Thiamine levels in malnourished children in PMGH

A prospective research done as a requirement for attaining Masters in Medicine in Child Health – University of Papua New Guinea

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Outline of presentation

- Acknowledgement
- Introduction
- Research Question
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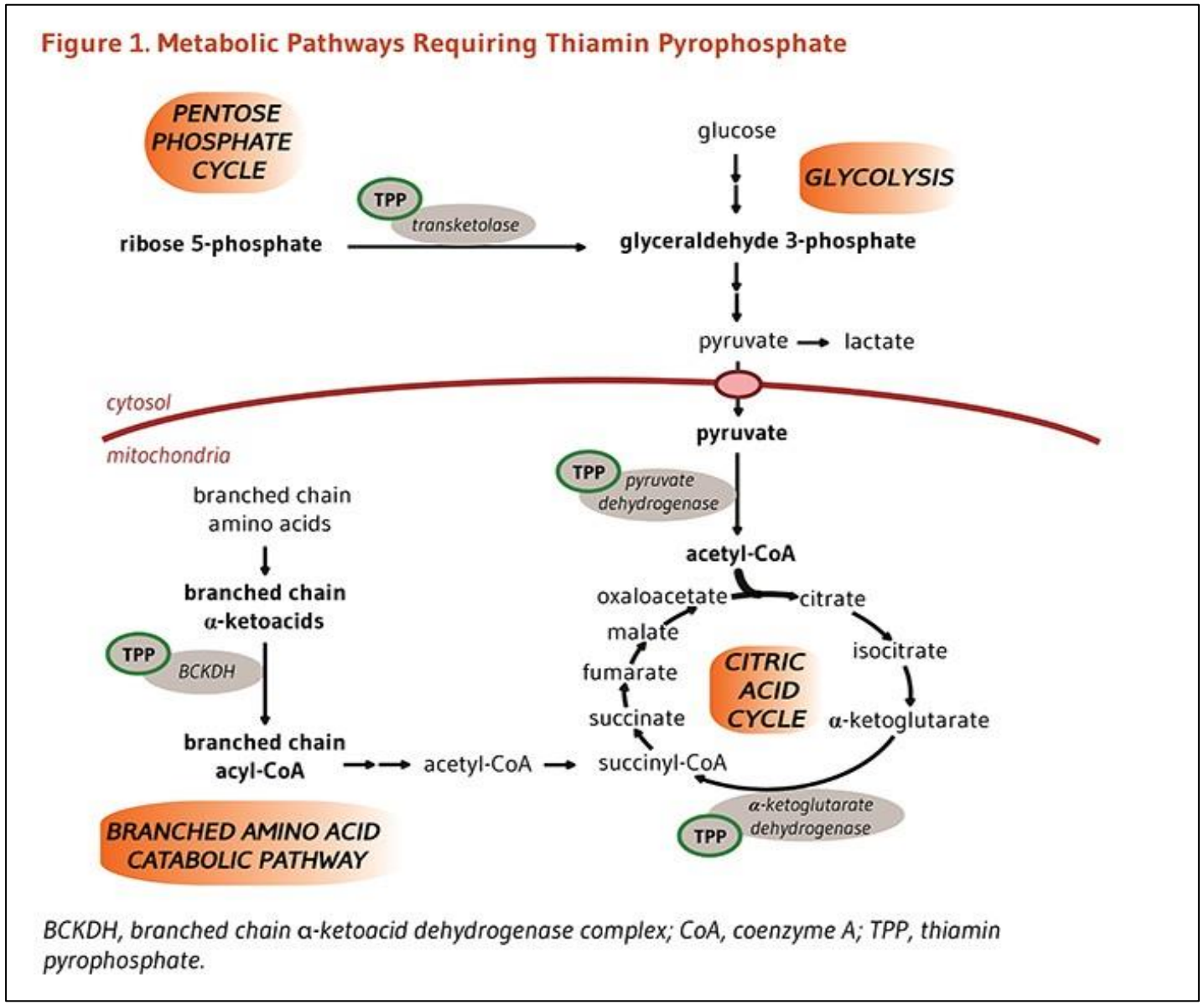
- Discussion of results
- Conclusion
- Recommendations

- References

Thiamine

- Thiamine – Vitamin B1
- Essential micronutrient
  - No endogenous synthesis or stores – adequate dietary intake is important

- Thiamine – active form thiamine pyrophosphate (TPP) function as a crucial cellular cofactor for several metabolic enzymes
  - Carbohydrate metabolism
  - Branched-chain amino acid metabolism
  - Production of neurotransmitters, myelin, and nucleic acids
  - Plays a role in immune and anti-inflammatory processes and gene regulation



Metabolic Pathways of Thiamine - Source: lpi.oregonstate.edu

Earlier failed activities of PDH and α-KGDH

↓

Reduced ATP Synthesis - induce an oxidative insult to the cell

↓

Cascade reactions lead to the generation of damaging reactive oxygen species (ROS)

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Apoptotic Cell death

- Sources of thiamine
  - Whole-grain food
  - Meat, fish, poultry, eggs
  - Milk and Milk products
  - Vegetables (green leafy vegetables, potatoes etc)
  - Legumes (lentils, soybeans, nuts, seeds)
  - Orange and tomato source

- Thiamine Deficiency – Causes
  - Reduced dietary intake/ Poor intestinal absorption/ losses in food during cooking
  - Increased metabolism/use – hypermetabolic states such as severe infections, shock, burns, fever, hyperthyroidismsepsis
  - Use of anti-thiamine – betelnut, tea; or thiaminases like raw fish, mycotoxins, stored food
  - Increased losses – use of diuretics, osmotic diuresis in diabetes, hyperemesis, chronic gastroenteritis

Severe Malnutrition

- Severe acute malnutrition in children
  - 2nd commonest cause of admission (PHR 2019).
  - Direct cause of admission
  - Associated comorbidity in 8.1 % of children (PHR, 2019)
  - Case fatality rate of 10.4%.

- Obvious macronutrient deficiency, significant hidden micronutrient deficiency
- Heart failure, shock and sepsis are common complications that often cause fatalities (even in PMGH)
- Others – magnesium, potassium, calcium, phosphate imbalances

- Is it possible that thiamine may be deficient in severely malnourished patients and contributing to the complications, including the refeeding syndrome?
  - It is important to know because treatment can be instituted to correct thiamine deficiency which may contribute to improved outcomes

Studies done on Thiamine levels in malnourished children

	Study Title	Type of test for thiamine	Findings
Hailerman et al	Thiamine status in malnourished and normal children in Jamaica, 1985	Erythrocyte transketolase assay	Subclinical thiamine deficiency present in 7% of normal children compared to 37% of malnourished children on admission
Neumann et al	Biochemical evidence of thiamine deficiency in young Ghanaian children	Erythrocyte transketolase assay	40 % of malnourished children had thiamine deficiency
Lu´cio Fla´vio Peixoto de Lima, et al	Thiamine levels and its prognostic significance in children admitted to ICU	HPLC-based method was used to measure whole-blood thiamin concentrations	No significant association between low blood thiamine concentrations and malnutrition in children upon admission to the intensive care unit
PNG			
Temple, Temu et al	Thiamine (vitamin B1) status of boarding school students in the Southern Region of Papua New Guinea	Whole-blood thiamine pyrophosphate concentration (WBTPPC)	Thiamine deficiency in 6 % of boarding school children in the southern region of PNG
No study done in PNG on thiamine levels in malnourished children			

AIM:

- To determine the prevalence of thiamine deficiency in children with severe acute malnutrition admitted to PMGH

Objectives

- To determine the serum levels of thiamine in children aged 2 months to 13 years admitted to PMGH with severe acute malnutrition.
- To determine the serum thiamine levels of non-malnourished patients in the same age group seen at or admitted to PMGH
- To compare the serum thiamine levels of malnourished patients with non-malnourished patients in the same age group seen at PMGH
- To identify any associated factors that may contribute to thiamine deficiency, if present in these children
- To make relevant recommendations depending on the results of this study

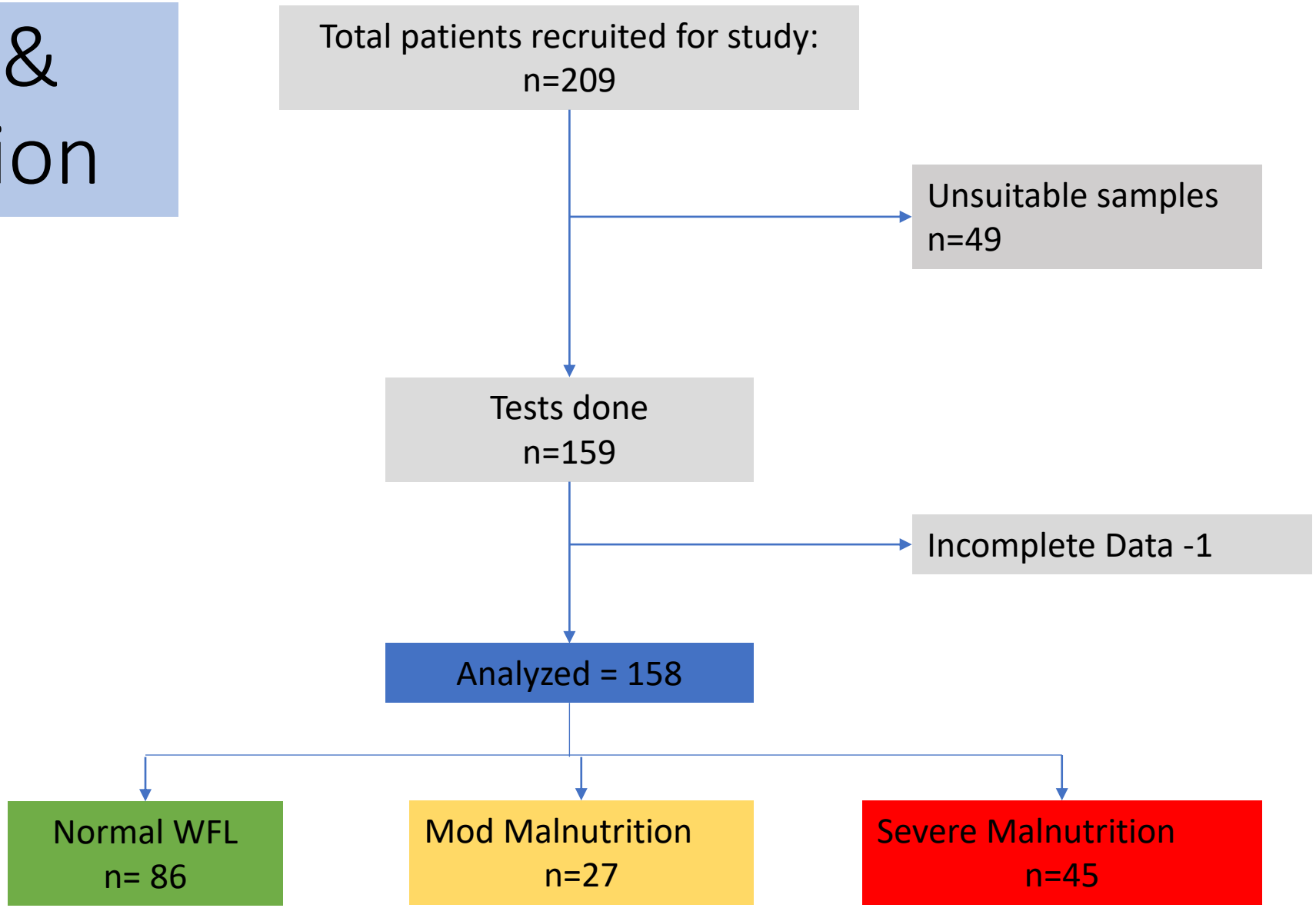
Method

- Study design – Prospective descriptive study
- Site: PMGH Paediatric wards and CED
- Time frame: July 2021-Septemer 2021
- Study population
- Children between the ages of 2 months to 13 years with malnutrition admitted to PMGH compared with non malnourished children in the same age group, also admitted to PMGH.
- Ethical clearance was approved by the UPNG SMHS Research and Ethical Committee and PMGH DMS office

Method

- Convenience sampling
- Anthropometric measurements were done and WHO Standard weight for length/height z-scores used to categorise malnutrition from non malnourished patients
- An informed consent for participation in the study was obtained from parents prior to sample collection
- Questionnaires were used to collect data including the demographic details and types of diets of mother and child, use of known thiaminases (betel nut and strong tea and coffee) and presenting complaints.
- 1-2 ml of blood was collected in a plain bottle and tests were run on the plasma using ELISA assays for thiamine at the BMS lab, UPNG
- Analysis was done using Microsoft excel and STATA/ IBM SPSS Stat 20

Results & Discussion



Demographic Characteristics

	N=158
Mothers Age (years)	Median : 26.5 IQR: 23 - 32
Educational Status	None : 3 (2%) Primary : 99 (63%) Secondary : 40 (25%) Tertiary : 16 (10%)
Marital Status	Single : 0 Married : 148 (93.7 %) Se parated/Divo rced : 9 (5.7 % Widowed : 1 (0.6%)
Ch ild ’s Age (months)	Median age : 15 : IQR : 11 - 32
Gender	Male : 88 (56%) Female : 70 (44%)
Weight (kg)	Median : 9 ; IQR: 7 - 12
Height (cm)	Median : 77 ; IQR: 72 - 89.25
M UAC (cm)	Median: 13 ; IQR 11.2 - 14.0
H ead Circumference (cm)	Median: 46 ; IQR : 44 - 48
W eight for Height/ Lenght	Normal Z - score : 86 (54%) Mod Malnutrition (Z score - 2 - 3 SD) : 27 (17%) Severe Mal nutrition (Z score below ? 3SD) ; 45 (2 9 %)
SPO2	Mean: 98% Median: 99% (IQR: 97 - 100%)
Co morbidities	
Anaemia (Hb<8g%)	No: 142 (90%) Yes: 16 (1 0 %)
HIV Confirmed (DBS or AB >2yrs)	10 (6.3%)
TB	27 (17%)
CHD	2 (1.3%)
Malaria Positive	2 (1.3%)
Meningitis (CSF confir med)	6 (3.8%)
L ength of Stay (days)	N ormal WFH – 3. 2 Mod. Malnutrition – 5. 67 Severe Malnutrition - 11.09
Covid Test ing	Not Done : 115 (73%) Done & Neg: 42 (27%) Done & Positive: 0 (0%)
Serum Thiamine levels (ng/ml)	Mean: 34. 18 ± 5.81 (Min 20.1, Max 49.3)

Nutritional Status and thiamine levels

Nutritional status class	Number	Mean serum thiamine level	Standard deviation	Minimum	Maximum
Normal nutrition	82	33.52	5.64	20.09	48.06
Moderate malnutrition	27	35.31	5.64	26.19	47.01
Severe malnutrition	45	34.41	5.85	22.55	48.99

- Normal serum thiamine levels (Reference level 16-48ng/ml)
- No difference between 3 groups

Types of food eaten by the child and thiamine levels

Food eaten on a typical day	**Number who eat / number who do not**	**Thiamine level if eaten**	**Thiamine level if not eaten**
Fruits	110 / 48	34.10	34.02
Vegetables	131 / 27	33.88	35.03
Unwashed rice	102 / 56	33.71	34.76
Washed rice	31 / 127	34.05	34.09
Brown rice	3 / 155	32.42	34.11
Meat	14 / 144	35.23	33.97
Fish	48 / 110	33.86	34.18
Eggs	89 / 69	34.07	34.09
Biscuits	118 / 40	33.86	34.13
Processed snacks	54 / 104	33.65	34.30

- There was no difference in
  - Betelnut chewing in the mother and thiamine levels
  - Extent of betelnut chewing and thiamine level.

Conclusion

- Malnutrition is the 2nd commonest cause of admission to hospitals and has a 10% case fatality rate

- Thiamine deficiency was not seen in all the children in this study in both malnourished and non-malnourished children
  - Plasma thiamine concentration reflects recent intake rather than body stores (less than 10% blood thiamine is contained in plasma)
    - Test use may not be sensitive for thiamine levels in blood
    - Whole blood thiamine testing is more accurate, as 90% of thiamine is Thiamine Diphosphate (TDP) in red blood cells
  - Increased intestinal reabsorption of thiamine that takes place under deficient conditions

Recommendation

- Further study be done using either whole blood testing or transketolase activity
- Continue current care / management of SAM
  - Prompt recognition and appropriate management of problems and complications in SAM will save lives

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