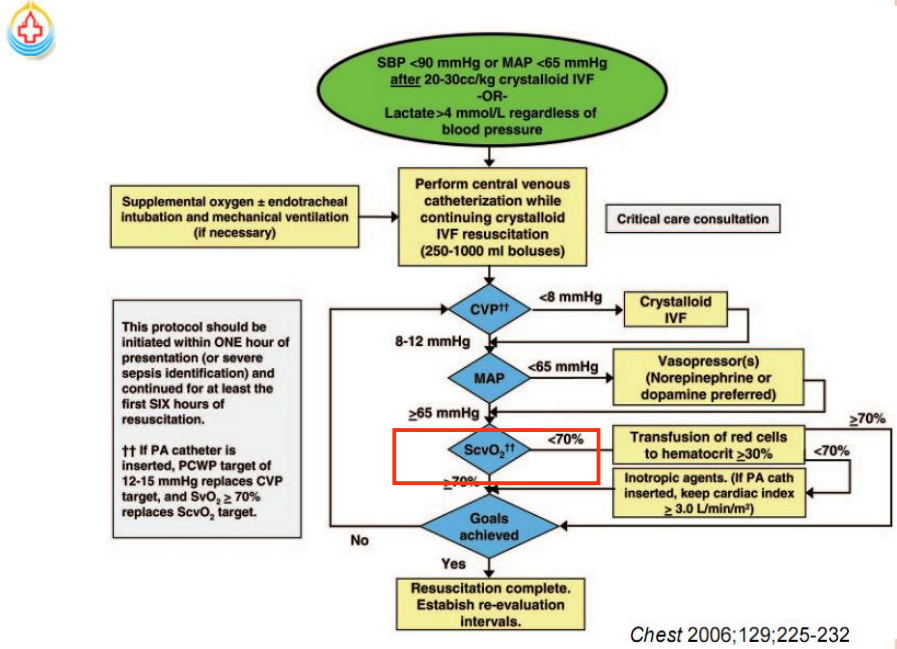
Early Goal-Directed Therapy in the Treatment of Severe Sepsis and Septic Shock

Emanuel Rivers, M.D., M.P.H., Bryant Nguyen, M.D., Suzanne Havstad, M.A., Julie Ressler, B.S., Alexandria Muzzin, B.S., Bernhard Knoblich, M.D., Edward Peterson, Ph.D., and Michael Tomlanovich, M.D., for the Early Goal-Directed Therapy Collaborative Group*

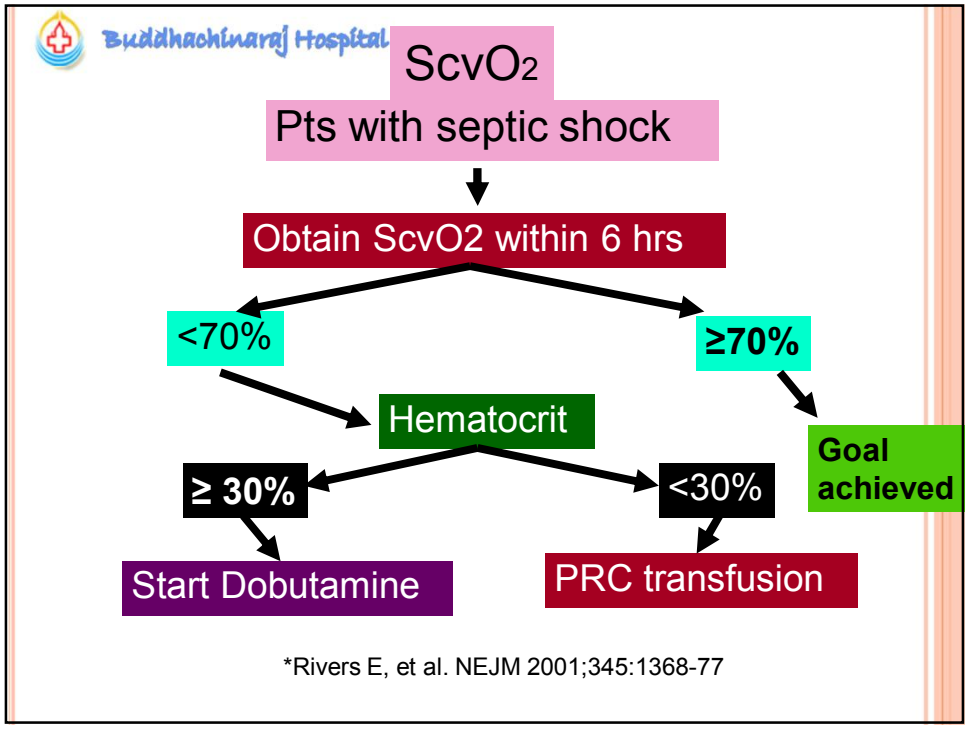
Early Goal Directed Therapy



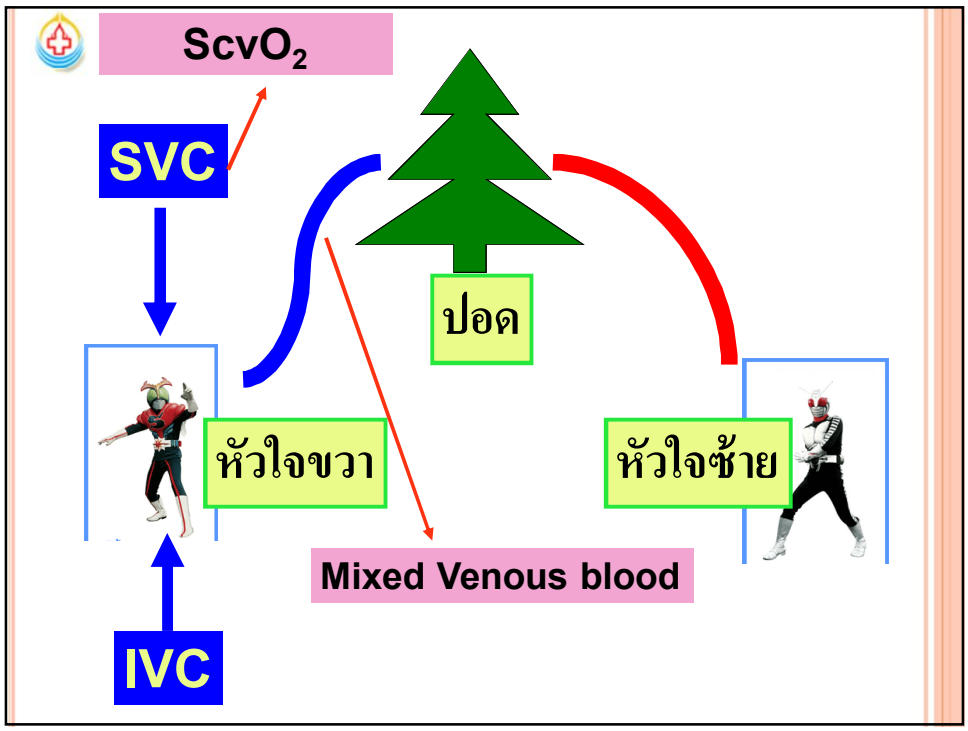
Chest 2006;129;225-232

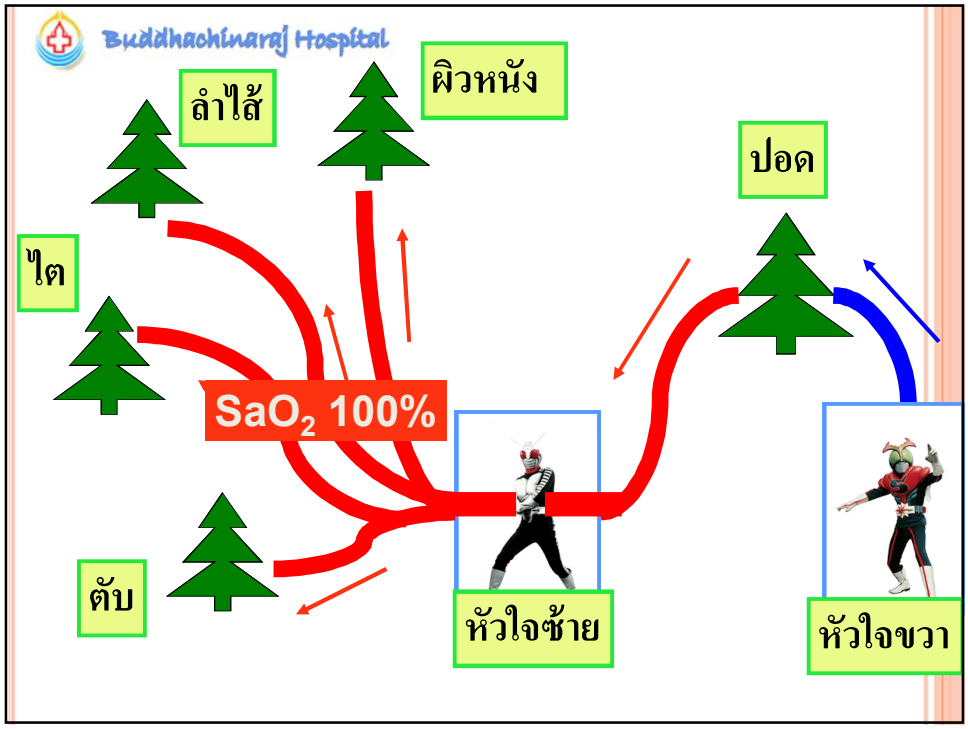


Chest 2006;129;225-232



*Rivers E, et al. NEJM 2001;345:1368-77

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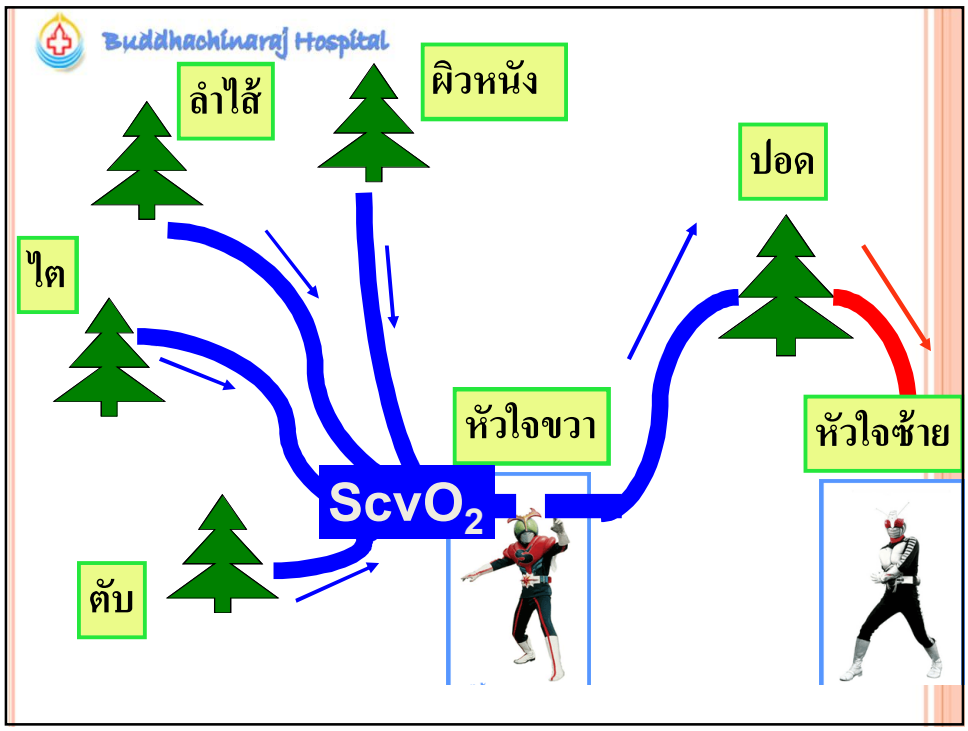
ลำไส้
ผิวหนัง
ปอด
ไต
SaO_2 100%
ตับ
หัวใจซ้าย
หัวใจขวา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ลำไส้
ผิวหนัง
ปอด
ไต
หัวใจขวา
หัวใจซ้าย
$ScvO_2$
ตับ

Oxygen Delivery

Dobutamine

O2 delivery (DO2) = CO x O2 content

O2 content = (1.34 x Hb x SaO2) + (0.003 x PaO2)

เติมเลือด

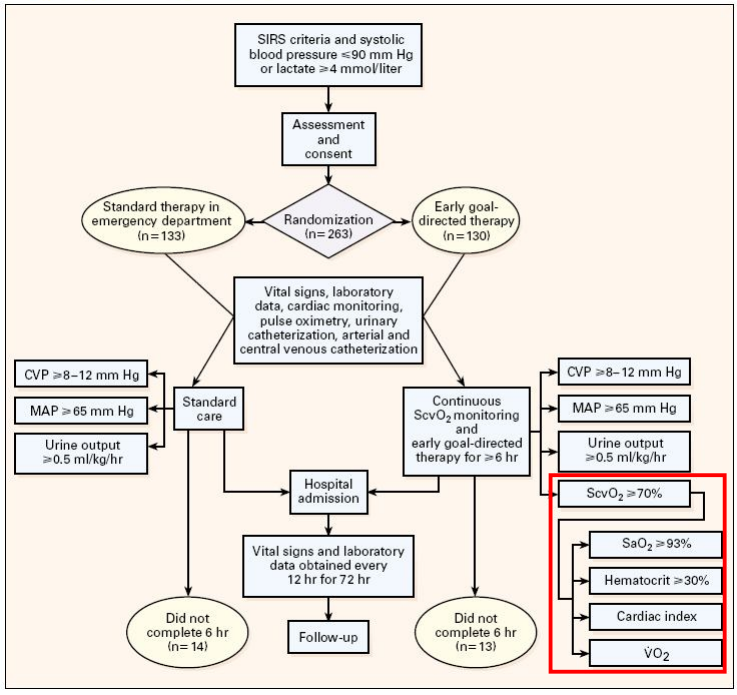

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TABLE 3. KAPLAN–MEIER ESTIMATES OF MORTALITY AND CAUSES OF IN-HOSPITAL DEATH.*

VARIABLE	STANDARD THERAPY (N=133)	EARLY GOAL-DIRECTED THERAPY (N=130)	RELATIVE RISK (95% CI)	P VALUE
	no. (%)			
In-hospital mortality†				
All patients	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

16% absolute risk reduction → largest in sepsis RCT

*CI denotes confidence interval. Dashes indicate that the relative risk is not applicable.

†Percentages were calculated by the Kaplan–Meier product-limit method.

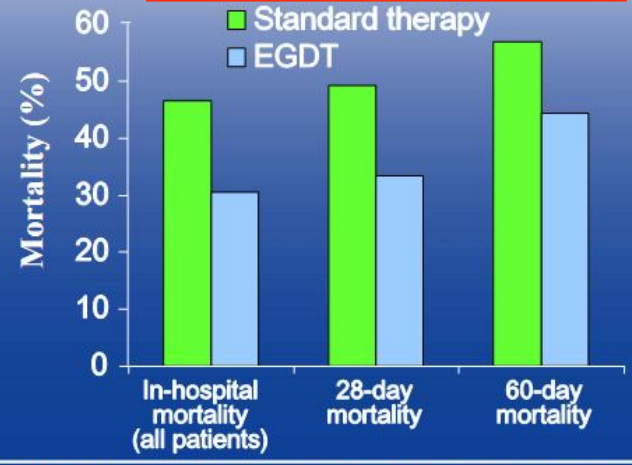
‡The denominators indicate the numbers of patients in each group who completed the initial six-hour study period.

The NEW ENGLAND JOURNAL of MEDICINE

Surviving Sepsis Campaign

The Importance of Early Goal-Directed Therapy for Sepsis Induced Hypoperfusion

NNT to prevent 1 event (death) = 6-8



Adapted from Table 3, page 1374, with permission from Rivers E, Nguyen B, Havstad S, et al. Early goal-directed therapy in the treatment of severe sepsis and septic shock. *N Engl J Med* 2001; 345:1368-1377

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Monitor hemodymic and perfusion for sepsis

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

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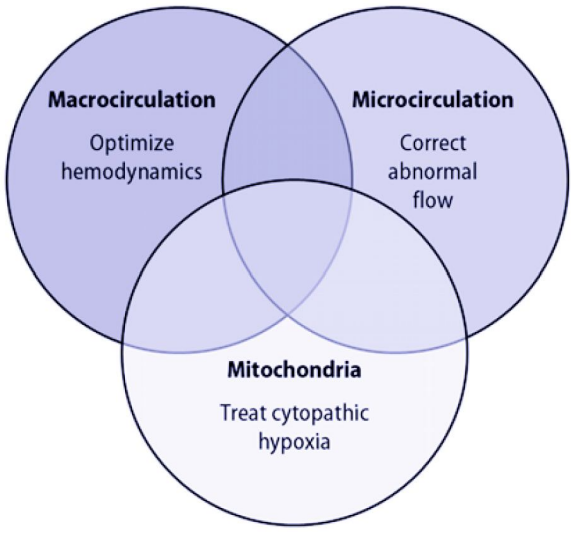

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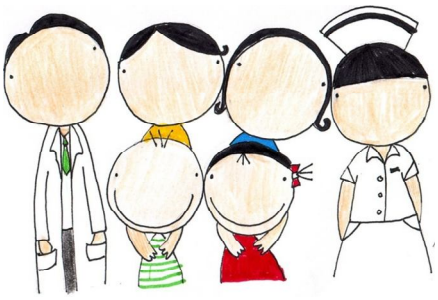
Put the Right patient to the Right place, Right time and Right therapy



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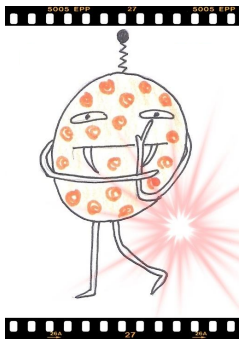
ด้วยความขอบคุณโรงพยาบาลชุมชนทุกแห่งในจังหวัดพิษณุโลก
แผนกอุบัติเหตุและฉุกเฉิน
และแผนกอายุรกรรมโรงพยาบาลพุทธชินราช
ที่ร่วมกันดูแลผู้ป่วย Sepsis ให้มีประสิทธิภาพมากยิ่งขึ้น



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Thai Sepsis Website