At a Glance
Maple Syrup Urine Disease (MSUD)

Deficient enzyme: Branched-chain keto acid dehydrogenase enzyme complex

Toxic Metabolite: Leucine and its keto acid (2-oxo-isocaproic acid)

Restricted Amino Acid: Branched-chain amino acids (BCAA: isoleucine, leucine, and valine)

Clinical presentation, in untreated patients:

Classic: neonatal onset, poor feeding, lethargy, altered tone, ketoacidosis, seizures, developmental delays

Intermediate: failure to thrive, ketoacidosis, developmental delays, classic symptoms during catabolic illness

Intermittent: normal development, episodic ataxia, ketoacidosis

Goal Treatment Range[1]: Maintain plasma BCAA as close to normal as possible. Acceptable ranges:

Leucine: 100-300 µmol/L
Isoleucine: 100-300 µmol/L
Valine: 200-400 µmol/L

Nutrient Needs by Age[1]

Age	Leucine mg/kg/d	Isoleucine mg/kg/d	Valine mg/kg/d	Intact Protein[2] g/kg/d	Total Protein g/kg/d	Energy kcal/kg/d
0-6 months	40-100	30-100	40-95	1.0-1.6	2.5-3.5	95-145
7-12 months	40-75	30-70	30-80	0.8-1.4	2.5-3.0	80-135
1-3 years	40-70	20-70	30-70	0.6-1.2	1.5-2.5	80-130
4-8 years	35-65	20-30	30-50	0.4-0.9	1.3-2.0	50-120
9-13 years	30-60	20-30	25-40	5.0-8.0 g/day	1.2-1.8	40-90
14-18 years	15-50	10-30	15-30	5.0-8.0 g/day	1.2-1.8	35-70
19+ years	15-50	10-30	15-30	5.0-8.0 g/day	1.1-1.7	35-45

Starting a MSUD Diet[1]

1. Determine goals for Leucine (mg), Intact Protein (g), Total Protein (g), Energy (kcal)
   - if estimating mg of leucine from grams of protein: 60 mg leucine is ~1 g protein
2. Calculate amount of intact protein source (breast milk, infant formula, food) needed to meet Leu goal.
3. Calculate amount of medical food needed in addition to the intact protein source to meet total protein goal.
4. Calculate energy intake from intact protein and medical food sources to ensure total calorie needs are met.

Diet During Illness[1]

In consultation with the medical team, if the patient's plasma leucine is significantly elevated:

1. Reduce intact protein by 50-100%, depending on the leucine levels and severity of illness, until plasma leucine is in the treatment range. Withholding all intact protein for extended periods may lead to catabolism.
2. Increase medical food and non-protein energy sources to support anabolism.
3. Add L-isoleucine and L-valine supplements (20-120 mg/kg/d of each) to maintain plasma isoleucine and valine higher than the normal treatment range. Goal is 400-800 µmol/L.

Note: For acute crisis management, including parenteral nutrition guidelines, utilize the SERN/GMDI MSUD Management Guidelines (https://southeastgenetics.org/ngp/guidelines.php).

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	Abbott abbottnutrition.com	Cambrooke www.cambrooke.com	Mead Johnson hcp.meadjohnson.com	Nutricia NutriciaMetabolics.com	Vitaflo www.vitafloUSA.com
Infant (0-1 yr)	Ketonex®-1		BCAD 1	MSUD Anamix® Early Years	
Toddler & Young Children	Ketonex-1 Ketonex-2	Vilactin™ AA Plus Powder 15	BCAD 1 BCAD 2	MSUD Anamix Early Years Complex MSD® Essential Complex MSD Amino Acid Blend	MSUD express™ Plus 15 MSUD express Plus 20 MSUD cooler® 15
Older Children & Adults	Ketonex-2	Vilactin AA Plus Powder 15	BCAD 2	Complex MSD Essential Complex MSD Amino Acid Blend MSUD Maxamum® MSUD Lophlex®LQ	MSUD express 15 MSUD cooler 15

Nutrition Supplementation[1]

Thiamine

- Trial of 100-1,000 mg/d to determine responsiveness (only effective in variant forms of MSUD)

L-isoleucine and L- valine

- Given to maintain plasma ILE and VAL in treatment range (dose varies)
- Used during metabolic crisis to decrease plasma leucine (see Diet During Illness)

Laboratory Monitoring [2]

Plasma Leucine [A,C]
Plasma Amino Acids [B,C,E]
Ketones [A,C]
Prealbumin [D,E]
Albumin [D,E]
Ferritin [D,E]
CBC [D,E]

[A] Daily until stable, weekly to twice weekly until 6 months old
[B] Monthly
[C] Monthly after 24 months of age, weekly during pregnancy
[D] Every 6 months until age 8
[E] With every clinic visit/assessment

References

1. van Calcar, S. Nutrition Management of Maple Syrup Urine Disease. In LE Bernstein, F Rohr, S van Calcar (Eds.) *Nutrition Management of Inherited Metabolic Diseases (2nd Edition)*. Springer: 2021
2. SERN/GMDI MSUD Management Guidelines; https://southeastgenetics.org/ngp/guidelines.php