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Research Article

Studies On Some Haematological Parameters and Serum Electrolytes in Asthmatic Patients Attending Imo State Specialist Hospital, Umuguma, Owerri, Nigeria

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Abstract

Asthma is a chronic inflammatory disorder characterized by reversible airflow obstruction, airway hyperresponsiveness, and mucus overproduction. It affects individuals of all ages, with a significant impact on quality of life and healthcare systems globally. This study was aimed at evaluating the levels of some hematological parameters and serum electrolytes in asthmatic patients attending Imo State Specialist hospital, Umuguma, Owerri, Nigeria. A total of sixty subjects were recruited for the study (30 asthmatic patients and 30 healthy subjects). The participants who gave their informed consent and completed the questionnaire were enrolled in the study. Eight (8) milliliters of blood was collected, 3ml was dispensed into ethylenediaminetetraacetic acid (EDTA) containers, mixed gently and stored in the refrigerator at 40C and used for the analysis of PCV, Hb, TWBC, Differential white cell count, platelet count, ESR using microhematocrit, Cyanmethemoglobin, Manual (Turks solution), Manual method (Romanowsky stain), Ammonium oxalate, and Westergren methods respectively, while the remaining 5ml was dispensed into plain containers for sodium, potassium and chloride determination using flame photometer method for both sodium and potassium and mercuric nitrate intrametric method for Chlorides. The samples in the plain containers were centrifuged at 3,000pm for 5 minutes after clotting to separate and to obtain the serum. Data generated were analyzed using SPSS version 21, and mean, standard deviation, t-test, correlation and p-values were determined. The mean values of hemoglobin (9.21±1.54)g/dl and PCV (26.93±4.13)% were significantly lower in asthmatic patients when compared to the controls (12.43±1.21)g/dl and (35.90±3.59)% (p=0.000). The mean values of WBC (10.74±3.81) cells/µl, neutrophils (65.53±14.65)%, eosinophils (2.50±1.41)%,and platelets (352.93±148.75) cells/µl were significantly higher in asthmatic patients when compared to the controls (5.96±1.73) cells/µl, (40.63±10.19)%, (1.23±0.89)%, (184.17±55.68) cells/µl (p=0.000). The mean values of lymphocytes (28.73±13.94)% and monocytes (3.13±2.74)% were significantly lower in asthmatic patients when compared to the controls (53.00±9.95)% and (5.30±3.84)% (p=0.000). The mean values of sodium (126.63±8.13) mmol/l, potassium (3.02±0.57) mmol/l, and chlorides (95.27±5.92) mmol/l were significantly lower in asthmatic patients when compared to the controls (139.83±7.89) mmol/l, (4.09±0.74) mmol/l and (105.37±7.62) mmol/l (p=0.000). The mean value of ESR (67.27±45.06)mm/hr was significantly increased in asthmatic patients when compared to controls (1.23±0.89)mm/hr (p=0.000). There was no significant difference in the mean values of PCV, Hemoglobin, Total WBC count, differential white cell count, ESR, Platelets, sodium, potassium, and chlorides when compared based on age and gender(p=0.000). There was non - significant positive correlation of ESR with PCV, hemoglobin, TWBC, neutrophils, lymphocytes, eosinophils, sodium, potassium and chlorides(r=0.25,p=0.187; r=0.24, p=0.184; r=0.56, p=0.222, r=0.29, p=0.769; r=0.87, p=0.489, r=0.86, p=0.478, r=0.84,p=0.441; r=0.65, p=0.752, r=0.93, p=0.961; r=0.28, p=0.548 and r=0.23, p=0.695). In conclusion, the study has shown that levels of PCV, hemoglobin, WBC, neutrophils, lymphocytes, eosinophils, sodium, potassium and chlorides are altered in asthmatic patients, but age and gender do not have any effect on these parameters in asthmatic condition. Therefore, we recommend that clinicians should investigate these parameters in asthmatic conditions for proper management of these patients and to prevent complications.

1. INTRODUCTION

Allergic respiratory disorders, in particular asthma, are increasing in prevalence, which is a global phenomenon (Kathryn *et al*., 2015). The word "asthma"is from the Greek, which means "panting" (Murray and John, 2020). Asthma is a common long-term inflammatory disease of airways of the lungs. It is characterized by variable and recurring symptoms, reversible airflow obstruction, and bronchospasm. Symptoms include episodes of wheezing, coughing, chest tightness, and shortness of breath. These episodes may occur a few times a day or a few times per week. Depending on the person, they may become worse at night or with exercise (Lemanske and Busse, 2020).

There is no cure for asthma. Symptoms can be prevented by avoiding triggers, such as allergens and irritants, and by the use of inhaled corticosteroids. Long-acting beta agonists (LABA) orantileukotriene agents may be used in addition to inhaled short-acting beta agonist taken by mouth. In very severe cases intravenous corticosteroids, magnesium sulfate, and hospitalization may be required (Kathryn *et al*., 2015). In 2015, 358million people globally had asthma, up from 183million in 1990. It caused about 397,100 deaths in 2015, most of which occurred in the developing world. It often begins in childhood. The rates of asthma have increased significantly since the 1960s. Asthma was recognized in Ancient Egypt.

Hematological parameters are measurable blood indices that can be used as markers in the diagnosis and monitoring of certain physiological and pathological abnormalities (Price *et al*., 2016). Hematological parameters can be affected by disease conditions affecting hematopoietic physiology and due to immunological response. For example, allergic diseases such as asthma may affect the hematological parameters including eosinophils and neutrophils (Fahy, 2017). Allergy is a disorder of the immune system in a form of hypersensitivity in response to allergens. Asthma, allergic rhinitis and eczema are common allergic diseases. Asthma affects the airways that carry air to and from lungs. The inside walls of airways of asthmatic patients can be swollen or inflamed. This swelling or inflammation makes the airways extremely sensitive to irritations and increases susceptibility to allergic reaction (WHO, 2016). As inflammation causes the airways to become narrower, less air can pass through them, results tissue hypoxia and/or hypoxemia.

Bronchial asthma (BA) is a type I hypersensitivity reaction where immunoglobulin E (IgE) antibodies along with various allergens produce airway inflammation and symptoms of bronchial asthma (Gajanand *et al*., 2020).

Abnormal electrolytes concentrations in asthma patients can be attributed to low intake or secondary to asthma medications (Prince *et al*., 2018). Electrolytes levels directly influence excitability of airways smooth muscles (ASM) by influencing the state of ion exchangers and Na+ /K+ pump. hyponatremia inhibits Na+ /Ca++ exchange10, K+ -free solution inhibit Na+ /K+ pump and the addition of K+ (10 or 30 mM) activates Na+/K+-pumping (Raeburn and Fedan, 2019). Recently, experimental evidences suggest that modification of K+ channel activity may induce bronchodilation, reduce cough and mucus production and inhibit of airway inflammation and remodeling. In addition, controlling voltage-gate sodium channel in the central nervous system and lung tissue can lead to safer strategies for asthma prevention and treatment (Hoang *et al*., 2015).

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out at the medical-out patients department of Imo State Specialist Hospital, Umuguma, Owerri, Imo state

2.2 Study Design

A cross-sectional study was conducted from the month of June to August, 2023, and all subjects who gave written informed consent and completed the questionnaire were enrolled in the study. A total of 30 asthmatic patients were recruited for the study. An equivalent number of apparently healthy non- asthmatic subjects (30) were used as the control groups. Screening tests such as HIV I &II, HBsAg, HCV, and Syphilis were conducted on the two groups to rule out all other infections. The procedure was carried out at Imo State Specialist Hospital, Umuguma, Owerri. The results of the tests were analyzed using SPSS version 21.

2.3 Method of Recruitment

A total of sixty subjects were recruited for the study (30 asthmatic patients and 30 healthy subjects).The study participants were given an informed consent form and questionnaires to fill, and Subjects who completed the questionnaires and gave their informed consent were enrolled in the study.

2.4 Sample Collection

Using a sterile disposable syringe 8mls of blood was collected, 3ml was dispensed into EDTA containers, mixed gently and stored in the refrigerator at 4^0C for the determination of haematological parameters while the remaining 5ml was dispensed into plain containers for serum electrolytes. The samples in the plain containers were centrifuged at 3,000pm

for 5 minutes after clotting to separate and obtain serum. The sera were extracted using a pasteur pipette, put into appropriate specimen containers, and stored at -20^{o}C prior to use.

2.5 Ethical Consideration

The study was approved by the ethics and research committee of Imo Specialist hospital, Owerri. All study participants who gave their informed consent were enrolled in this study and samples were taken.

2.6 Selection Criteria

2.6.1 Inclusion criteria

1. Patients of age 18 years and above.
2. Patients with history of paraoxysmal respiratory dyspnea, wheezing, cough and presence of bilateral bronchi.
3. Patients who gave written informed consent.
4. Age-matched subjects who served as controls.

2.6.2 Exclusion criteria

1. Patients below the age of 18 years.
2. Patients with hepatitis B and C, syphilis and HIV infection, leukaemia etc.
3. Patients who refused to give their informed consent.

2.7 Laboratory Analysis

The haemoglobin concentration was estimated using the cyanmethaemoglobin method. The microhaematocrit method was used to determine the packed cell volume. White blood cell count was estimated manually using the neubaeur counting chamber, while the differential white cell count was done using thin blood film and hand tally. The platelet count was also estimated manually using the counting chamber, while the erythrocyte sedimentation rate was determined using westergren method. Flame photometry was used to determine sodium and potassium concentrations, while serum chlorides were estimated using the mercuric nitrate “nitrimetric” method.

2.8 Statistical Analysis

The generated data were systematically analyzed as appropriate for means, standard deviation. Student’s test and pearson correlation was employed on SPSS software version 21 (California Inc.). Results were presented as mean ± standard deviation. A two-sided $p< 0.05$ were considered statistically significant.

RESULTS

Table 1: Mean Values of PCV, Haemoglobin, Total WBC Count, Differential Count, ESR, Platelets in Asthmatic Patients compared to Controls (mean ±SD)

The mean values of haemoglobin (9.21±1.54)g/dl and PCV (26.93±4.13)% were significantly lower in asthmatic patients when compared to the controls (12.43±1.21)g/dl and (35.90±3.59)% respectively ($t= 8.99$, $p = 0.000$) and ($t =897$, $p = 0.000$). The mean values of WBC (10.74±3.81) cells/µl, platelets (352.93±148.75) cells/µl were significantly higher in asthmatic patients when compared to the controls (5.96±1.73) cells/µl and (184.17±55.68) cells/µl ($t = 6.26$, $p =0.000$ and $t = 5.82$, $p = 0.000$) while ESR (67.27±45.06)mm/hr was significantly higher in asthmatic patients when compared to controls (1.23±0.89)mm/hr($t = 8.03$, $p = 0.000$)

Parameter	Test	Control	t-value	p-value
Hb (g/dl)	9.21±1.54	12.43±1.21	8.99	0.000*
PCV (%)	26.93±4.13	35.90±3.59	8.97	0.000*
WBC (cells/µl)	10.74±3.81	5.96±1.73	6.26	0.000*
PLT (cells/ µl)	352.93±148.75	184.17±55.68	5.82	0.000*
ESR (mm/hr)	67.27±45.06	1.23±0.89	8.03	0.000*

KEY;

*: Significant p value

Hb: Haemoglobin; Wbc: White blood cell; Neu; neutrophils; Lym: lymphocyte; Mono: monocyte; Eos: eosinophils

Table 2: Mean Values of Differential White Cell Count, in Asthmatic Patients Compared to Controls (Mean ± SD)

The mean value of neutrophils (65.53±14.65) %, and eosinophils were significantly higher in asthmatic patients when compared to the controls (40.63±10.9) % and (1.23±0.89)% ($t = 7.64$, $p = 0.000$; $t = 4.16$, $p = 0.000$).

The mean values of lymphocytes (28.73±13.94)% and monocytes (3.13±2.74)% were significantly lower in asthmatic patients when compared to the controls (53.00±9.95)% and (5.30±3.84)%. (t = 7.76, p= 0.000; t = 2.52, p = 0.000).

Parameter	Test	Control	t-value	p-value
Neu (%)	65.53±14.65	40.63±10.19	7.64	0.000*
Lym (%)	28.73±13.94	53.00±9.95	7.76	0.000*
Mon (%)	3.13±2.74	5.30±3.84	2.52	0.000*
Eos (%)	2.50±1.41	1.23±0.89	4.16	0.000*

KEY:
Neu: Neutrophils; Lym: Lymphocytes; Mon: Monocytes; Eos: Eosinophils

Table 3: Mean Values of Sodium, Potassium, and Chloride in Asthmatic Patients Compared to Controls (Mean ±SD)
The mean values of sodium (126.63±8.13) mmol/l, potassium (3.02±0.57) mmol/l, and chloride (95.27±5.92) mmol/l were significantly lower in asthmatic patients when compared to the controls (139.83±7.89) mmol/l, (4.09±0.74) mmol/l and (105.37±7.62) mmol/l. (t=6.38, t = 6.30, t = 5.73, p=0.000).

Parameter	Test	Control	t-value	p value
Sodium (mmol/l)	126.63±8.13	139.83±7.89	6.38	0.000*
Potassium (mmol/l)	3.02±0.57	4.09±0.74	6.30	0.000*
Chloride (mmol/l)	95.27±5.92	105.37±7.62	5.73	0.000*

Table 4: Mean Values of PCV, Haemoglobin, Total WBC Count, Differential White Cell Count, ESR, Platelets, Sodium, Potassium and Chlorides in Male and Female Asthmatic Patients Compared to Controls (Mean ±SD).
There was no significant difference in the mean values of PCV(27.71±3.62)%, Haemoglobin (9.37±1.41)%, Total WBC count (11.06±4.28) cells/ µl, neutrophils (67.78±14.61)%, lymphocytes (26.57±12.97)%, monocytes (2.86±3.25)%, eosinophils (2.57±1.09)%, ESR (59.50±44.08) mm/hr, Platelet count (332.36±122.70) cells/ul, Sodium (130.86±7.02) mmol/L, Potassium(3.05±0.74)mmol/L, and Chlorides (96.28±6.21)mmol/L in male asthmatic patients when compared to female (9.06±1.67)g/dl,(26.25±4.52)%,(10.46±3.46)cells/ul,(63.56±14.87)%,(30.63±14.90) %,(3.37±2.28)% (2.43±1.67)%(74.06±46.21)mm/hr,(370.94±170.25)cells/ul,(122.94±7.34)mmol/L,(2.98±0.39) mmol/L and (94.37±5.71) mmol/L asthmatic patients(t=0.56, t = 0.97, t = 0.42, t =0.78, t = 0.78, t = 0.51, t= 0.26, t =0.70, t =3.01, t = 0.29, t = 0.88, t= 0.89), (p=0.583, p=0.341, p=0.677, p=0.441, p=0.437, p=0.614, p=0.800, p=0.488, p=0.006, p=0.771, p=0.388 and p=0.387).

Parameter	**Male**	**Female**	**t-value**	**p-value**
Hb (g/dl)	9.37±1.41	9.06±1.67	0.56	0.583
PCV (%)	27.71±3.62	26.25±4.52	0.97	0.341
WBC (cells/ µl)	11.06±4.28	10.46±3.46	0.42	0.677
Neu (%)	67.78±14.61	63.56±14.87	0.78	0.441
Lym (%)	26.57±12.97	30.63±14.90	0.78	0.437
Mon (%)	2.86±3.25	3.37±2.28	0.51	0.614
Eos (%)	2.57±1.09	2.43±1.67	0.26	0.800
ESR (mm/hr)	59.50±44.08	74.06±46.21	0.89	0.387
PLT (cells/ µl)	332.36±122.70	370.94±170.25	0.70	0.488
Sodium (mmol/l)	130.86±7.02	122.94±7.34	3.01	0.006
Potassium (mmol/l)	3.05±0.74	2.98±0.39	0.29	0.771
Chloride (mmol/l)	96.28±6.21	94.37±5.71	0.88	0.388

KEY:
Hb: Haemoglobin; Pcv: Packed cell volume; WBC: White blood cell; Neu: Neutrophils; Lym: Lymphocytes; Mon: Monocytes; Eos: Eosinophils

Table 5: Comparison of the Mean Values of PCV, Haemoglobin, Total WBC, Differential Count, ESR, Platelet Count, Sodium, Potassium and Chlorides in Asthmatic Patients based on Age.
There was no significant difference in the mean values of PCV, haemoglobin, total WBC count, differential count, ESR, platelet count, sodium, potassium, and chlorides in asthmatic patients when compared based on age (p=0.309, p=0.279, p=0.036, p=0.589, p=0.617, p=0.895, p=0.459, p=0.220, p=0.346, p=0.753, p=0.322 and p=0.766).

Parameter	18-30	31-43	>43	f-value	p-value
Hb (g/dl)	8.87±1.68	9.20±1.51	9.86±1.17	1.23	0.309
PCV (%)	26.24±4.59	25.75±3.50	28.78±3.07	1.34	0.279
WBC (cells/µl)	12.09±4.04	7.10±1.15	9.80±2.81	3.78	0.036
Neu (%)	67.47±14.87	59.00±11.52	64.78±16.01	0.54	0.589
Lym (%)	27.18±12.96	35.00±12.67	28.89±16.86	0.49	0.617
Mon (%)	3.06±3.11	3.75±1.89	3.00±2.50	0.11	0.895
Eos (%)	2.29 ±1.05	2.25±2.06	3.001.73	0.81	0.459
ESR (mm/hr)	62.00±41.14	77.50±45.19	72.67±55.35	0.27	0.766
PLT (cells/ µl)	394.53±159.58	305.50±96.78	295.44±131.29	1.61	0.220
Sodium (mmol/l)	127.94±6.92	121.25±6.94	126.56±10.38	1.10	0.346
Potassium (mmol/l)	2.98±6.92	2.90±0.42	3.13±0.41	0.29	0.753
Chloride (mmol/l)	94.29±5.71	93.75±2.22	97.78±7.07	1.18	0.322

KEY:
Hb: Haemoglobin; PCV: Packed cell volume, WBC: White cell cell; Neu: Neutrophils; Lym: Lymphocytes; Mon: Monocytes; Eos: Eosinophils; PLT: Platelets; ESR: Erythrocyte sedimentation rate.

Table 6: Correlation of ESR with PCV, Haemoglobin, Total WBC Count, Differential Count, Platelet Count Sodium, Potassium, and Chlorides in Asthmatic Patients.

There was a non-significant positive correlation of ESR with PCV, Haemoglobin, Total WBC count, Differential count, ESR, Platelet count Sodium, Potassium, and chlorides in asthmatic patients(r=0.25, p=0.187; r=0.24, p=0.184; r=0.56, p=0.222; r=0.29, p=0.769; r=0.87, p=0.489; r=0.86, p=0.478, r=0.84, p=0.441; r=0.65, p=0.752, r=0.93, p=0.961, r=0.28, p=0.548 and r=0.23, p=0.695).

Variable	N	r	p-value
PCV	30	0.25	0.187
Hb	30	0.24	0.184
WBC	30	0.56	0.222
Neu (%)	30	0.29	0.769
Lym (%)	30	0.87	0.489
Mon (%)	30	0.86	0.478
Eos (%)	30	0.84	0.441
PLT (cells/ µl)	30	0.65	0.752
Sodium (mmol/l)	30	0.93	0.961
Potassium (mmol/l)	30	0.28	0.548
Chloride (mmol/l)	30	0.23	0.695

Discussion

Asthma is a public health problem in all countries regardless of the level of development. Most asthma related deaths occur in low and lower middle income countries. Asthma is under - diagnosed and under- treated.

The present study revealed that the mean values of PCV and Hb were significantly lowered in asthmatic patients when compared to controls. A decrease level in packed cell volume and Hb concentration among asthmatic patients might be due to the fact that asthma affects erythropoietin production. Erythropoietin is the principal stimulator of erythropoiesis and is induced under hypoxic conditions. But studies by Leung, (2016), disagree with the result of this study. They reported that hypoxia elevates PCV, hence it is concluded that hypoxic conditions may provoke synthesis of more Hb and hence an increase in haemoglobin level in asthmatic patients. Certain factors such as treatment regimen, sample size and environmental factor might be a factor causing the disparity in results.

In this study, total WBC count was significantly increased in asthmatic patients when compared to the control group. Another similar study done in Assam Medical College and Hospital, India, reported significant difference in WBC count (Dihingia *et al*., 2013). The increase in WBC might be due to increased levels of neutrophils which have been reported by previous studies to be elevated in cases of asthma and eosinophils are increased in allergic condition.
The mean values of neutrophils and eosinophils were significantly higher in asthmatic patients as compared to the control groups in this study. The increase in eosinophil count in this study was consistent with previous similar studies, which

reported circulating eosinophils were elevated in asthmatic patients (Dihingia *et al*., 2013). These might be due to the fact that circulating eosinophils are elevated in patients with allergic conditions. It has been reported that eosinophils recruitment is being induced by exotaxin and the involvement of IL–4 and IL–13 in allergic reactions (Ogunbileje *et al*., 2015).

The current study showed mean lymphocyte count were significantly lower in asthmatic patients compared to the control group. This finding was supported by other previous study (Dihingia *et al*., 2013). This might be due to the fact that neutrophil influx and the subsequent neutrophil activation involve IL–8 mediation, which results in the activation of innate immune mechanisms rather than acquired immunity (Douwes *et al*., 2012). Also, neutrophils release anti-inflammatory cytokines such as IL-10 and TGF-ß, which can suppress lymphocyte proliferation and activity (Murphy and Weaver, 2017).

In this study, the mean value of monocyte count was low in asthmatic patients but the decrease was not significant when compared to controls. The result of this study was supported by previous studies which reported evidence for activation of alveolar macrophages, but not peripheral blood monocytes, among asthmatic patients (Viksman *et al*., 2017). This might be due to monocytes migration from the bone marrow to the inflamed tissue through the peripheral blood system and mature into macrophages, the functional cell of the lineage. Then, monocytes can produce a complex repertoire of cytokines and can actively participate in the pathogenesis of inflammatory diseases (Antonio *et al*., 2018).

The mean value of platelet count was higher in asthmatic patients when compared to the control group. Other studies reported that there was significantly high platelet cell count in asthmatic patients who were allergic, hospitalized and ambulatory patients in the Department of Internal Diseases at the Medical University of Bialystok (Kemona–Chetnik *et al*., 2017). The higher platelet count might be be due to platelet activation in asthma by exposure to allergens or inflammatory mediators like histamine, leukotrienes, and prostaglandins (Dworski et al., 1990).

Sodium, potassium and chlorides were significantly lower in asthmatic patients when compared to the controls. This might be due to the effects of airway inflammation, excessive mucus production, hyperventilation, and certain medications, and these electrolyte imbalances can occur in severe or poorly controlled asthma cases (Henderson et al., 2014; Woolcock et al., 1980 and Boucher, 2007).

The current study reveals that the mean value of ESR was significantly increased in patients with asthmatic condition when compared to controls. ESR is widely used as an indicator of acute-phase response in several immune-mediated inflammatory diseases, including asthma. The increase in ESR in asthma reflects an inflammatory activation or an acute-phase response, accompanied by raised levels of circulating pro-inflammatory cytokines and their receptors, which in turns causes an increase in ESR. This observation is consistent with the findings carried out by (Kemona–Chetnik et al., 2017) who stated that "disease activity in asthma is assessed by examining symptoms of inflammatory disease, functional status and various laboratory tests of immune activation, such as erythrocyte sedimentation rate (ESR). Though they noted that the ESR is not diagnostic of any particular disease, it is an inexpensive and a practical indicator of response of acute phase proteins in plasma Beighton et al., (2015).

There was no significant difference in the mean values of PCV, haemoglobin, total WBC count, differential count, ESR, platelet count, sodium, potassium, and chlorides in asthmatic patients when compared based on gender and age. The result clearly indicates that age and gender do not have any effect on haematological parameters and electrolytes level in asthmatic patients. The result of this study is in agreement with the study carried out by Dihingia *et al*., (2013), who reported a similar finding.

This study showed a non - significant positive correlation of ESR with PCV, haemoglobin, TWBC, neutrophils, lymphocytes, monocytes, eosinophils. platelets, sodium, potassium and chlorides in asthmatic patients. This indicates that no relationships exist among them in asthmatic condition.

Conclusion

This study has shown that haematological parameters such as, PCV, haemoglobin, TWBC, neutrophils, lymphocytes, eosinophils, ESR, sodium, potassium, and chlorides are altered in asthmatic patients, but age and gender do not affect the levels of these parameters in asthmatic condition.

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