

  
**The new generation of lipid emulsion for pediatric parenteral nutrition**  
 中國醫藥大學兒童醫學中心  
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**Patients, who need parenteral nutrition**



Goal of the nutritional therapy:  
 Optimal provision of energy and all necessary nutrients without further impairment of the situation of the patient

**Lipids in parenteral nutrition**

•1944 Helfrick & Abelson  
*(J. Pediatrics 1944, 25, 400-403)*  
 Infusion of a 10% lipid emulsion made out of olive oil and lecithin to a 5month old girl with severe malnutrition due to Hirschsprung's disease.  
 Over 5 days this lipid emulsion contributed some 30% of the infused energy and was reported to be well tolerated.  
 The girl grew and recovered obviously.



1961 Arvid Wretling:  
 1. Industrially available and well tolerated lipid emulsion based on soybean oil

**Lipids & Fatty Acids**

**Triglycerides**

$$\begin{array}{c}
 \text{O} \\
 \parallel \\
 \text{H}_2\text{C}-\text{O}-\text{C}-\text{R}_1 \\
 | \\
 \text{H}-\text{C}-\text{O}-\text{C}-\text{R}_2 \\
 | \\
 \text{H}_2\text{C}-\text{O}-\text{C}-\text{R}_3
 \end{array}$$

Structured lipids ; artificial

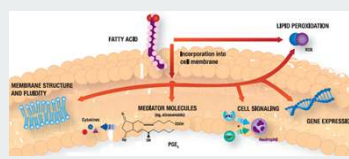
**Phospholipids**

$$\begin{array}{c}
 \text{O} \\
 \parallel \\
 \text{H}_2\text{C}-\text{O}-\text{C}-\text{R}_1 \\
 | \\
 \text{H}-\text{C}-\text{O}-\text{C}-\text{R}_2 \\
 | \\
 \text{H}_2\text{C}-\text{O}-\text{P}-\text{O}-\text{R}_4 \\
 | \\
 \text{OH}
 \end{array}$$

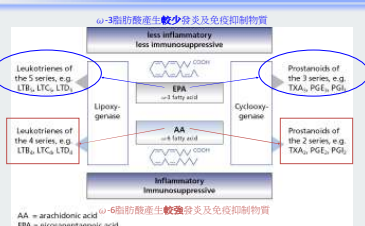
R4; N-base (choline, serine, ethanolamine)

**Biology of the Lipids**

- Nutritional
- Structural - Cell membrane
- Metabolic - Lipid mediators



**脂質調節系統**



AA = arachidonic acid  
 EPA = eicosapentaenoic acid


**靜脈營養液中脂肪乳劑所扮演的角色**

- Supply of: 供應
  - energy (9 kcal/ g fat) 每公克脂肪提供9大卡熱量
  - essential fatty acids 提供必須脂肪酸
  - carrier for fat-soluble vitamins 攜帶脂溶性維生素
- Modulation of: 調節
  - immune function 免疫功能
  - inflammation 發炎反應

**Relevance of oxidative stress pediatric PN patients**

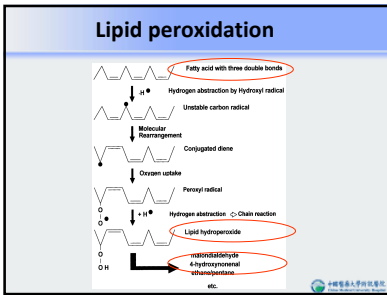
- Oxidative stress is of particular concern in preterm or critically ill infants:
  - These infants are often exposed to high oxidative stress during:
    - Infection
    - Intensive care treatment
    - Exposure to hyperbaric oxygen treatment and are handicapped by low antioxidative capacity
- But also in those, who are on long-term parenteral nutrition

**Oxidative stress**



HO<sup>•</sup> (hydroxyl radical):
 

- most potent oxidant known
- extremely short half-life
- reacts at the site of its formation
- attacks most biological molecules (carbohydrates, nucleic acids, proteins, lipids)



### Lipid peroxidation and diseases

Cardiovascular disease

- Atherosclerosis
- Myocardial infarction

Pulmonary disease

- Respiratory distress syndrome
- Oxygen therapy
- **Bronchopulmonary disease (BPD) in pediatrics**

Chronic and acute inflammatory conditions

- Trauma
- Sepsis
- Burns

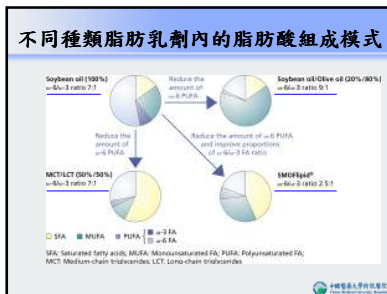
### Lipids

FFA	IV Lipids (TG)
SFA	1. LCT
MCT	2. LCT/MCT mixture, structured
PUFA	3. LCT, n-9 (n-3) ClinOleic
	4. LCT, MCT, n-3, n-9 Omegaven, SMOF
MUFA	
n-6; C18:2 n-6	
n-3; C18:3 n-3	
n-9; C18:1 n-9	

### Evolution of IV Lipid Emulsions

1st Generation LCT-based	2nd Generation Reduce LCT Intro. MCT	3rd Generation Reduce ω-6 & MCT Intro. ω-3 and/or ω-9
1961	1984	1944 & 1990s
Soybean oil (ω-6) Safflower oil PUFA	MCT/LCT mixture (soybean, coconut oils) Structured PUFA + SFA	<ul style="list-style-type: none"> <li>- Fish oil, Olive oil</li> <li>- Olive/soybean/coconut</li> <li>- Olive/soybean/fish/coconut</li> <li>- SFA+MUFA+PUFA(ω-3 or not)</li> </ul>

On evolution; Reduce soybean oil contents and add others



### 各種脂肪乳劑內ω-6/ω-3 fatty acid 比值

Lipid emulsion	ratio of ω-6/ω-3 fatty acids
Recommendations <sup>1</sup>	4:1-2:1
Soybean oil emulsion <sup>1</sup>	7:1
MCT/LCT emulsion <sup>1</sup>	7:1
Olive oil/soybean oil emulsion <sup>2</sup>	9:1
SMOFlipid <sup>3</sup> (approx.)	2.5:1

<sup>1</sup> Morlion BJ et al. Clin Nutr. 1997; 16(5):49  
<sup>2</sup> Faust P and Kuhn KS. Clin Nutr. 2000; 19:7-14  
<sup>3</sup> Adolphs M. Clin Nutr. 2002; 21(5):411-4  
<sup>4</sup> Grimm H et al. J. Parent. Sci. Technol. 2004; 28(3):142-148  
<sup>5</sup> Grimm H and Kraus A. Arch Surg. 2002; 386:369-376

### 最適當的 ω-6/ω-3 比值為何?

“...today an n-6/n-3 ratio of about 2:1 to 3:1 is regarded to have only a minor impact on immune function. This ratio may be achieved by supplementation of standard lipid emulsions with a fish oil-based lipid emulsion, or using the latest generation lipid emulsions which include fish oil.”

“n-6/n-3 脂肪酸比值落在 2:1 至 3:1 對免疫功能影響最小”

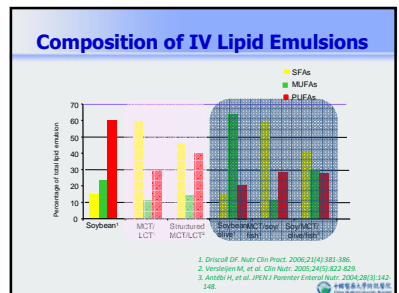
Mayer et al. Curr Opin Clin Nutr Metab Care 2006

### FA Composition of IV Lipid Emulsions

	LCT-based (PUFA-rich)		Reduce LCT (ω-6)		Introduce ω-3 and/or ω-9 (Reduce ω-6 and SFA)			
	Intralipid <sup>®</sup> 20%	Lipofundin <sup>®</sup> MCT/LCT 20%	Struzlipid <sup>®</sup> 20%	Omegaven <sup>®</sup> 10%	ClinOleic <sup>®</sup> 20%	Lipofundin <sup>®</sup> 20%	SMOFlipid <sup>®</sup> 20%	
Oil source	100% soy	50% coconut 50% soy	36% coconut 64% soy	100% fish	80% olive 20% soy	40% soy 20% coconut 10% olive 10% fish	30% soy 30% coconut 20% olive 10% fish	
SFA (%)	15.0	59.4	46.3	21.2	14.5	11.5	23.3	
MUFA (%)	61.1	36.8	47.0	42.3	22.6	28.2	26.4	
PUFA (%)	19.9	4.8	5.8	36.2	2.8	3.1	7.3	
ω-6 (%)	53.1	25.3	35.0	7.1	19.3	21.5	18.1	
ω-3 (%)	24.0	11.0	14.0	15.1	62.3	10.6	27.7	

1. Dose-Dependent  
 2. Effects of mixtures are diff. from separated dose

1. Warren GA, Collier PC. Am J Clin Nutr. 2007;85(5):1171-1184.  
 2. Orsillo DF. Nutr Clin Pract. 2006;21(4):383-386.



### How to Choose IV Lipids in pediatric patient

1. Stability of emulsion (alone / in AIO)
2. PUFA & Peroxides
3. Safety : long-term use, toxicity
4. Doses of anti-oxidants
5. Ratio : SFA / MUFA / PUFA
6. Ratio : N-6 / N-3
7. Immune function
8. Anti-inflammation
9. Antioxidant

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### New generation of lipid

- 1. ClinOleic 20%
- 2. SMOFlipid®

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### ClinOleic 20%

# C18:1 n-9

(FDA prove for adult)

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### Comparison of lipid emulsions with mother's milk

Unsaturated fatty acids: Proportional portion of mono- and polyunsaturated fatty acids

→ Compared to soybean oil emulsions: ClinOleic has a fatty acid profile which is more similar to human milk.

Carlson et al., 1998  
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### High content of olive oil in α-Tocopherol

Protection against peroxidation

Recommendations for α-tocopherol intake:

- 15 mg/d (Dietary Reference Intakes 2000, J. Am. Diet. Assoc. 200)
- > 0.4 mg/g PUFA (British Nutrition Foundation's Task Force 1994, Valk et al. 2000)

Pironi et al. Nutrition 2003	ClinOleic 20%	Soybean oil 20%	MCT/LCT 20%
α-tocopherol	30 mg/L	27 mg/L	≈ 11 mg/L
PUFA	≈ 40 g/L	≈ 120 g/L	≈ 60 g/L
α-tocopherol/PUFA	0.75 mg/g	0.225 mg/g	≈ 0.18 mg/g

➡ ClinOleic is more in line with recommendations than soybean oil emulsion as well as MCT/LCT emulsion.

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### α-Tocopherol to protect against oxidative stress

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### Lowest PUFA Content Minimize Potential Exposure to Oxidative Stress

ClinOleic PUFA含量最低 不會造成氧化上升 減少併發症風險

• ω-3, DHA, EPA (PUFA), and vitamin E lipid emulsion content are important when the risk of lipid peroxidation and oxidative stress is considered

• ClinOleic has a low proportion of PUFAs and is naturally high in the anti-oxidant vitamin E!

1. Drouot G. Eur J Clin Nutr 2004;58:381-386.  
2. Alessi MC et al. J Pediatr Gastroenterol Nutr 2004;39(5):743-748.  
3. Goulet O. et al. J Clin Nutr 1999;70(2):338-345.  
4. Sato-Yok A. et al. Eur J Clin Nutr 1999;53:1465-1474.  
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### ClinOleic不易造成脂質過氧化物的形成，有效減輕氧化壓力

在人體細胞PBMC研究中，ClinOleic產生的過氧化物與控制組無異，但 Fish Oil及 SMOFlipid 則明顯產生較多的過氧化物，且濃度愈高愈顯著。

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### Long-term pediatric study

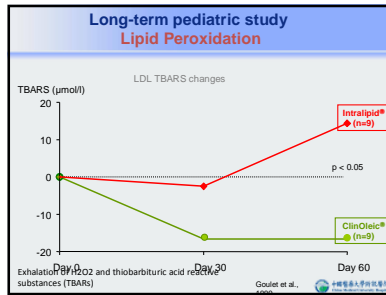
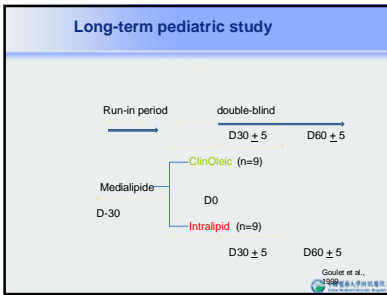
Evaluate the safety and efficacy of ClinOleic vs standard soybean oil emulsion

- Safety and efficacy
- Lipid profile
- Fatty acids in plasma and red cell phospholipids
- Peroxidation index

Double blind, randomised trial

Children aged <10y (n = 18)

Goulet et al., 1999  
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### Summary

Long-term efficacy and safety of a new olive oil-based intravenous fat emulsion in pediatric patients: a double-blind randomized study  
D. Goulet et al., Am J. Clin. Nutr. 1999; 70: 888-95

- Patient group:
  - 18 children with short bowel, intractable diarrhea or chronic intestinal pseudo-obstruction
- Method:
  - Long term study (TPN>3 months); Lipid- and fatty acid profile, Peroxidation of lipoproteins and erythrocytes, safety and efficacy
- Comparison with soybean oil
- Main statements:
  - ClinOleic is safe in long-term treatment and guarantees physiologic fatty acid metabolism
  - With ClinOleic: lower total cholesterol
  - LDL and LDL less peroxidizable → lower risk for formation of peroxides, which damage cell membranes, lipoproteins

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### ClinOleic 20 % in preterm infants

Evaluate the safety and efficacy of the olive oil emulsion (O) vs standard soybean oil emulsion (S)

- metabolic and clinical tolerance
- polyunsaturated fatty acid (PUFA) status
- vitamin E status
- urinary malondialdehyde (MDA) excretion

Double blind, randomised trial

Preterm infants in a tertiary neonatal intensive care unit (n = 33)

Göbel, Koletzko et al., 2002

### ClinOleic 20 % in preterm infants

No group differences for:

- Plasma lipids
- Biochemical indicators for liver function and integrity: total & conj. Bilirubin, ASAT, ALAT,  $\gamma$ -GT, alk. phosphatase
- Differential blood counts, platelets, CRP
- Clinical events
- MDA (malondialdehyde) excretion
- No serious adverse events

ClinOleic group showed:

a fatty acid composition of plasma lipids more similar to that of breastfed infants in the first week of life

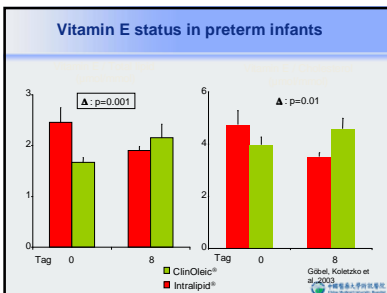
Göbel, Koletzko et al., 2002

### ClinOleic 20 % in preterm infants

Plasma phospholipid fatty acid composition

- at study end groups did not differ in plasma phospholipid: arachidonic acid, total n-6 and n-3 metabolites
- olive oil group showed:
  - higher values of the PUFA intermediates C18:3 n-6 and C20:3 n-6
  - a fatty acid composition of plasma lipids more similar to that of breastfed infants in the first week of life
- Urinary MDA(malondialdehyde) excretion
  - no difference between groups

Göbel, Koletzko et al., 2002



### Summary

Parenteral fat emulsions based on olive and soybean oils: a randomized clinical trial in preterm infants  
Göbel et al., JPEN 2003; 37:155-167

- Patient group:
  - 33 preterm infants (gestational week 28-36)
- Method:
  - Randomised, double blind controlled study, 7 days TPN; Efficacy and safety, determination of the fatty acid profile in plasma
- Comparison with soybean oil (Intralipid)
- Main statements:
  - ClinOleic is safe for preterm infants
  - Results in increased  $\Delta^5$ -desaturation and chain elongation of linoleic acid
  - Improved vitamin E-status
  - ClinOleic is a valuable alternative for preterm infants, being very often exposed to increased oxidative stress with concomitantly reduced antioxidant status.

Vitamin E (µg/ml)

Intralipid

ClinOleic

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### 會不會擔心PUFA 不夠?

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### FA Composition of IV Lipid Emulsions of ClinOleic 20 %

- SAFA:14.5%
- MUSA:63.7%
- PUFA:22%
- W3:2.8%
- W6:19.2%
- W9:62.3%

### Mid-term pediatric study in children with a low EFA status

Design: Randomised, open, comparative

Number of patient: ClinOleic n=8, Intralipid n=10

Age: 2-57 months

Treatment duration: 17 days

Lipid dosage: 2.9 g/kg and day

Evaluation criteria: Plasma and membrane fatty acid profiles

### Mid-term pediatric study in children with a low EFA status

#### Correction of EFA deficiency

Group	Baseline	End (D17)
ClinOleic (n=8)	~0.5	~0.1
Intralipid (n=10)	~1.2	~0.2

### Mid-term pediatric study in children with a low EFA status

#### Correction of EFA deficiency

Results:

- ClinOleic was very well tolerated
  - ClinOleic enabled the signs of EFA deficiency observed in the study population to be corrected
  - A balanced intake of fatty acids allows better utilisation of the substrates and therefore facilitates desaturation and elongation of the chains
  - In the ClinOleic group an increase of  $\alpha$ -Tocopherol and HDL-cholesterin was observed

### Potential Preservation of Hepatobiliary Function

Original Paper

Use of Olive Oil Based Emulsions as an Alternative to Soybean Oil Based Emulsions in Total Parenteral Nutrition and Their Effects on Liver Regeneration following Hepatic Resection in Rats

### Potential Preservation of Hepatobiliary Function

- In an animal model of hepatectomy, liver regeneration following partial resection was significantly higher in rats receiving CLINOLEIC versus control solution or an MCT/LCT emulsion at 48 and 72 hours

Group	48 h	72 h
Control	25.8	25.2
MCT/LCT emulsion	31.6	29.7
CLINOLEIC	52.8	49.1

### Preserved Hepatobiliary Function in Burn Patients

Parenteral nutrition providing a restricted amount of linoleic acid in severely burned patients: a randomised double-blind study of an olive oil-based lipid emulsion vs. medium/long-chain triacylglycerols

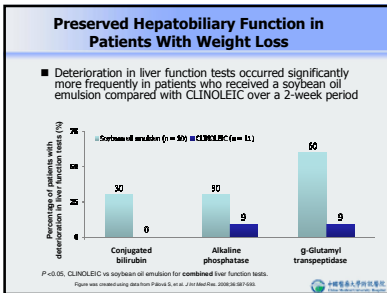
### Preserved Hepatobiliary Function in Burn Patients

- A lower percentage of burn patients who received CLINOLEIC had biochemical evidence of cholestasis after 6 days of PN compared with those who received an MCT/LCT emulsion

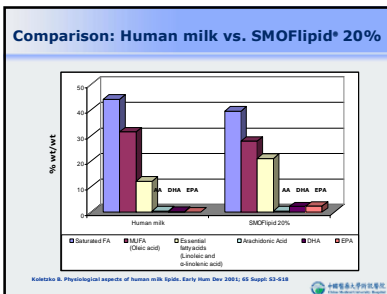
Group	Percentage (%)
MCT/LCT emulsion (n=11)	81.8
CLINOLEIC (n=9)	33.3

### Preserved Hepatobiliary Function in Patients With Weight Loss

Comparison of Soybean Oil- and Olive Oil-based Lipid Emulsions on Hepatobiliary Function and Serum Triacylglycerols Level During Realimentation



- ### SMOFlipid® 的組成
- 20% SMOFlipid
- 30% Soybean oil
  - 30% MCT oil
  - 25% Olive oil
  - 15% Fish oil
- Extra add vitamin E (dl- $\alpha$ -tocopherol)



### Soybean oil as part of SMOFlipid®

Soybean oil is a reliable source of the essential fatty acids linoleic acid ( $\omega$ -6 fatty acid) and  $\alpha$ -linolenic acid ( $\omega$ -3 fatty acid).  
黃豆油可提供亞麻油酸、次亞麻油酸等必須脂肪酸

In SMOFlipid® the soybean oil content is:  
60 g/1000 ml (30% of the mixture)

to cover the essential fatty acid requirements of patients receiving total parenteral nutrition.

### Essential fatty acids — requirements

ASPEN guidelines

To prevent essential fatty acid deficiency in adult and paediatric patients with specialized nutrition support:

- linoleic acid: minimum 1-2% of total energy intake
- $\alpha$ -linolenic acid: minimum 0.5% of total energy intake

SMOFlipid® 5.6% linoleic acid  
0.7%  $\alpha$ -linolenic acid  
(calculation basis: 30% of total energy intake from lipids)

### MCT\* as part of SMOFlipid®

SMOFlipid® contains:

60 g MCT/1000 ml (30% of the mixture)  
derived from purified coconut or palm kernel oil

This proportion guarantees the provision of rapidly available energy and an efficient triglyceride elimination from the bloodstream.

中鏈脂肪酸(MCT)可確保快速得到能量，及有效的清除血液中的三酸甘油酯

\*Medium-chain triglycerides

- ### MCT的好處
- act as rapidly available energy source  
快速得到能量的來源
  - are taken up into mitochondria mainly in a carnitine independent pathway  
不需依賴肉鹼便能進入粒線體中代謝
  - lead to controlled triglyceride levels due to quick elimination  
可控制血清中三酸甘油酯濃度
  - are well tolerated in a proportion  $\leq$  50%  
脂肪乳劑中MCT的比例佔50%以內，人體皆有良好的耐受性

### Olive oil as part of SMOFlipid®

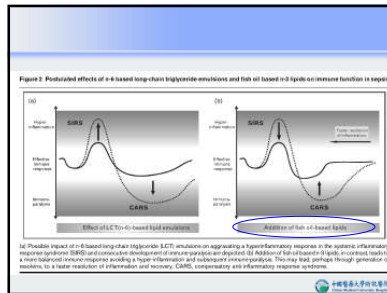
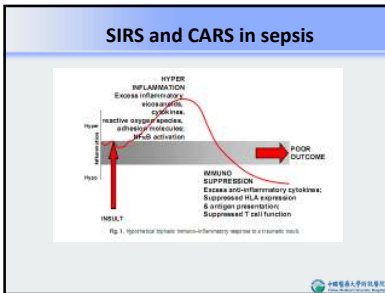
SMOFlipid® contains:

50 g olive oil/1000 ml (25% of the mixture)

The olive oil share together with the other oil components guarantee a balanced fatty acid supply. The inclusion of olive oil decreases the total PUFA content of the emulsion.

橄欖油可提供單元不飽和脂肪酸 (MUFA)，藉此降低脂肪乳劑中多元不飽和脂肪酸 (PUFA) 的含量  
Olive oil可減少動脈硬化，改善 HDL cholesterol 和降低心血管疾病 與死亡率

Ann J Clin Nutr 2006; 67: 229-235  
Circulation 2005; 112: 2111-2113  
N Engl J Med 2005; 353: 205-211  
J Lipid Res 2002; 43: 1149-1152  
Am J Clin Nutr 2002; 75: 1149-1152



Fish oil:  
Bleeding tendency concern??

根據美國FDA資料建議每日EPA+DHA攝取量不超過3公克，便不會影響凝血功能。而一瓶250ml的SMOFlipid內共含2.3公克EPA+DHA，因此在建議範圍內。

The FDA report from the Federal Register Volume 62, #108, lists menhaden oil as generally safe. Reference is made to the bleeding time, "when consumption of fish oil is limited to 3 grams or less of EPA and DHA, there is no significant risk for increased bleeding time beyond the normal range."

Fish oil 穩定嗎?  
會容易產生過氧化物嗎??

### Vitamin E as part of SMOFlipid®

SMOFlipid® contains:

- ~ 200 mg dl-α-tocopherol/1000 ml
- ~ 50 mg dl-α-tocopherol/250ml/bottle
- ~ 20 mg dl-α-tocopherol/100 ml/bottle

- for adequate antioxidative protection 提供足夠的抗氧化保護
- to prevent antioxidant depletion 預防抗氧化物質的耗竭
- to maintain an adequate vitamin E status 維持足夠的VEE濃度

### 靜脈營養對維生素E(α-tocopherol)攝取的建議

Minimum 最少:  
50 mg α-tocopherol equivalents for ICU patients  
Up to:  
100-200 mg α-tocopherol equivalents in special critically ill patients (e.g. burns, ARDS)

80-100 mg α-tocopherol daily in critically ill patients

維生素E單位換算:  
~ 1 mg α-tocopherol (~ 1.1 IU)

### Elimination & tolerance of a new parenteral lipid emulsion (SMOFlipid®)

— a double-blind cross-over study in healthy male volunteers

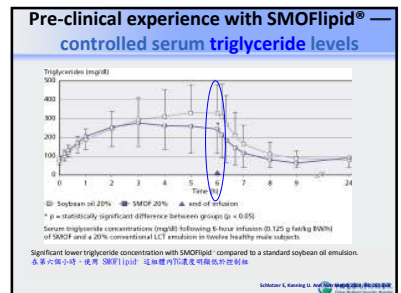
Design: Double-blind, cross-over volunteer study

Volunteers: 12 healthy male volunteers 12位健康自願者

Infusion: 0.125 g lipids/kg body weight/h over 6h

Groups: 1) Control: soybean oil emulsion 20%  
2) SMOFlipid® 20%  
And vice versa after a wash out phase of 6 days

Parameters: Serum triglycerides, clinical laboratory parameters, blood pressure, temperature, heart rate, ECG before and every hour during infusion.



### Liver function and plasma antioxidant status in ICU patients requiring TPN: comparison of 2 fat emulsions

**Design:** Double-blind, controlled, randomised clinical study

**Patients:** 20 patients after major surgery

**TPN:** PN over 5 postoperative days, lipid intake 1.5 g/kg BW/d, amino acids 1.5 g/kg BW/d, glucose 3.5 g/kg BW/d

**Groups:** 1) Control: soybean oil emulsion 20%  
2) SMOFlipid® 20%

Antibi H. et al. *JPEN* 2004; 28:142-148

### SMOFlipid® — controlled serum triglyceride levels

使用5天TPN之後，於第6天抽血檢測，SMOFlipid® 這組體內TG濃度明顯較低

Group	Triglyceride (mmol/L)
Soybean oil	~1.1
SMOFlipid	~0.7

SMOFlipid® group: Lower triglyceride increase from day 0 (before start of infusion) to day 6 (following the end of the infusion for over 5 days)

Antibi H. et al. *JPEN* 2004; 28:142-148

### Hepatocellular integrity in patients requiring parenteral nutrition: comparison of fish oil containing new lipid emulsion versus a lipid emulsion based on olive and soybean oil

S. Piper, I. Schade, R. Beschmann, K. Röhm

Euro J Anaesthesiology 2009

### Methods

- 44 postoperative surgical patients with an indication for parenteral nutrition
- Patients were thus allocated to one of two nutrition regimens:
  - SMOFlipid (n=22), ClinOleic (n=22)
- Lipid emulsions were administered during 5 days postoperatively, and venous blood samples for measurements of
  - AST
  - ALT
  - $\alpha$ -GST ( $\alpha$ -glutathion S-transferase)
- Blood test time
  - D0 Before start of PN
  - D2 Day 2
  - D5 Day 5

### Results

- There was no significant difference at d0, but at D2 and D5 significantly lower AST, ALT, and  $\alpha$ -GST ( $\alpha$ -glutathion S-transferase) levels were found in SMOF group compared to the control group.
  - AST (SMOFlipid®: 31 ± 14 vs. Olive-Soybean Oil: 56 ± 45 u/l)
  - ALT (SMOFlipid®: 26 ± 15 vs. Olive-Soybean Oil: 49 ± 44 u/l)
  - $\alpha$ -GST (SMOFlipid®: 6 ± 7 vs. Olive-Soybean Oil: 24 ± 27 ug/l)

### Conclusions

- Hepatic integrity was well retained with the administration of SMOFlipid® whereas in patients receiving a lipid emulsion based on olive and soybean oil, liver enzymes were elevated indicating a lower liver tolerability.

### Effect of a new type of lipid emulsion based on soybean oil, MCT, olive oil and fish oil (SMOF) in surgical patients

**Design:** Double-blind, randomised clinical study in 2 centers which analysed lipid and immunological parameters

**Patients:** 33 surgical patients (19 SMOFlipid®, 14 soybean oil emulsion)

**TPN:** 5 days TPN postoperatively, 1.5 g amino acids/kg BW/d; 1.5 g lipids/kg BW/d; 3-4 g glucose/kg BW/d

**Groups:** 1) Control: soybean oil emulsion 20%  
2) SMOFlipid® 20%

Grimm H. et al. *Eur J Nutr* 2006; 45: 55-60

### SMOFlipid® — increased concentration of $\omega$ -3 fatty acids

SMOFlipid® 這組血液中的 $\omega$ -3脂肪酸明顯較高

Group	$\omega$ -3 fatty acids concentration
Soybean oil	~4
SMOFlipid	~10

Higher incorporation of  $\omega$ -3 fatty acids into plasma phospholipids in the SMOFlipid® group.

Grimm H. et al. *Eur J Nutr* 2006; 45: 55-60

### SMOFlipid® — immunomodulatory and anti-inflammatory effects

Higher increase in leukotrienes (LTB<sub>5</sub>) production and a maintained LTB<sub>5</sub> production in the SMOFlipid® group.

Grimm H. et al. *Eur J Nutr* 2006; 45: 55-60



## SMOFlipid®

- **Safety and tolerance**
  - Controlled serum triglyceride levels
  - Beneficial effects on liver function
- **Increased concentrations of ω-3 fatty acids in plasma and cell membranes** 增加血液及細胞膜上ω-3 脂肪酸
- **Immunomodulatory and anti-inflammatory effects**

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## SMOFlipid® 20% - Clinical experience

Clinical Studies => double-blind, randomized, controlled

- Devlieger/Rayan => preterm babies
- Tomits => preterm babies
- Goulet => home PN infants and children

Case reports

- Tafereel/Prostherse et al 2009
- Ferreira/ Koegimeier et al 2009
- Anish A et al 2010
- Pichler J et al 2010 => retrospective study

**General remark:**  
SMOFlipid 20% has proven safety and efficacy  
=> Approval paediatric indication: European MRP countries!  
=> Approval paediatric indication: Australia, Malaysia and South Korea, Taiwan

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### Parenteral nutrition with a lipid emulsion containing a mixture of soybean, olive, medium chain triglycerides and fish oils – a randomized, double-blind study in premature infants

Devlieger H et al.; JPEN 2010 (submitted)

Fatty acid pattern in **red blood cells** post-treatment (mean ± SD)

n = 53  
中國醫藥大學附設醫院  
Sino-American Joint Research Institute

### Parenteral nutrition with a lipid emulsion based on soybean oil, MCT, olive oil and fish oil in preterm neonates

Rayyan M et al.; Acta Paediatrica 2009; 98 (Suppl 460):17

Bilirubin decrease post-treatment

n = 53  
中國醫藥大學附設醫院  
Sino-American Joint Research Institute

## SMOFlipid臨床實證

Controlled serum triglyceride levels 血清中(TG) 濃度降低	Schlötzer E, Kanning Ann Nutr Metab 2004	Amébi H, et al JPEN 2004 S.N.Piper et al Critical Care 2009
Beneficial effects on liver function 對肝臟功能的有益性	Amébi H, et al JPEN 2004	S.N.Piper et al Euro J Anaesthesiology 2009
Increased concentrations of ω-3 fatty acids in plasma and cell membranes 增加血液及細胞膜上ω-3 脂肪酸濃度	Grimm H et al. Eur J Nutr 2006	
Immunomodulatory and anti-inflammatory effects 免疫調節 抗發炎效果	Grimm H et al. Eur J Nutr 2006	K. D. Röhm et al Critical Care 2008
Improved antioxidant status 抗氧化狀態改善	Amébi H, et al JPEN 2004	Grimm H et al. Eur J Nutr 2006
Reduced length of hospital stay 降低住院天數	Mermes et al. Ann Nutr Metab 2006	Grimm H et al. Eur J Nutr 2006

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## Summary

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## ClinOleic for pediatric patients

ClinOleic offers:

- Registered product for the pediatric patient population
- Clinical experience with different patient populations
- Proven product safety and tolerance
- Short and long-term support in pediatric patients

• And in comparison to soybean oil emulsions even more:

- **Fatty acid profile, which is more similar to human milk** when compared to soybean oil emulsions
- **A more physiological fatty acid profile of plasma lipids in preterm infants** as it is more similar to that of breast-fed infants in the first week of life
- **Advantageous effects on vitamin E status and decreased lipid peroxidation rates**

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## SMOFlipid® – clinical experience

- **Safety and tolerance**
  - Controlled serum triglyceride levels
  - Beneficial effects on liver function
- **Increased concentrations of ω-3 fatty acids in plasma and cell membranes**
- **Immunomodulatory and anti-inflammatory effects**
- **Improved antioxidant status**
- **Clinical outcome:**
  - Reduced length of hospital stay 降低住院天數

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## Thanks for your attention

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