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Nutrient intake, nutrient status and pattern of infections in HIV sero-positive patients in Chulaimbo Sub-district hospital, Kenya

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Abstract: HIV worsens the nutritional status by increasing the body's requirement for food and also leads to opportunistic infections, which in turn, increase body nutrition requirements. The objective was to assess nutrient intake, nutrient status and nutritional status and establish the infection pattern of HIV seropositive patients attending a Comprehensive Care Clinic. A prospective cohort design was adopted where 497 HIV and AIDS patients enrolled at the hospital were followed for six months. This comprised of 105 males and 392 females attending the AMPATH Comprehensive Care Clinic in Chulaimbo Sub-district hospital from February 2010 to July 2010. Analysis of nutrient intake using 24-hour recall, food frequency checklist, nutrient status using biochemical assessment indicators (haemoglobin, creatinine, serum glutamate pyruvate (SGPT) and mean corpuscular volume (MCV) and pattern of infections using a morbidity tool. There was inadequate nutrient intake reported in most of the patients although a slightly more than half (55.3%) had three meals per day. Malnutrition was observed in 20.3% of 497 HIV sero-positive patients were who had a mean BMI < 18.5kg/m^2. The common co-infections/opportunistic infections were pneumonia (16.1%), tuberculosis (14.9%), dermatitis (8.7%), malaria (5.6%) and oral candidiasis (0.8%). Therefore, nutrition assessment of HIV and AIDS patients is important at all stages of the disease in order to identify those with signs of malnutrition. This will assist in preventing or detecting malnutrition from the early stages of HIV infection among HIV and AIDS patients.

Keywords: Infections, Nutrient Intake, Human Immunodeficiency Virus, AIDS, Nutrient Status, Malnutrition

1. Introduction

Good nutrition is vital for health, and the immune function is affected with inadequate nutrient intake and this could lead to infections. In disease states like HIV infection inadequate nutrient intake and micronutrients can have an adverse effect on the immune function. When macronutrient intake is insufficient to meet metabolic needs, protein-calorie malnutrition (PCM) and deficiencies of micronutrients develop (1). These deficiencies impair both the synthesis of molecules necessary for the immune response and the function of immune-related enzyme systems (2). When this impairment occurs the individual is predisposed to opportunistic infections. In HIV disease, the presence of malnutrition strongly predicts patient survival independent of CD4 (Cluster of Differentiation) T-lymphocyte counts (2). Clinical deficiencies of some nutrients occur rapidly in response to dietary deficiencies, malabsorption, or altered metabolism, while those having a storage form in the body may take longer. Malnutrition alters the immune function with increase in susceptibility to infections, faster disease progression, reduced functional status, quality of life, and increased morbidity and mortality (3).The presenting symptoms of malnutrition typically include weight loss, a change in body habitus (loss of lean

body mass) or a change in functional status (inability to perform daily activities) (1).

Infections affect the nutritional status of an individual suffering from HIV and AIDS in various ways. The pathogenesis of nutritional impairment in HIV-positive patients is multifaceted and includes decreased food intake, decreased nutrient absorption and decreased efficiency of utilization, in addition to increased nutritional demand (4). HIV infection accelerates the release of pro-oxidants, cytokines and other reactive oxygen species, leading to increased utilization of antioxidants such as vitamin E, C, beta-carotene and micronutrients e.g. iron, zinc, selenium, manganese and copper (5). An imbalance between these pro-oxidants and antioxidants causes oxidative stress which further damages the immune cells, proteins and enzymes, thus accelerating HIV replication (3).

HIV and nutrition are intimately linked in that HIV infection can lead to malnutrition, while poor diet can in turn speed disease progress. AIDS is characterized by progressive depletion of a specific group of immune cells called (CD4+) helper T lymphocytes whose loss leads to opportunistic infections and cancer (1). Micronutrients play an important role in building cellular structures, generating biological energy and acting as biocatalysts of multiple enzymatic processes in the body. Macro-and micronutrient deficiencies could impair host immune functions and promote viral replication and pathogenicity, thus potentially affecting the clinical course of HIV infection (2).Micronutrient deficiency and infections are mutually aggravating, as infections can turn marginal micronutrient deficiencies into severe conditions, and vice versa (5). Vitamins A, C, B-group, D and E support the production of white blood cells, as well as various cytokines and cellular modulators of immunity, including antibody production (5). Among other important biological factors impacting on immunity at cellular and organ levels are availability of minerals, such as iron, copper, magnesium, selenium and zinc, (2).

2. Materials and Methods

This study was carried out at Chulaimbo Sub-district hospital which is situated in Kisumu West District in Nyanza Province, Kenya. The study adopted a prospective cohort research design with the sampling unit being an adult patient either female or male aged 18 to 60 years attending the Academic Models for the Prevention and Treatment of HIV and AIDS (AMPATH) clinic. Of the 497 HIV sero-positive patients recruited for the study, 493 completed the study. Two of the patients were transferred to other clinics, one declined to continue and one died. The study was performed two days a week, the days being selected from a table of random numbers. Patients requiring hospitalization were excluded. Each patient was recruited once on the first visit and followed for six months. A standardized interview schedule was used to collect morbidity, demographic and socio-economic information of the patients. The interview schedule consisted of both open-ended and closed-ended questions. This tool was administered by the research assistants with the help of the clinicians and researcher. Diet variety was assessed using a food frequency checklist once at the start of the study and nutrient intake using 24-hour dietary recall and a morbidity survey tool was used to collect information on the types and the rate of infections of the patients every month for six months. Creatinine, haemoglobin, Serum glutamate pyruvate transaminase (SGPT) and mean corpuscular volume (MCV) measures were used to assess the nutrient status of the patients at the start of the study and at the end of the study. Ethical clearance was obtained from Institutional Ethics Research Committee, Moi University Teaching Hospital (FAN: IREC 000470). The researcher also sought informed consent from the patients and who were briefed on the research procedures and assured of confidentiality. The analysis of the nutrient value of the foods consumed within 24 hours was done by the use of the food composition tables by Sehmi (6). A value of over 100% was considered as above RDA nutrient consumption, whereas those consuming 90%– 100% was considered optimum nutrient consumption and those consuming <90% considered as below RDA nutrient consumption, this was obtained by dividing he total nutrient intake by the RDA multiplied by 100% (Onyango *et al.,*(7). Statistical analysis was performed using the Chi-square test and *t*-test. Analyses were conducted using SPSS version 16. Differences were considered significant if $P < 0.05$.

3. Results

Morbidity and infections were studied in terms of sex and there were no differences in prevalence of morbidity. Those who experienced illnesses were 229 (46.1%), pneumonia 80 (16.1%), and tuberculosis 74 (14.9%) and diarrhoea 188 (37.8%) were the most prevalent infections, as illustrated in Table 1. The males 46 (43.8%) had higher prevalence of diarrhoea compared to the females 142 (36.2%).

Table 1. *Distribution of HIV Sero-positive Patients by Prevalence of Morbidity and Sex* $n = 497$

Characteristics	Male	Female	Total
	No. (%)	No. (%)	No. (%)
Morbidity			
Experienced illness	52 (49.5%)	177 (45.2%)	229 (46.1%)
Not experience illness	53 (50.5%)	215 (54.8%)	268 (53.9%)
Total within morbidity	105 (100%)	392 (100%)	497 (100%)
Total within sex	105 (21.1%)	392 (78.9%)	497 (100%)
Type of infections			

Characteristics	Male	Female	Total
	No. (%)	No. (%)	No. (%)
Pneumonia	14 (13.3%)	66 (16.8%)	80 (16.1%)
Tuberculosis	21 (20.0%)	53 (13.5%)	74 (14.9%)
Candidiasis	1 (1.0%)	3 (0.8%)	4 (0.8%)
Dermatitis	9 (8.6%)	34 (8.7%)	43 (8.7%)
Malaria	7 (6.6%)	21 (5.4%)	28 (5.6%)
Upper respiratory tract infections	0 (0.0%)	0 (0.0%)	0 (0.0%)
No infection	53 (50.5%)	215 (54.8%)	268 (53.9%)
Total within infections	105 (100%)	392 (100%)	497 (100%)
Total within sex	105 (21.1%)	392 (78.9%)	497 (100%)
Diarrhoea			
Suffered diarrhoea	46 (43.8%)	142 (36.2%)	188 (37.8%)
Not suffered	59 (56.2%)	250 (63.8%)	309 (62.2%)
Total within diarrhoea	105 (100%)	392 (100%)	497 (100%)
Total within sex	105 (21.1%)	392 (78.9%)	497 (100%)
Frequency of diarrhoea			
Daily	1 (1.0%)	7 (1.8%)	8 (1.6%)
Weekly	4 (3.8%)	14 (3.6%)	18 (3.6%)
Monthly	5 (4.8%)	12 (3.1%)	17 (3.4%)
Occasionally	36 (34.2%)	109 (27.8%)	145 (29.2%)
Not suffered diarrhoea	59 (56.2%)	250 (63.7%)	309 (62.2%)
Total within frequency of diarrhoea	105 (100%)	392 (100%)	497 (100%)
Total within sex	105 (21.1%)	392 (78.9%)	497 (100%)

Assessment of biochemical indicators was done twice at the beginning and end of the study (n= 495). There was no significant difference in the mean nutrient status indicators between the HIV patients who suffered from infections and those who had not as shown in Table 2.

Table 2. *Comparison of Mean Values of Nutrient Status Indicators by sex in HIV Patients*

Biochemical Assessment Indicator	Sex	N	Mean ± (SD)	Normal range
Haemoglobin (g/dL)	Male	105	11.41 (± 2.60)	14-18
	Female	392	11.19 (± 4.25)	12-16
Creatinine (mg/dL)	Male	105	0.73 (± 0.22)	0.6-1.5
	Female	392	0.60 (± 19.14)	0.6-1.5
SGPT(IU)	Male	105	27.71 (± 20.21)	0-50
	Female	392	24.06 (± 18.78)	0-50
MCV (femtoliters)	Male	105	86.63 (± 15.93)	79-100
	Female	392	84.61 (± 14.51)	79-100

Key: * α= 0.05, SGPT = Serum Glutamic Pyruvate Transaminase, MCV = Mean Corpuscular Volume

There was a significant difference in mean nutrient intake of niacin (t-test = -2.93, df = 997.73, p = 0.003) and thiamine (t-test = -2.032, df = 2881.64, p = 0.042), being higher for non-infected patients as shown in Table 3.

Table 3. *Comparison of Mean Values of Nutrient Intake against Infections in HIV Patients*

Nutrients	Infections	N	Mean (± SD)	Normal Values	t	Sig
Energy(kcal)	Suffered infection	1565	1608.06 (±858.86)	2100-3000	-1.14	0.254
	Not suffered	1399	1639.00 (± 608.26)			
Protein(g)	Infected	1565	39.50 (± 11.94)	46-56	-1.17	0.241
	Not infected	1399	40.01 (± 1.83)			
Iron(mg)	Infected	1565	10.48 (±3.23)	8-18	0.25	0.802
	Not infected	1399	10.45 (± 3.20)			
Calcium(mg)	Infected	1565	519.18 (± 320.59)	1200	0.32	0.747
	Not infected	1399	515.40 (± 317.20)			
Vit A(IU)	Infected	1565	4805.64 (± 5736.15)	17000	-0.10	0.919
	Not infected	1399	4829.34 (± 6787.31)			
Vit C(mg)	Infected	1565	51.21 (± 25.75)	75-90	-1.55	0.121
	Not infected	1399	52.66 (± 25.11)			
Thiamine(mg)	Infected	1565	1.68 (± 0.67)	1.1-1.2	-2.03	0.042*
	Not infected	1399	1.73 (± 0.71)			
Riboflavin(mg)	Infected	1565	0.45 (± 0.41)	1.1-1.3	-0.32	0.751
	Not infected	1399	0.45 (± 0.40)			
Niacin(mg)	Infected	1565	10.19 (± 4.12)	14-16	-2.93	0.003*
	Not infected	1399	10.65 (± 4.30)			

* α= 0.05

Assessment of the episodes of diarrhoea was done twice at the beginning and end of the study for nutritional status indicators and immune status measures (305 episodes) and monthly for BMI and nutrient levels (922 episodes). There was no statistically significant difference in the nutrient intake between those suffered episodes of diarrhoea and those who did not in the mean values of nutritional status. Even as this was the case those who suffered episodes of diarrhoea had lower means compared to those who did not except the creatinine levels (0.65 ±0.22) as shown in Table 4. There was a statistical significant difference in the mean nutrient intake of calcium (495.11mg vs. 527.46mg, t-test = -2.617, df = 1877.48, p = 0.009), thiamine (1.64mg vs. 1.73mg, t-test = -3.345, df = 2006.35, p = 0.001) and niacin (10.16mg vs. 10.52mg, t-test = -2.141, df = 1790.45, p = 0.032), as shown in Table 4.

Table 4. *Comparison of Mean Values of Nutritional Status and Nutrient Intake across Episodes of Diarrhoea*

Characteristics	Health Status	Episode	Normal range	Mean (± SD)	t	Sig
Nutritional Status						
Haemoglobin (g/dL)	Diarrhoea	305	12-18	11.02 (±2.31)	-1.01	0.315
	No diarrhoea	685		11.21 (±3.57)		
Creatinine (mg/dL)	Diarrhoea	305	0.6-1.5	0.65 (±0.22)	1.74	0.082
	No diarrhoea	685		0.62 (±0.20)		
SGPT (UI/L)	Diarrhoea	305	0-50	24.45 (±17.42)	-0.39	0.696
	No diarrhoea	685		24.941 (±19.76)		
MCV (femolitres)	Diarrhoea	305	79-100	85.06 (±15.84)	0.01	0.995
	Did not diarrhoea	685		85.05 (±15.84)		
BMI and Nutrient levels						
BMI (kg/m^2)	Diarrhoea	922	18.5-24.9	21.06 (±5.03)	-2.19	0.029*
	No diarrhoea	2042		21.47 (±3.73)		
Energy (kcal)	Had diarrhoea	922	2100-3000	1612.04 (±985.94)	-0.448	0.662
	Did not diarrhoea	2042		1627.00 (±616.67)		
Protein (g)	Had diarrhoea	922	46-56	39.56 (±11.87)	-0.55	0.581
	Did not diarrhoea	2042		39.82 (±11.89)		
Iron (mg)	Had diarrhoea	922	8-18	10.42 (±3.17)	-0.57	0.571
	Did not diarrhoea	2042		10.49 (±3.24)		
Calcium (mg)	Had diarrhoea	922	1200	495.11 (±305.55)	-2.62	0.009*
	Did not diarrhoea	2042		527.46 (±324.39)		
Vitamin A (IU)	Had diarrhoea	922	17000	4586.38 (±5520.28)	-1.44	0.151
	Did not diarrhoea	2042		4920.87 (±6556.08)		
Vitamin C (mg)	Had diarrhoea	922	75-90	51.23 (±26.02)	-0.94	0.345
	Did not diarrhoea	2042		52.20 (±25.20)		
Thiamine (mg)	Had diarrhoea	922	1.1-1.2	1.64 (±0.63)	-3.35	0.001*
	Did not diarrhoea	2042		1.73 (±0.71)		
Riboflavin (mg)	Had diarrhoea	922	1.1-1.3	0.44 (±0.38)	-1.00	0.317
	Did not diarrhoea	2042		0.45 (±0.42)		
Niacin (mg)	Had diarrhoea	922	14-16	10.16 (±4.19)	-2.14	0.032*
	Did not diarrhoea	2042		10.52 (±4.22)		

* α= 0.05

4. Discussion

Nutritional quality of the diet does improve with consumption of greater food diversity, (8); (10).Diet diversity has however widely been associated with high socio-economic status (9). This is because people with high income may have the economic ability to purchase different types of foods from different food groups whereas those with low income stick to the few cheaper foods available, and this limits diet diversification among the poor people (5). Monthly income can be a strong and significant predictor of diet diversity among HIV patients. Studies have shown that diet diversity correlates with nutrient adequacy. Hatløy *et al.,* (10) and Slattery *et al.,* (9) observed that nutritional quality of the diet does improve with consumption of greater food diversity. A study by Stewart, (11) reported that daily servings of the same food from each food source may not be enough, but that one should choose variety within food sources because the characteristic nutrients in each group vary greatly for individual foods.

The findings of this study showed that there was variety in the intake of foods from various food sources even though the amounts were not sufficient among the HIV sero-positive patients. This supports the findings of (5) in which a diversified diet contributed to resistance to opportunistic infections in AIDS patients. However it is generally understood that no food contains all necessary nutrients and that diversity in the diet is needed to ensure a balanced diet. This implies that diversified diets are likely to ensure nutrient adequacy, and individuals who diversify diets have a likelihood of having a good nutritional status. The most commonly consumed food sources were vegetables (23.8%) and fats or oils (49.6%). The foods consumed and the frequency of consumption determines an individual's food security status (17). Therefore if the food

consumption and frequency is low the HIV-sero-positive patient becomes more food insecure.

There was inadequate food intake reported by most of the patients although majority (55.3%) had three meals per day. In the month of June majority of the patients had two meals (42.9%).Adequate diet is vital for the health and survival of all HIV-infected persons and this reduces immunosuppression. As observed in this study, the mean energy intake is lower than the RDA for both male and female patients. The patients may have been consuming a variety of carbohydrate sources (daily 15.5%, weekly 13.7%, occasionally 54.5% and not consuming 16.4%) but not in adequate amounts to meet their dietary needs. This does not agree with findings as reported by Hogg *et al*., (12) that in a study in South Africa most HIV-infected patients had energy and protein intakes that met at least 67% of the recommended daily amount. However, most of these patients had indications of low intake of vitamins C, A, D and B_6 and of zinc, iron and calcium. This is probably due to their high consumption of carbohydrate sources like maize meal, which contains only low levels of these nutrients. The results in this study are consistent with findings by Onyango *et al.,* (7) that only 48.3% met the RDA for energy among HIV sero-positive patients. Energy intake is related to the stage of the infection, rapid weight loss, anorexia, opportunistic infections, malabsorption and altered metabolism (14). Thus it is clear that HIV-infected patients are at increased nutritional risk. Both male and female patients had a mean protein intake of 41.65g (± 15.67) and 39.23g (± 11.89) lower than the RDA of 63g and 50g. The results differ from the findings by Watson (1994), which reports a mean protein intake in HIV-positive patients that was higher than the RDA. Studies carried out on HIV-infected patients in the Free State province of South Africa and in Boston (USA) reported that a majority of the patients had a protein intake that met at least 67% of the RDA (15). The low intake of protein observed in this study may be associated with the patient's economic ability. There is the increased urinary nitrogen loss, increased protein utility, decreased skeletal protein synthesis and increased skeletal muscle breakdown reported in HIV-infected individuals as a result of this the low protein intake reported in this study may not compensate for the increased needs.

In this study, the majority of patients had an inadequate or low intake of micronutrients that was < 90% or lower than the RDA. The study also established that the intake of calcium and vitamin A and riboflavin was less than RDA in both females and males. The female patients had higher intake of most of the nutrients compared to the males except iron intake. Studies have shown that some minerals/trace elements may be key factors in maintaining health despite human immunodeficiency virus infection and in reducing mortality. Values higher than the RDA were identified for thiamine (male 135.8% and female 160%) and iron in male (128.8%) in this study population. Each of the mineral/trace elements examined in this study may contribute to the general well-being of HIV-infected persons. Calcium has been shown to reduce diarrhoea in HIV-positive/AIDS patients (16). In this study, the mean calcium intake in male patients was 487.57 ±306.15 and in female patients it was 542.21 ±320.59; both being lower than the RDA (1200mg). Therefore, the results obtained from this study tend to suggest that patients with a high dietary intake might be able to replace lost calcium and in turn reduce the burden of diarrhoea. Iron is essential for the formation and functioning of red blood cells, and vitamin C is known to promote the absorption of iron. In male patients, the iron intake (10.49 ±3.49) was higher than the RDA, nonetheless the females had a lower intake as shown in Table 4. Iron is one of the micronutrients that is commonly deficient in HIV infection. Haemoglobin level (11.405 mg/dl (±2.60) in males and 11.185 mg/dl (±4.25) in females) was determined in this study to verify its correlation with dietary intake. As mentioned earlier, the female population had an inadequate intake of iron as opposed to the male population. The reason for this discrepancy is not clear, but it may be related to the fact that iron is lacking in women's food due to a lack of knowledge, consuming foods/diets deficient in iron or because of extra demands during the menstrual cycle (women need extra iron until they pass the menopause stage).

Tang *et al*., (18) observed a slower progression of disease and reduced risk of mortality with an increased intake of riboflavin, thiamine and vitamin C. Vitamin C has been found to affect immune function in several ways (19). It can stimulate the production of interferons; the protein that protect cells against viral attack. However, the dietary intake of vitamin C was below RDA among the patients in this study. There is evidence that increased intakes of vitamin C may help to reduce the risk of diseases associated with increased oxidative stress (19). It is therefore envisaged that the inadequate vitamin C intake reported among the patients in this study is not beneficial to the patients. Although, the greater percentage of patients in this study had a dietary intake of the thiamine higher than the RDA, it should be noted that even a mild state of deficiency of these vitamins could result in an altered immune function, especially in patients who are not on antiretroviral drugs. As HIV infection progresses, coupled with opportunistic infections and metabolic demand, HIV-infected individuals may be unable to meet their required nutritional needs. This may be due to decreased oral intake, decreased nutrient absorption, increased nutrient requirements and changes in metabolism and nutrient transport, which could steadily result in greater inadequacy of these vitamins.

The dietary intake of vitamin A in this study was lower than the RDA for most of the patients (22.8% male and 26.7% female). Tang *et al*. (18) reported that 12% - 19% of HIV-positive patients at various stages of HIV infection show vitamin A inadequacy that is more prevalent in women than in men. However this study established that the females had a higher intake of vitamin A compared to

the males. Studies have shown that there is a relationship between the dietary intake of vitamin A and immune function (20). High dietary intake of vitamin A may be related to metabolic demand during the acute phase of HIV infection, or an increased dietary intake, while the low intake could probably be associated with a more rapid progression to AIDS (21). There were low levels of haemoglobin (males 11.41 ±2.60 and females 11.19 ±4.25) and creatinine, SGPT and MCV levels were at the cut off for majority of the female patients. When Haemoglobin measures are low, tissues may not be receiving enough oxygen, leading to poor healing and less efficient organ function.

HIV related malnutrition has several causes (22), including but not limited to a decrease in food intake, the effects of opportunistic infections (23), metabolic inefficiencies due to cytokine activity and diarrhoea. Malnutrition itself can induce immunodepression and worsen HIV-related immunodepression (24). Once HIV has weakened the immune system, various infections can take hold, some of which can affect appetite and ability to eat (25).

Tuberculosis (TB) has been associated with malnutrition in HIV patients (26). HIV patients have an increased risk of developing TB because they have weakened immune systems. Host resistance to TB is dependent on cell mediated immune response, which is compromised in HIV positive individuals. One study found that HIV replicates faster when tuberculosis is also present (27). Infections may affect the nutritional status of an individual suffering from HIV and AIDS in various ways, such as a reduction in food intake and nutrient absorption and by increasing the utilization and excretion of proteins and micronutrients (28). This study established that 31% of the patients either suffered from pneumonia or tuberculosis as shown in Table 4. The patients also had respiratory tract infections especially from the month of April to July and this may be attributed to the cold season at this time of the year in Kenya.

Diarrhoea is one of the major infections among HIV patients and is well recognized as an important component of HIV related morbidity. Majority of the HIV sero-positive patients in this study were at an advanced stage of HIV disease (AIDS) as confirmed by clinical staging and CD4 level (26). Diarrhoea was experienced by over 50% of AIDS patients at some time during the course of their illness. It is an important cause of morbidity and mortality in up to a quarter of all HIV sero-positive patients (28). Diarrhoea is the most common Gastrointestinal (GI) symptom in patients with HIV. In this study 37.8% of the patients had some episode of diarrhoea and of these 29.2% had episodes of diarrhoea occasionally. Diarrhoea was most strongly associated with low nutrient intake especially calcium which is known to reduce the burden of diarrhoea in HIV infection. The worst hit month in the study was June with 59.6% suffering various infections, with malaria (21.1%) having the highest frequency.

5. Conclusion

An adequate, well balanced diet, providing required foods and consequently adequate nutrients meets the increased requirements of HIV infection/AIDS. High dietary intake of major macronutrients and micronutrients will help in maintaining the nutritional status and in reducing wasting in the HIV patients. It is therefore recommended that adequate dietary intake and nutrient supplementation should be encouraged in HIV infection to improve both survival and quality of life.

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