Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jptcp.v30i7.2614

''TO EVALUATE ACID-BASE DISTURBANCES IN ACUTE DIARRHEAL ILLNESS'

Dr. Divya[1*], Dr. Sanjay Dhawale[2], Dr. Ragini Tarole[3], Dr. Seema[4]

[1*]Junior Resident, Department Of General Medicine, Grmc Gwalior
[2]Professor, Department Of General Medicine, Grmc Gwalior
[3]Junior Resident, Department Of General Medicine, Grmc Gwalior
[4]Senior Resident, Department Of General Medicine, Ssmc Rewa.

***Corresponding Author:** Dr. Seema
***** Senior Resident, Department Of General Medicine, Ssmc Rewa.

Abstract-

Introduction- Diarrhea can cause a variety of fluid volume, acid-base and electrolyte abnormality which can cause disruption of various organs functioning and also complicate the disease itself to contribute it to morbidity and mortality.

Maintenance of Acid- base balance requires the cooperation of three major organs: liver, kidneys and lungs. So, it can be said that the disease of these organs can contribute to an important proportion of acid- base disturbances.

Aims and objectives- Main aim of study is **''To evaluate acid-base disturbances in acute diarrheal illness''.**

An observational study was conducted on 96 patients admitted in general ward at Department of Medicine, G.R. Medical College and JAH Group of hospitals, Gwalior. These patients were assessed at the time of admission by a detailed history taking and duration of illness also giving due importance to comorbidities like diabetes, chronic renal disease, COPD, any drug history, etc. A thorough clinical examination was done for patients which included general examination, vitals, and other systemic examinations.

Results- Among the studied 96 patients, maximum cases belong to the two age groups 20-29 years and 40-49 years with mean age 40.08. Out of studied 96 patients, 50 were males and 46 were females. Among diarrheal illness patients, 88 were having duration of illness <7 days and 8 patients were having duration ≥ 7days. Out of 96 patients, 56.3% of study participants were severely dehydrated, 28.1% were moderately dehydrated and only 15.6% were mildly dehydrated. Among diarrheal illness patients, it was observed that Sinus tachycardia, sinus tachycardia with U wave and with flat T wave was found statistically associated. Majority of ECG changes were found in severely dehydrated patients. Out of 96 patients, it was found that 31.3% participants were having metabolic acidosis and only 6.3% were having high anion gap in ABG analysis.

Conclusion- The most common acid-base abnormality apart from normal ABG study, observed in patients with acute diarrheal disease is NORMAL ANION GAP METABOLIC ACIDOSIS. Increased anion gap metabolic acidosis is the acid-base abnormality observed in post diarrheal ARF. In acute diarrheal illness and post diarrheal acute renal failure, metabolic acidosis is a prognostic factor and its outcome can be improvedwith early recognition and correction.

INTRODUCTION

Diarrhea can cause a variety of fluid volume, acid-base and electrolyte abnormality which can cause disruption of various organs functioning and also complicate the disease itself to contribute it to morbidity and mortality.

Maintenance of Acid- base balance requires the cooperation of three major organs: liver, kidneys and lungs. So, it can be said that the disease of these organs can contribute to an important proportion of acid- base disturbances.

The present study aims to evaluate various acid- base disturbance in its homeostasis in the patients of acute diarrheal illness.

Metabolic acidosis is the most characteristic acid- base disorder known to occurs in patient with diarrhea. The pathophysiology says, that the loss of bicarbonate stores through diarrhea or renal vascular wasting leads to a metabolic acidosis state characterized by increased plasma chloride concentration and decreased plasma bicarbonate concentration.

AIMS AND OBJECTIVES

This observational study done in department of medicine in J. A. Group of hospitals,Gajra Raja Medical College, Gwalior on an inpatient basis, after ethical committee approval. This study was conducted over a period of 18 months (January 2021 –June 2022), in 96 patients. Main aim of study is **''To evaluate acid-base disturbances in acute diarrheal illness''**

MATERIALS AND METHODS

INCLUSION CRITERIA

- Patients older than 1 years of age, who presented with acute diarrhea were included.
- Acute diarrhea with duration less than 14 days, both sexes were included.

EXCLUSION CRITERIA

- Patients who had coexisting diseases which likely produces respiratory acidosis in ABG like COPD or other lung diseases, or underlying liver diseases, and kidney diseases were excluded because these diseases themselves produces ABG abnormalities.
- Patients who were taking drugs which likely produces acid-base abnormalities were excluded. Example. Acetazolamide, spironolactone, metformin, cotrimoxazole, cholestyramine, calcium chloride, triamterene.

METHODS OF DATA COLLECTION

Patients of acute diarrheal illness were selected for our study whichsubjected to:

1. Detailed history taking clinical examination at admission.
   Relevant history and physical examination including symptoms of diarrhoea, signs of dehydration and other finding were recorded.
2. Hematological and biochemical workup included the measurement of haemoglobine, total leucocyte count, platelet count,serum urea, serum creatinine, serum sodium, serum potassium, serum chloride. In all patients, routine urine analysis for sugar, albumin deposits were done.
3. If any patient was found to have renal failure (defined as serum creatinine >2mg%) serial measurements were made as appropriate and after treatment.

STATISTICAL ANALYSIS

The results are analysed using SPSS software version 2.0 and shallbe generated by Microsoft Excel and Word.

Associations between variables were analysed using chi-square test. The primary association expected was severe metabolic acidosis and severe dehydration with electrolyte imbalance and severity of diarrhoea. A p value of less than 0.05 considered statistically significant.

OBSERVATIONS AND RESULTS

Results

Table 1 Demographic profile of study participants

Demographic profile		**Frequency**	**Percent**
Age Groups	<20 Year	15	15.6
	20-29 Year	18	18.8
	30-39 Year	11	11.5
	40-49 Year	18	18.8
	50-59 Year	14	14.6
	60-69 Year	15	15.6
	≥79 Year	5	5.2
Gender	Female	50	52.1
	Male	46	47.9
Duration	<7 days	88	91.7
	≥7 days	8	8.3
Total		96	100

In present study 20 year to more than 80-year participants were enrolled and all age group had almost similar around 15% of participation. Gender wise almost equal participation of male and female having history of acute diarrheal disease.

Table 2: ABG findings

ABG readings		**Frequency**	**Percent**
ABG nterpretation	Normal	66	68.8
	Metabolic Acidosis	30	31.3
Anion Gap	High	6	6.3
	Normal	90	93.8
Total		96	100

In ABG analysis 31.3% participants were having metabolicacidosis and only 6.3% were having high anion gap.

Table-3 Durationof dehydration study participants

Duration ofacute diarrheal disease	Dehydration			Total	P value
	Mild	Moderate	Severe		
	N (%)	N (%)	N (%)		
<7 days	15 (100%)	27 (100%	46 (85.2%)	88 (91.7%)	0.034
≥7 days	0 (0%)	0 (0%)	8 (14.8%)	8 (8.3%)	
Total	15 (100%)	27 (100%	54 (100%)	96 (100%)	

Severe dehydration (14.8%) was found significantly higher inpatients with ≥ 7 days of acute diarrheal disease.

Table 4: Association between categories of dehydration andElectrolytes

Electrolyte		Dehydration			Total	P value
		Mild	Moderate	Severe		
		N (%)	N (%)	N (%)		
SerumUrea	<20 mg% (below normal)	4 (26.7%)	1 (3.7%)	0 (0%)	5 (5.2%)	<0.001
	20-45 mg% (normal)	10 (66.7%)	22 (81.5%)	29 (53.7%)	5 (5.2%)	
	>45mg% (above normal)	1 (6.7%)	4 (14.8%)	25 (46.3%)	16 (16.7%)	
Serum Creatinine	<0.70	9 (60%)	13 (48.1%	16 (29.6%)	38 (39.6%)	0.109
	0.70-1.30	6 (40%)	13 (48.1%	31 (57.4%)	50 (52.1%)	
	>1.30	0 (0%)	1 (3.7%)	7 (13.0%)	8 (8.3%)	
Serum Sodium	<136	9 (60%)	15 (55.6%)	50 (92.6%)	74 (77.1%)	0.001
	136-145	6 (40%)	11 (40.7%	4 (7.4%)	21 (21.9%)	
	>145	0 (0%)	1 (3.7%)	0 (0%)	1 (1%)	
Serum Potassium	<3.6 mg% (below normal)	4 (26.7%)	13 (48.1%	39 (72.2%)	56 (58.3%)	0.003
	3.6-5.0 mg% (normal)	11 (73.3%)	14 (51.9%)	15 (27.8%)	40 (41.7%)	
Serum Calcium	<09mg% (below normal)	0 (0%)	4 (14.8%)	10 (18.5%)	14 (14.6%)	0.104
	9-11 mg% (normal)	10 (66.7%)	21 (77.8%)	37 (68.5%)	68 (70.8%)	
	>11mg% (above normal)	5 (33.3%)	2 (7.4%)	7 (13.0%)	14 (14.6%)	

Serum Urea, Serum sodium and potassium was found statistically associated with severity of dehydration and Serum creatinine and serum calcium had shown no statistical association. 46.3 % of participants were presented with raised serum urea level with severe dehydration similarly, Serum sodium and potassium was found below the normal value in 92.6% and 72.2% severely dehydrated participants respectively.

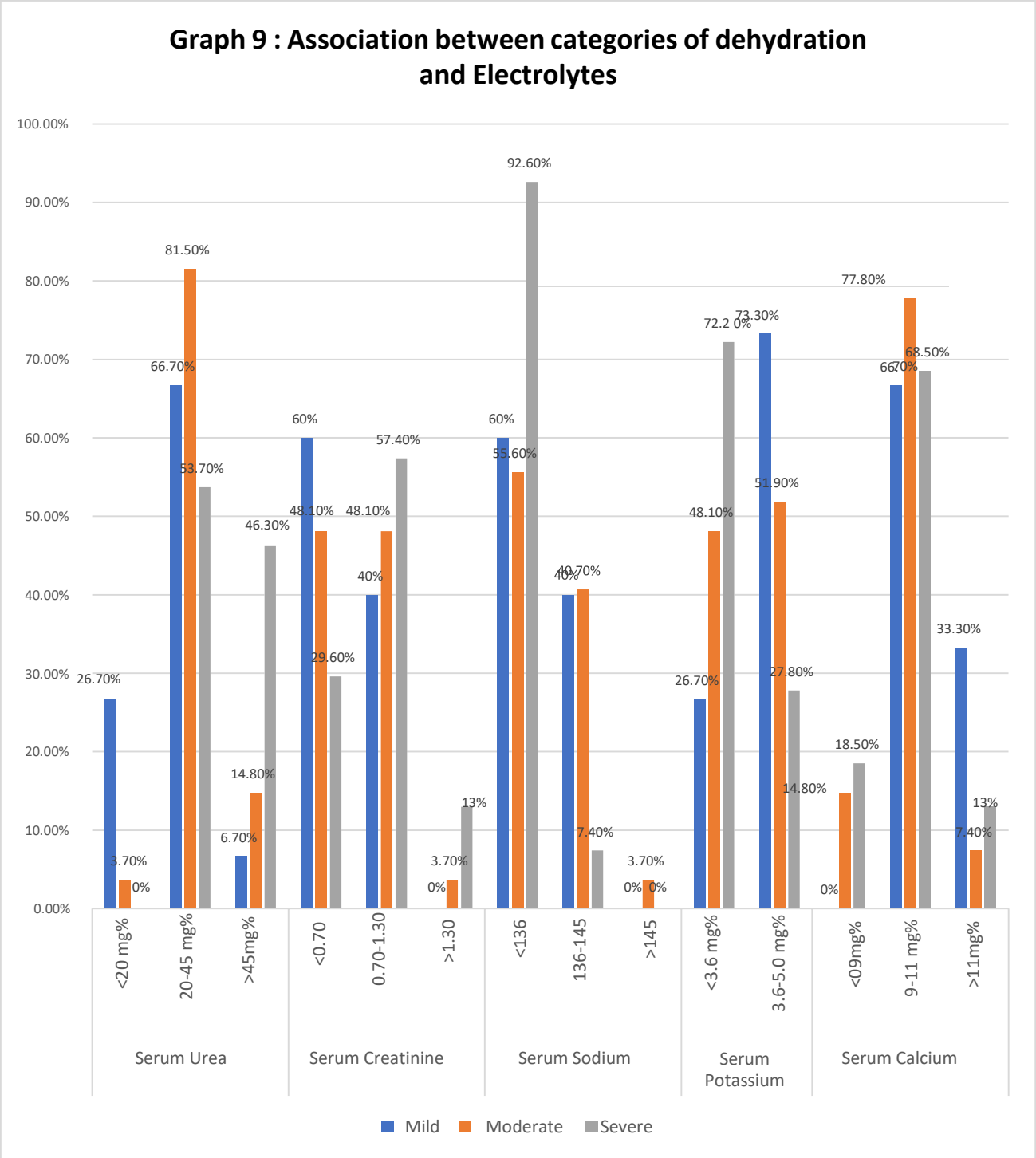
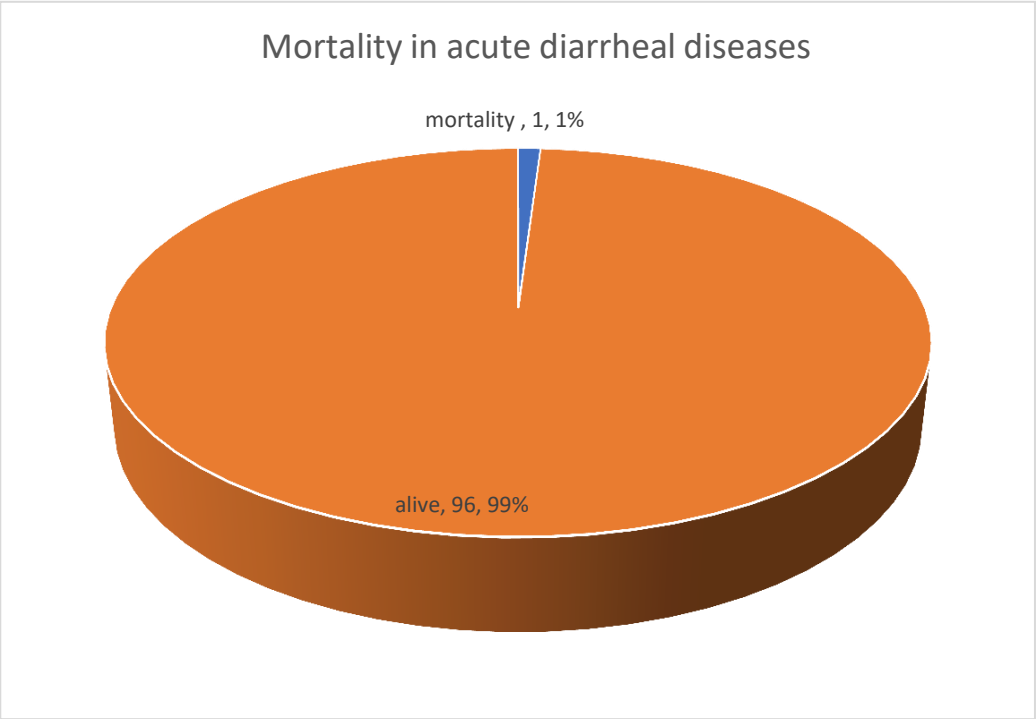


Table 5: Mortality in acute diarrheal diseases

Total No ofparticipants	**Mortality**	**%**
96	1	1.04%



DISCUSSION

An observational study was conducted on 96 patients admitted in general ward at Department of Medicine, G.R. Medical College and JAH Group of hospitals, Gwalior. These patients were assessed at the time of admission by a detailed history taking and duration of illness also giving due importance to comorbidities like diabetes, chronic renal disease, COPD, any drug history, etc. A thorough clinical examination was done for patients which included general examination, vitals, and other systemic examinations. Patients were also categorized according to hydration status into mild, moderate and severe using system adopted from Mandell, Douglas Text Book on Principles and Practice of Infectious Diseases

Out of 96 patients of acute diarrheal illness, 50 were females and 46 were males. The mean duration of diarrhea at presentation was less than 3 days.

Among the 96 patients studied 4 patients (2 Men &2 Women) had renal failure (serum creatinine more than 2mg%) at initial presentation to the hospital (25). The mean duration of diarrhea on admission, in this population was 3 days. None of the patients developed renal failure after admission to hospital.

The ABG values of all 96 patients were interpreted in a systematic way as previously described.

I. ACID BASE CHANGES OCCURRING IN ACUTEDIARRHEA

The following 3 types of Acid-Base changes were observed on analyzing the ABG values of all 96 patients:

1. Normal ABG study
2. Normal anion gap metabolic acidosis
3. Increased anion gap metabolic acidosis

Out of the 96 patients studied, 66 patients had a normal ABG values, 24 patients had a normal anion gap metabolic acidosis, 6 patients had increased anion gap metabolic acidosis.

Hence it is shown that, though normal ABG study was found to be prevalent in maximum number of patients but NORMAL ANION GAP METABOLIC ACIDOSIS IS THE MOST COMMON ACID-BASE

ABNORMALITY in acute diarrheal illness.

The reason for a normal anion gap metabolic acidosis, as describedpreviously is loss of bicarbonate in diarrheic stools.

The other findings noted in this population of patients included

i. Hyperchloremia findings (Sr. Chloride > 105 m Eq/L) **Rudman etal**.
ii. Normal Na+ and K+ values in maximum patients.
iii. A less severe acidosis (i.e., pH > 7.20) in most (22 out of 24) patients
iv. Expected range of respiratory compensation.

Hyperchloremia occurring in this population was a compensatory response to loss of bicarbonate in stools, so as to maintain the electro neutrality of Extra Cellular Fluid (ECF) (Hence referred to as HYPERCHLOREMIC ACIDOSIS) **Zalunardo et al, Wang F Butler et al**., [20]. Even though serum sodium and potassium levels were normal, hypokalemia can also be anticipated, because patients with acute diarrheal disease lose potassium through GIT. Likewise, abnormalities in serum sodium levels can also be anticipated.

22 out 24 patients had a pH above 7.20 and all had respiratory compensation in the expected range.

The next common acid-base-disturbance observed was an increased anion gap metabolic acidosis (6 patients).

A patient with acute diarrheal illness can develop increased anion gap metabolic acidosis for the following reasons.

i. Development of renal failure with retention of acidic anions like sulphate, phosphate etc.
ii. Lactic acidosis occurring as a result of tissue hypoperfusion.
iii. Keto acidosis due to starvation.

All patients in this group were evaluated with the abovepossibilities in mind.

It was observed that all 4 patients had renal failure (Sr. creatinine >

2.0 mg%) and their urine tested negative for ketones.

During this study , maximum number of patients exhibited wasnormal ABG study in acute diarrheal illness (66 patients).

The following 3 possibilities must be considered when oneencounters a normal ABG analysis in acute diarrhea :

All 66 patients who had normal ABG study were clinically suffering from a milder to moderate degree of diarrhea and dehydration and vomiting was not a prominent manifestation. So, a milder diarrheal illness may be postulated as the reason behind the normal ABG study, than a mixed acid base disorder.

No significant difference in the clinical presentation of each of the3 groups of patients could be noted.

II. ACID BASE CHANGES IN ARF DUE TO ACUTE DIARRHEA

This study also aims to analyse the acid-base changes that occur inpatients developing renal failure due to acute diarrhea also which was also analysed by a study conducted by **Shivkumar et al**.

Among the 96 patients studied 4 patients had renal failure at presentation to hospital.

All 4 patients demonstrated a HIGH ANION GAP METABOLIC ACIDOSIS. 3 out of 4 patients had severe metabolic acidosis (pH < 7.2), **Thomas et al**.

In all 4 patients urine tested negative for acetone and 48 serum albumin was normal.

III. INCIDENCE OF SEVERE METABOLIC ACIDOSIS

It was found that 9 out of 96 patients with acute diarrhea had a severe metabolic acidosis i.e., pH < 7.2 in ABG study, similar resultswere also conducted by **Mara Nitu et al**. Hence the incidence of

severe metabolic acidosis in patients with acute diarrhea was 8.64%. Among these 9 patients; 4 patients had renal failure and 5 patients had normal renal function. Hence severe metabolic acidosis occurred in both groups of patients with acute diarrhea (i.e., patients with renal failure and patients with normal renal function), also shown by a study conducted by **V. K .Praveen Kumar et al**.

CONCLUSION

The most common acid-base abnormality apart from normal ABG study, observed in patients with acute diarrheal disease is NORMAL ANION GAP METABOLIC ACIDOSIS.

Other acid-base patterns observed include increased anion gap metabolic acidosis.

A normal ABG must be interpreted in the clinical context because mixed acid base disorders may produce normal values in ABG analysis.

Increased anion gap metabolic acidosis is the acid-base abnormality observed in post diarrheal ARF.

In acute diarrheal illness and post diarrheal acute renal failure, metabolic acidosis is a prognostic factor and its outcome can be improved with early recognition and correction.

REFERENCES

1. Acute Diarrheal Disease, Epidemiology of Communicable Diseases – 25th edition, ``PARKS TEXT BOOK OF PREVENTIVE AND SOCIAL MEDICINE``.
2. Diarrhea – B.S. Ramakrishna, Gastroenterology, 12th Eiditon, ``API TEXT BOOK OF MEDICINE``.
3. Hydrogen Ion Concentration ``INTERPRETATION OF BLOOD GASES`` ``ROBERT L.WILKINS, 7th Edition, Clinical Assessment in Respiratory Care`` by Wilkins, Krider and Sheldon.
4. Introduction to Acid Base Physiology – 7. ``Understanding Acid Base Balance`` by Benjamin Abelow M.D.,
5. Transport of oxygen and Carbondioxide in Blood and Body Fluids– 40. `TEXT BOOK OF MEDICAL PHYSIOLOGY`` - 14thEdition, Guyton and Hall.
6. ``Understanding Acid Base Balance`` by Benjamin Abelow M.D., .Acidosis and Alkalosis– 42,Thomas B. Dubose JR. ``HARRISONS PRINCIPLES OF INTERNAL MEDICINE`` Volume 1, 20th Edition.
7. Buffering of Hydrogen Ions in Body Fluids, Regulation of Acid Base Balance – 30, `TEXT BOOK OF MEDICAL PHYSIOLOGY``- 14th Edition, Guyton and Hall.
8. Role of the Kindeys in Acid Base Balance, Urinary Stones, Nephrocalcinosis and Renal Tubular Acidosis – 20.13 Robert J. Unwin William G. Robertson. ``OXFORD TEXT BOOK OF MEDICINE`` 5th Edition.
9. Acute Renal Failure due to Acute Diarrheal Diseases –S. Shivakumar, M.A. Muthusethupathi, JAPI Vol.38. Feb-1990.
10. Gastrointestinal causes of Metabolic Acidosis, Chapter 16,``UNDERSTANDING ACID BASE BALANCE`` by BenjaminAbelow M.D.,
11. Clinical Acid-Base Disorders – 2.6. by Biff. F.Palaer, Robert G. Narins and Jerry Yee in ``OXFORD TEXT BOOK OF CLINICAL NEPHROLOGY`` 5th Edition, Volume-1.
12. Metabolic causes of Metabolic Acidosis by Benjamin Abelow in`` UNDERSTANDING ACID BASE BALANCE`` by BenjaminAbelow.
13. Metabolism of Ketone Bodies, in Chapter – 13, Lipids – Part II, ``TEXT BOOK OF BIOCHEMISTRY`` Vasudevan, 10th Edition.
14. Clinical Acid-base Disorders – 2.6. by Biff. F.Palaer, Robert G. Narins and Jerry Yee in ``OXFORD TEXT BOOK OF CLINICAL NEPHROLOGY`` 5th Edition, Volume-1.
15. Disorders of Hydrogen Ion Homeostasis – In ``CLINICAL CHEMISTRY``- 5th Edition by William J. Marshall and Stephen K. Bengert.
16. Interpretation of Arterial Blood Gases, Chapter 6, by Robert L. Wilkins in ``CLINICAL ASSESSMENT IN RESPIRATORY CARE`` 4th Edition, Wilkins, Krider and Sheldon.
17. Acid-Base Disturbances in ``THE WASHINGTON MANUAL OF MEDICAL

THERAPEUTICS`` 36th Edition.
18. Limitations of Compensation for Acid Base Disorders in Interpretation of Arterial Blood Gases, Chapter 6, by Robert L.WILKINS,8th Edition, ``CLINICAL ASSESSMENT IN RESPIRATIORY CARE`` by Wilkins, Krider and Sheldon.
19. ``Anion Gap`` in Acidosis and Akalosis by Thomas D. Dubose, JR. in 20th Edition HARRISON'S PRINCIPLES OF INTERNAL MEDICINE Volume 1, 20th Edition.
20. . Metabolic Acidosis in Acid-base disturbances in ``THE WASHINGTON MANUAL OF MEDICAL THERAPEUTICS``31st Edition.
21. Treatment of Metabolic Acidosis. Thomas D. Dubose, JR. in 19th Edition, HARRISON'S PRINCIPLES OF INTERNAL MEDICINE Volume 1, 19th Edition.
22. Base Excess and Base Defecit, ``CLINICAL ASSESSMENT IN RESPIRATORY CARE`` 4th Edition, Wilkins, Krider and Sheldon.
23. Arterial Blood Sampling ``CLINICAL ASSESSMENT IN RESPIRATORY CARE`` 4th Edition, Wilkins, Krider and Sheldon.
24. Acute Renal Failure due to Acute Diarrheal Diseases –S. Shivakumar, M.A. Muthusethupathi, JAPI Vol.38. Feb-1990.
25. Metabolic Acidosis in Renal Failure, Acidosis and Akalosis by Thomas D. Dubose, JR. in 20th Edition HARRISON'S PRINCIPLES OF INTERNAL MEDICINE Volume 1, 20thEdition.
26. ``ACID BASE CHEMISTRY AND BUFFERING`` by Madias NE.
27. Halpern ML. ``BIOCHEMISTRY AND PHYSIOLOGY OF AMMONIUM EXCRETION``. Chapter 76 in ``THE KIDNEY`` by knepper MA.
28. Winter SD. The fall of serum anion gap. Arch. Internal Medicine 1990; 150:311-313.
29. ``Mixed-Acid Base Disorders, Clinical Examples`` Harrington JT. Allen S. J., Okoko B., Martinez E., Gregorio G., Dans L. F. Probiotics for Treating Infectious Diarrhea. Cochrane DatabaseSystematic Reviews. 2004;(2):CD003048. [PubMed]
30. Peter G., Myers M. G. the National Vaccine Advisory Committee, and the National Vaccine Program Office. . Intussusception, Rotavirus, and Oral Vaccines: Summary of a Workshop. Pediatrics. 2002;110:e67. [PubMed]
31. Ronsmans C., Bennish M. L., Wierzba T. Diagnosis and Management of Dysentery by Community Health Workers. Lancet. 1988;8610:552–55. [PubMed]
32. Ruxin J. N. Magic Bullet: The History of Oral RehydrationTherapy. Medical History. 1994;38:363–97. [PMC free article] [PubMed]
33. Ryan E. T., Calderwood S. B. Cholera Vaccines. ClinicalInfectious Diseases. 2000;31:561–65. [PubMed]
34. Salam M. A. Antimicrobial Therapy for Shigellosis: Issues on Antimicrobial Resistance. Japanese Journal of Medical Science andBiology. 1998;51(Suppl.):S43–62. [PubMed]
35. Santos ., Victora C. G., Martines J., Goncalves H., Gigante D. P., Valle N. J., Pelto G. Nutrition Counseling Increases Weight Gain among Brazilian Children. Journal of Nutrition. 2001;131:2866–73. [PubMed]
36. Snyder J. D., Merson M. H. The Magnitude of the Global Problem of Acute Diarrhoeal Disease: A Review of Active Surveillance Data. Bulletin of the World Health Organization. 1982;60:604–13. [PMC free article] [PubMed]
37. Tucker A. W., Haddix A. C., Bresee J. S., Holman R. C., Parashar U. D., Glass R. I. Cost-Effectiveness Analysis of a Rotavirus Immunization Program for the United States. Journal of the American Medical Association. 1998;279:1371–76. [PubMed]
38. Victora C. G., Bryce J., Fontaine O., Monasch R. Reducing Deaths from Diarrhoea through Oral Rehydration Therapy. Bulletin of the World Health Organization. 2000;78:1246–55. [PMC free article] [PubMed]
39. WHO (World Health Organization). 1997. *Health and Environment in Sustainable Development Five Years after the Health Summit*. WHO/EHG/97.8. Geneva: WHO.