Enteral and Parenteral Nutrition in Critically Ill Patients

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Critically Ill Patients

- When these processes are correlated in response to the injury (trauma) &/ or sepsis
- Key features of the critically ill patient are severe respiratory, cardiovascular or neurological derangement, often in combination, reflected in abnormal physiological observations
What’s to be done?
• Metabolic response to critical illness
  • Supportive strategies
• **Adequate nutritional support**
  at right time
  via right route
  in a right proportion

Outcome
• Significantly decreasing morbidity and mortality
  in critically ill patients
Practice Guidelines for Nutrition in Critically Ill Patients:

Recommendation:
1. Medical nutrition therapy shall be considered for all patients with ICU stay > 48 h
2. General clinical assessment for malnutrition until validation of specific tool

Statement:
Every critical ill patient with ICU stay > 48 h RISK FOR MALNUTRITION
- Physical examination → assessment of body composition
- Muscle mass & strength

Adequate nutrition therapy has shown to attenuate metabolic response to stress and favorably modulate immune responses.
• Important determinant of the effect of nutritional therapy:
  ▶ timing of initiation
  ▶ route of delivery → EN vs PN
  ▶ targeted amount of macronutrient
  ▶ how to progress
Enteral Nutrition

Feeding Routes Through The Nose
(or alternatively may be oral)
1. Nasogastric
2. Nasoduodenal
3. Nasojejunal

Gastrostomy Options*
- Percutaneous Endoscopic Gastrostomy (PEG)
- Percutaneous Radiologic Gastrostomy (PRG)
- Percutaneous Endoscopic Jejunostomy (PRJ)
- Percutaneous Radiologic Jejunostomy (PJU)
- Percutaneous Endoscopic Gastrojejunostomy (PEG/J)
- Button
- Surgically placed Gastrostomy

Guided tube
- Fluroscopic
- Endoscopy

Bedside blindly directed
- Prokinetic drugs
- Tube manipulation
- Distending stomach with air
- Patient positioning
- External magnetic devices
- pH sensors
- Tubes with integrated camera

Percutaneous feeding tubes
- Endoscopic
  - PEG
  - PEG/J
  - PEJ
- Radiologic
  (Fluroscopic, ultrasound and computed tomography)
  - PRG
  - PRJ

Surgical
- Laparoscopy
- Open laparotomy

<table>
<thead>
<tr>
<th>Enteral access</th>
<th>Complications</th>
</tr>
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| Nasal and oral feeding tubes (NGT, NDT, NJT, OGT) | *Minor Complications:* Local oral or nasal irritation, epistaxis, sinusitis, tube dislodgement, tube malposition, tube clogging, tube kinking, feeding intolerance  
|                                             | *Major Complications:* Arrhythmia, esophageal perforation, duodenal perforation, gastric rupture, aspiration, tracheoesophageal fistula, pneumothorax, tube feeding into pulmonary tree |
| Percutaneous gastrostomy and gastrojejunostomy (PEG/J) | *Minor Complications:* Stoma leakage, wound infection, bleeding, tube dislodgement, pain, gastroesophageal reflux, tube blockage, ileus  
|                                             | *Major Complications:* Gastrocolocutaneous fistula, necrotizing fasciitis, tumor implantation at the stoma site, cardiac failure with hypoxia, bowel obstruction, small bowel perforation, subcutaneous emphysema, volvulus, gastric hemorrhage, peritonitis, cellulitis, hematoma, internal bleeding, catheter dislodgement into the peritoneal cavity, buried bumper syndrome, pressure necrosis from internal or external bumpers, aspiration pneumonia |
| Radiological and surgical gastrostomy and jejunostomy | Surgical and anesthesia complications, otherwise same as above                                    |
If oral intake is not possible, early EN (within 48 h) in critically ill adult patients should be performed/initiated rather than delaying EN.

To avoid overfeeding, early full EN and PN shall not be used in critically ill patients but shall be prescribed within 3–7 days.

Continuous rather than bolus EN should be used.
Gastric access should be used as the standard approach to initiate EN.

In patients with gastric feeding intolerance not solved with prokinetic agents, postpyloric feeding should be used.

Prokinetic agent:
1\textsuperscript{st} line: IV erythromycin 100-250 mg 3 times/days 2-4 day
Alternatively, IV metoclopramide 10 mg 2-3 times a day or a combination of metoclopramide and erythromycin

EN should be delayed

- if shock is uncontrolled and hemodynamic and tissue perfusion goals are not reached, whereas low dose EN can be started as soon as shock is controlled with fluids and vasopressors/inotropes, while remaining vigilant for signs of bowel ischemia;
- in case of uncontrolled life-threatening hypoxemia, hypercapnia or acidosis, whereas EN can be started in patients with stable hypoxemia, and compensated or permissive hypercapnia and acidosis;
- in patients suffering from active upper GI bleeding, whereas EN can be started when the bleeding has stopped and no signs of re-bleeding are observed;
- in patients with overt bowel ischemia;
- in patients with high-output intestinal fistula if reliable feeding access distal to the fistula is not achievable;
- in patients with abdominal compartment syndrome; and
- if gastric aspirate volume is above 500 ml/6 h.

Low dose EN should be administered

- in patients receiving therapeutic hypothermia and increasing the dose after rewarming;
- in patients with intra-abdominal hypertension without abdominal compartment syndrome, whereas temporary reduction or discontinuation of EN should be considered when intra-abdominal pressure values further increase under EN; and
- in patients with acute liver failure when acute, immediately life-threatening metabolic derangements are controlled with or without liver support strategies, independent on grade of encephalopathy.
EN in Hemodynamic Unstable Patient

• Critically ill patients may be facing reduced peristalsis, gastrointestinal hypoperfusion and mesenteric ischemia. EN may trigger intestinal ischemia in patients who are not hemodynamically stable

• In hemodynamic unstable patients, EN should be initiated when the patient is on stable/declining doses of vasopressors and adequately volume resuscitated. Trophic feeding (10–20 mL/h) to initiate nutrition is the best strategy

• EN should be administered within 24–48 h once the patient is stable with vasopressors

• Enteral route is more physiologic, providing nutritional benefits without adversely affecting structural–functional integrity of gut and intestinal microbial diversity

EN Formula for Critically Ill Patients

- Feeding-related nosocomial infections in the critically ill patients can be prevented by maintaining the sterility of formula feeds.
- Limitations of blenderized feeds include:
  - High microbial contamination,
  - Inconsistency in amount and supply of nutrients (16%–50%),
  - Higher osmolality and viscosity,
  - And possibility of blockage of the feeding tube.
- EN can be initiated with the standard polymeric formula.
- Scientific formula feed should be preferred over blenderized feeds to minimize feed contamination.

Perhitungan kalori
• Rule of thumb : 25 - 30 kkal/hari
• BB aktual kg x 25- 30 kkal/hr = .......kkal

Kebutuhan protein
• Kebutuhan protein 1.3-2 kgbb/hari
  1.3-2 x BB aktual = gr/hari

Persentase protein
• 1 gr protein = 4 kkal
  Kebutuhan protein x 4 kkal /total kalori x 100% = ..%
Perhitungan KH

• Kebutuhan KH
• 60% total kalori → 60% × (total kalori) kkal/hari = ---- kkal/hari
• 1 gr KH = 4 kkal
• (60% total kalori)....kkal/hr/4 kkal = ----- gr/hari
Perhitungan lemak

• KH 60%
• Protein 20%
• Persentase lemak ? → 100% - KH % - P % = -- %
  ( -- % x kebutuhan kkal = .... Kkal )
• 1 gr lemak = 9 kkal
• ... kkal/9 kkal =
Perhitungan cairan

• Kebutuhan cairan
• 30 cc/kgbb/hari atau 1cc/kalori

Jika ada residu
• Total kebutuhan cairan + cairan resid
Jalur pemberian nutrisi

Pilihan:
ENTERAL ??
PARENTERAL (Multichamber)
Parenteral Nutrition

Parenteral: “alongside” or “outside” the gastrointestinal tract
Now used to describe the administration of drugs or nutrients by vein (intravenously, or IV).

• Parenteral nutrition (PN), developed in the 1960s to sustain the lives of individuals with severe gastrointestinal impairment
Indication

TPN should be used only when enteral feedings are contraindicated in patients who require nutrition support.

Absolute contraindications for enteral nutrition:
- Complete bowel obstruction
- No GI access
- Active upper GIT bleeding
- Abdominal compartment syndrome
- Bowel ischaemia
- Unsafe surgical anastomosis
- Vomiting, aspiration and increased gastric residues (> 500 cc/6 hour)

Matarese et al, Medical Nutrition & Disease, 2014; Singer et al, ESPEN LLL, 2013
<table>
<thead>
<tr>
<th></th>
<th>Central (CPN)</th>
<th>Peripheral (PPN)</th>
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<tbody>
<tr>
<td><strong>Volume</strong></td>
<td>Large</td>
<td>Small</td>
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<tr>
<td><strong>Osmolality</strong></td>
<td>&gt; 900 mOsm/L</td>
<td>&lt; 900 mOsm/L</td>
</tr>
<tr>
<td><strong>Time period</strong></td>
<td>Long term</td>
<td>Short term &lt; 14 d</td>
</tr>
</tbody>
</table>

Matarese et al, Medical Nutrition & Disease, 2014; Nelms et al, Nutritional Pathophysiology and Therapy, 2011
COMPLICATION

- Mechanic
- Infectious
- Metabolic
- Gastrointestinal

Derenski, ASPEN, 2016; Zeigler, NEJM, 2009
### Non-Infectious Catheter Complications

- Heparin-induced thrombocytopenia (HIT)
- Catheter occlusions
- Venous thrombus
- Air embolism

### Infectious Complications

Catheter-related bloodstream infections

### Gastrointestinal Complications

- Gut barrier (epithelial cell junction): Increased permeability to macromolecules and micro-organisms (bacteria, fungi)
- Enterocytes: Increased adherence of bacteria
- Intestinal flora: Overgrowth of pathogens
- Sub-mucosal immune system: Atrophy of Peyer’s patches. Decreased production of immunoglobulin A

### Metabolic Complications

- Hyper/Hypoglycemia
- Hypertriglyceridemia
- Deficiencies (vitamin, trace elements, EFA)
- Fluid-Electrolyte imbalance
- Refeeding Syndrome
- PNALD
- Metabolic Bone Disease

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Materase et al, Medical Nutrition and Therapy, 2014; Derenski, ASPEN, 2016; Singer, ESPEN LLL, 2014
In case of contraindications to oral and EN, PN should be implemented within three to seven days.

Early and progressive PN can be provided instead of no nutrition in case of contraindications for EN in severely malnourished patients.

When a patient is determined to be at high nutrition risk (e.g., NRS 2002 > 5) or severely malnourished, and EN is not feasible, the initiation of low-dose PN should be carefully considered and balanced against the risks of overfeeding and refeeding.
<table>
<thead>
<tr>
<th>Macronutrient</th>
<th>Initiation</th>
<th>Approximate Daily Requirements</th>
<th>Recommended Maximum Doses</th>
</tr>
</thead>
</table>
| Dextrose            | **General population**  
150–200 g/d  
15%–20%, g % of admixture  
Critically ill/DM/hyperglycemia  
100–150 g/d or  
10%–15%, g % of admixture  
Increase to goal when blood glucose <180 mg/dL | 50%–60% of TDC or 70%–85% of NPC  
**General population**  
4.3–7 g/kg/d (3–4.8 mg/kg/min)  
**Critically ill/DM/hyperglycemia**  
2.9–5.8 g/kg/d (2–4 mg/kg/min) | 7 g/kg/d |
| Amino acids         | Start near or at goal  
Caution with serum urea nitrogen >100 mg/dL | 10%–20% of TDC  
Up to 2.5 g/kg/d based on clinical condition | 2.5 g/kg/d |
| Intravenous fat emulsion | Start near or at goal  
Caution with serum triglycerides ≥400 mg/dL  
In critically ill, hold soybean oil–based IVFE during first week following PN initiation, or if there is a concern for EFAD, provide only 100 g/wk, divided into 2 doses | 20–40% TDC or  
15–30% NPC or  
0.5–1 g/kg/d | 2.5 g/kg/d in healthy adults or  
1.5 g/kg/d in critically ill or  
0.11 g/kg/h |
Things should be considered to initiate PN in critically ill:

- Nutritional status
- Underlying disease → hypercatabolism conditions, sepsis, high output fistula
- Metabolic status
- Protein requirement

Critical illness represents a heterogeneous patient population → Assess individually

PN composition
- TPN
- SPN → amino acid solution, lipid emulsion,
- Micronutrient supplementation

Nutritional Risk
Termination of PN

▪ Goal: restart oral/enteral food intake as soon as GI function improves.
▪ Gradual transition from PN to oral/enteral nutrition.
▪ Reduce infusion rate to 50% for 1-2 hrs before stopping PN (minimizes risk of rebound hypoglycemia).
▪ When 60% of total energy and protein requirements are taken orally/enterally, PN may be stopped.
▪ Oral or iv electrolytes supplementation may be needed
When EN is contraindicated or not feasible, PN should be considered as soon as possible (within 48 h) in high nutritional risk patients who are hemodynamically stable.

For optimal patient care, appropriate intravenous (IV) access protocols (central or peripheral), infection control practices and hang times (up to 24 h per bag) should be adhered to when providing PN.
For patients with high nutritional risk, supplemental PN can be considered if EN fails to provide more than 60% of nutrition goal (calories and proteins) after 3 days.

For all other patients, supplemental PN can be considered where EN fails to provide more than 60% of nutrition goal (calories and proteins) after 7 days.
Critically ill patients with high nutrition risk should have their protein and calories advanced towards their prescribed goal as quickly as clinically feasible and safe, reaching at least 80% of goal within 5 days. Patients at high nutrition risk should be monitored and managed for refeeding syndrome.
EN vs PN in Critical illness
EN vs PN

EN: more physiologic, providing nutritional and non-nutritional benefit including maintenance structural and functional gut integrity also preserve intestinal microbial diversity

PN: better secure the intended nutritional intake

EN: Potensial lower nutritional adequacy particularly in the acute disease phase and GI dysfunction

PN: Associated with more infectious complication
Fig. 2.5 The kinetics of IgA levels in the intestine and respiratory tract after parenteral nutrition (PN) with lack of enteral feeding. PN significantly decreased intestinal and respiratory IgA levels by day 3; *p < 0.05 vs. day 0. From Seres, DS et al. 2016. Nutrition support for the critically ill. London: Humana Press.
ASPEN-SCCM 2016: We Suggest EN over PN
[Low to Very Low Quality Evidence]

New Multi-center RCT, EN vs PN, Infections

- EN (n=1188) vs PN (n=1192), no difference treated infectious complications (0.22 vs 0.21, p=0.7), Harvey 2014
- EN (n=1202) vs PN (n=1208), HR infections 0.89 (0.72-1.09), Reignier 2017

Figure 3. Enteral nutrition (EN) vs parenteral nutrition (PN), infectious complications.
New Trials Since ASPEN-SCCM 2016
EN vs PN in Ventilated Patients with Shock, NUTRIREA-2 Trial

Multi-center RCT in 44 ICUs in France
EN, n=1202
PN, n=1208

No difference in 28-day mortality
No difference in infectious complications

More vomiting with EN, HR 1.89 (1.62-2.20)
More diarrhea with EN, HR 1.20 (1.05-1.37)
More gut ischemia with EN, HR 3.84 (1.43-10.3)

Reignier, Lancet 2017
The effect of enteral versus parenteral nutrition for critically ill patients: A systematic review and meta-analysis


Gensheng Zhang\textsuperscript{a,1}, Kai Zhang\textsuperscript{a,1}, Wei Cui\textsuperscript{a}, Yucai Hong\textsuperscript{b}, Zhongheng Zhang\textsuperscript{b,*}

A B S T R A C T

Study objective: To analyze the effect of enteral nutrition compared with parenteral nutrition in critically ill patients.

Design: Systematic review and meta-analysis of randomized controlled trials.

Setting: Intensive care unit.

Patients: 23 trials containing 6478 patients met our inclusion criteria.

Intervention: A systematical literature search was conducted to identify eligible trials in electronic databases including PubMed, Embase, Scopus, EBSCO and Cochrane Library. The primary outcome was mortality, the secondary outcomes were gastrointestinal complications, bloodstream infections, organ failures, length of stay in ICU and hospital. We performed a predefined subgroup analyses to explore the treatment effect by mean age, publication date and disease types.

Main results: The result showed no significant effect on overall mortality rate (OR 0.98, 95%CI 0.81 to 1.18, $P = 0.83, I^2 = 19\%$) and organ failure rate (OR 0.87, 95%CI 0.75 to 1.01, $P = 0.06, I^2 = 16\%$). The use of EN had more beneficial effects with fewer bloodstream infections when compared to PN (OR 0.59, 95%CI 0.43 to 0.82, $P = 0.001, I^2 = 27\%$) and this was more noteworthy in the subgroup analysis for critical surgical patients (OR 0.36, 95%CI 0.22 to 0.59, $P < 0.0001, I^2 = 0\%$). EN was associated with reduction in hospital LOS (MD $-0.90, 95\%\text{CI} -1.63 \text{ to } -0.17, P = 0.21, I^2 = 0\%$) but had an increase incidence of gastrointestinal complications (OR 2.00, 95%CI 1.76 to 2.27, $P < 0.00001, I^2 = 0\%$).

Conclusion: For critically ill patients, the two routes of nutrition support had no different effect on mortality rate. The use of EN could decrease the incidence of bloodstream infections and reduce hospital LOS but was associated with increased risk of gastrointestinal complications.
ICU Patients Are Not All Created Equal...
Should We Expect the Impact of Nutrition Therapy to be the Same Across All Patients?
Conclusion

• Enteral Nutrition still should be considered the first-line nutritional therapy in adult critically ill patients with a functioning gastrointestinal tract

• Taken together, timing, route and caloric/protein target should no longer be considered as three different issues, but should rather be integrated into a more comprehensive approach considering all these aspects.

• It may not be necessary to focus too much on comparing the effectiveness of EN and PN in critical illnesses because critical illness is very complex and responds differently.

• If it is considered beneficial to the patient then supplemental or total parenteral nutrition can be given according to the applicable protocol.

Thank you
Jalur pemberian

• Pasien membutuhkan PN (utamanya)

Contoh:
• 1200 kkal, protein 60 gr, lemak 27 gr
Metode NPC

- Total kalori 1200 kkal, protein 60 gr, total cairan 1800 cc
- Lemak (20%) = 1800 x 20% = 360 kkal/hari
- 360 kkal/2 kkal.cc
  180 cc/24 jam = 15 cc/jam = 15X20/60 = 5 tts/menit

Sisa cairan = 1800 cc - 180 cc = 1620 cc
Protein

• AA 60 gr/1620 cc x 100 = ±4% larutan AA
• Kalori dari protein
  60 gr x 4 kkal = 240 kkal/hari
• Kalori yg masih dibutuhkan =
  1200 kkal – (360 + 240) kkal = 600 kkal
Karbohidrat

• 1 gr dextrose = 3.4 kkal
• Dextrose: 600 kkal / 3.4 kkal = 176 gr/hr
• Konsentrasi 176/1620 cc x 100 = 10.8 % dextrose
• Multichamber (AA + Dextrose )
• 1620cc /24jam = 67.5 cc/jam
### Sediaan Nutrisi Parenteral

#### PT. Kalbe Farma Tbk.

<table>
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<tr>
<th>No.</th>
<th>Produk</th>
<th>Kms [mL]</th>
<th>Komposisi [g]</th>
<th>Kalsi [Kcal]</th>
<th>Elektrolit (mmol)</th>
<th>Osmolaritas [mOsm/L]</th>
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#### Sediaan Asam Amino Untuk Gangguan Fungsi Ginjal

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#### Sediaan Asam Amino Untuk Gangguan Fungsi Hati

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#### Sediaan Ready To Use / Multichamber

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#### Sediaan Asam Amino Campuran

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#### Sediaan Asam Amino Untuk Anak

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Keterangan: Kms = Kemasan  
AA = Asam Amino  
KH = Karbohidrat  
Lpd = Lipid
### Kebutuhan Kalori 610 Kcal

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<td>500</td>
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### Kebutuhan Kalori 710 Kcal

<table>
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<tr>
<th>No.</th>
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<th>Kgm (ml)</th>
<th>Aa</th>
<th>K</th>
<th>Liq</th>
<th>Komposisi (g)</th>
<th>Kcal</th>
<th>K</th>
<th>Mg*</th>
<th>Ca++</th>
<th>Co**</th>
<th>KCl</th>
<th>Na+</th>
<th>Osmolaritas (mOsm/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Celsap® NRG30E</td>
<td>1 bag</td>
<td>75</td>
<td>60</td>
<td>20</td>
<td>200</td>
<td>250</td>
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<td>1 bag</td>
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<td>270</td>
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<td>120</td>
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### Kebutuhan Kalori 1000 Kcal

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<th>K</th>
<th>Liq</th>
<th>Komposisi (g)</th>
<th>Kcal</th>
<th>K</th>
<th>Mg*</th>
<th>Ca++</th>
<th>Co**</th>
<th>KCl</th>
<th>Na+</th>
<th>Osmolaritas (mOsm/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Celsap® NRG30E</td>
<td>1 bag</td>
<td>75</td>
<td>60</td>
<td>20</td>
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<td>2</td>
<td>Celsap® 20RE</td>
<td>1 bag</td>
<td>75</td>
<td>60</td>
<td>20</td>
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### Kebutuhan Kalori 1200 Kcal

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<th>K</th>
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<th>Komposisi (g)</th>
<th>Kcal</th>
<th>K</th>
<th>Mg*</th>
<th>Ca++</th>
<th>Co**</th>
<th>KCl</th>
<th>Na+</th>
<th>Osmolaritas (mOsm/L)</th>
</tr>
</thead>
<tbody>
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<td>1</td>
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<td>2 bag</td>
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### Kebutuhan Kalori 1300 Kcal

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<th>Komposisi (g)</th>
<th>Kcal</th>
<th>K</th>
<th>Mg*</th>
<th>Ca++</th>
<th>Co**</th>
<th>KCl</th>
<th>Na+</th>
<th>Osmolaritas (mOsm/L)</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td>Celsap® NRG30E</td>
<td>1 bag</td>
<td>75</td>
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<td>20</td>
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### Kebutuhan Kalori 1400 Kcal

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<th>Liq</th>
<th>Komposisi (g)</th>
<th>Kcal</th>
<th>K</th>
<th>Mg*</th>
<th>Ca++</th>
<th>Co**</th>
<th>KCl</th>
<th>Na+</th>
<th>Osmolaritas (mOsm/L)</th>
</tr>
</thead>
<tbody>
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### Kebutuhan Kalori 1600 Kcal

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<th>Aa</th>
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<th>Liq</th>
<th>Komposisi (g)</th>
<th>Kcal</th>
<th>K</th>
<th>Mg*</th>
<th>Ca++</th>
<th>Co**</th>
<th>KCl</th>
<th>Na+</th>
<th>Osmolaritas (mOsm/L)</th>
</tr>
</thead>
<tbody>
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