Methanol Poisoning in Various Counties of Kenya, 2014

Onesmus Maina Muchemi[1,3*], Alfred Wandeba Wanyonyi[1,3] Allan F. Ogendo[2,3], Kadondi Kasera[1,3], Gachari Wilson[1], Waqo Boru[1,3], Tura Galgalo[3,4]

1. Ministry of Health, Kenya.
2. Ministry of Agriculture, Livestock and Fisheries, Kenya.
3. Field Epidemiology and Laboratory Training Program (FELTP, Kenya)
4. Africa Epidemiology Network (AFENET)

[*]**Corresponding authors: onesmuchemi@yahoo.com, wandeba@gmail.com**

***Abstract*- Background:** Methanol poisoning is the toxicity that results from ingestion, inhalation or absorption of methanol. Methanol toxicity remains a public health problem in many parts of the developing world, including Kenya. An outbreak was notified to the disease surveillance and response unit, Kenya in May 2014. FELTP, Kenya was requested to carry out the investigation.

Methods: We conducted a cross-sectional study between 28th May and 12th June 2014, to describe the distribution of the methanol poisoning cases, to assess methanol case management in affected facilities and to assess the disaster and emergency preparedness of the affected counties. A case was defined as a person who had consumed illicit brew or presented with signs and symptoms clinically compatible with methanol poisoning in Embu, Makueni, Kitui, Nakuru, Narok, Nyandarua and Kiambu Counties within 72 hours after consuming illicit brew in the month of May 2014.

Data was obtained through retrospective review of health records, key informant interviews and case tracing. Epi Info 7 was used for data analysis.

Results: We enrolled 278 cases of whom 106 (38%) were traced. Sixty-eight had died constituting a case fatality rate of 27 %. Males constituted 253(91%) and 80(53%) were married. The mean age of the patients affected was 37±12 years. Ninety (32%) were from Embu County. Two hundred fifty-six (92%) cases had sought medical attention, the main presentation being abdominal pain (41%, n=105). Cases were mainly treated with intravenous fluids (75%, n=193) and ethanol (53%, n=138). Eight facilities (67%) detected the outbreak through abnormal number of cases or deaths received at outpatient. The main responses involved health education campaigns (67%, n=8), mobilization of emergency supplies (50%, n=6) and coordination (42%, n=5).

Conclusion: Methanol poisoning is problem of public health importance in Kenya. There are no guidelines, flow charts and protocols to harmonize case detection, diagnosis and management and linkages to rehabilitation services. Preparedness and response to disasters is fair across facilities.

We therefore recommend health education and behavior change communication in affected counties; technical support from the disaster preparedness unit during disasters and emergencies, establishment of guidelines, flow charts and protocols to harmonize case detection, diagnosis, management and rehabilitation of cases.

***Index Terms*-** Methanol, Poisoning, Counties, Kenya,

I. Introduction

Methanol poisoning is the toxic effect of ingestion, inhalation, or absorption through the skin of methanol (methyl alcohol, wood alcohol) that may impair the central nervous system; causing severe acidosis, blindness, and shock; and result in death(1).Methanol is a constituent of many commercially industrial solvents and of poorly adulterated alcoholic beverages(2). Almost all cases of methanol toxicity result from ingestion, though rarely, cases have followed inhalation or dermal absorption. When ingested, absorption is rapid and peak methanol concentrations occur within 30-60 minutes. Methanol itself is harmless, but becomes toxic when converted in vivo into formaldehyde and formic acid. Methanol is oxidized by alcohol dehydrogenase to formaldehyde which is further oxidized to formic acid by formaldehyde dehydrogenase. Final breakdown of formic acid facilitated by 10-formyl tetrahydrofolate synthetase produces carbon dioxide and water. The acidosis that occurs in methanol poisoning appears to be caused directly or indirectly by formic acid. There is a direct correlation between formic acid concentration and increased morbidity and mortality (3). The prognosis of methanol poisoning is dependent on the amount ingested and the subsequent degree of metabolic acidosis(2).

According to WHO, 3.3 million die every year due to harmful use of alcohol, representing 5.9% of all deaths(4). Global, regional and country estimates of methanol poisoning burden are not documented, but methanol toxicity remains a common problem in many parts of the developing world especially among members of lower socio-economic classes. Recent outbreaks have been reported in Cambodia, Czech Republic, Ecuador, Estonia, India, Indonesia, Kenya, Libya, Nicaragua, Norway, Pakistan, Turkey and Uganda. The size of these outbreaks has ranged from 20 to over 800 victims, with case fatality rates of over 30% in some outbreaks (5).

Mass methanol poisonings occur when methanol is added to illicit alcoholic drinks. Such outbreaks can rapidly overwhelm health facilities. High concentrations of methanol arise when distillation process is not well managed, but more importantly when methanol is added to fortify informally-produced spirits and counterfeit alcoholic drinks. Often such drinks are sold in unlabeled containers or made to appear legitimate through bottle design and labelling such that consumers falsely believe that they are genuine alcoholic drinks. These alcoholic drinks are often cheap and therefore attractive to the low socio-economic class. Often victims delay in seeking medical care mainly because there is a latent period between ingestion and onset of toxic effects. Late presentation contributes to the high levels of morbidity and mortality experienced with methanol poisoning outbreaks(5).

Methanol typically induces nausea, vomiting, abdominal pain and mild central nervous system depression. There is often a latent period lasting approximately 12-24 hours depending on methanol dose ingested following which an uncompensated metabolic acidosis develops and visual function is impaired ranging from blurred vision, altered visual fields to complete blindness (3). The toxic dose of methanol varies between individuals. A blood concentration of more than 500mg/l is associated with severe toxicity while concentrations above 1500-2000mg/l will lead to death in untreated patients (6). Humans have limited ability to detoxify formic acid and this metabolite therefore accumulates and causes toxic effects. Co-ingestion with ethanol delays metabolism, delaying the onset of toxicity (7). Onset of toxicity often begins with drowsiness; the victim becomes unsteady and disinhibited. This is often ignored since it occurs in the context of drinking alcohol. Victims may thereafter experience hyperventilation and feeling of breathlessness. Coma, convulsions and finally death may result from respiratory arrest (6)

Diagnosis can be made by measuring the amount of methanol in blood, although this may not be available in most treatment centres. Presence of methanol increases the osmolality of blood as does ethanol. As poisoning progresses, the concentration of methanol in blood slowly decreases and that of its metabolites including formic acid begin to rise. Metabolic acidosis with high anion gap is the chemical characteristic of methanol poisoning upon biochemical analysis. It is often easier to measure formic acid during diagnosis than methanol (8). In summary, diagnosis can be made from history, presenting signs and symptoms, metabolic acidosis, elevated anion gap, elevated osmolar gap, presence of methanol and formic acid in serum assay (6).

The main therapeutic principles include prevention of further breakdown of methanol, correction of metabolic acidosis and supportive care. Specific therapeutic measures include correction of the metabolic acidosis with intravenous sodium bicarbonate and administration of enteral or parenteral ethanol or Fomepizole to competitively inhibit the metabolic breakdown of methanol to formic acid (2). Fomepizole, a potent Alcohol Dehydrogenase Inhibitor has largely replaced the antidotal ethanol use in France and two prospective U.S. trials definitely established its efficacy. Fomepizole appears safer than ethanol and is therefore recommended as the first-line antidote. However, ethanol is cheaper in comparison with the relatively high cost of Fomepizole. Administration of folic or folinic acid enhances the metabolism of formic acid. The summary below shows the basic antidotes that may be useful at the different phases of methanol metabolism (9)**Figure 6**. Intubation for mechanical ventilation and hemodialysis removes the toxic metabolites (3).

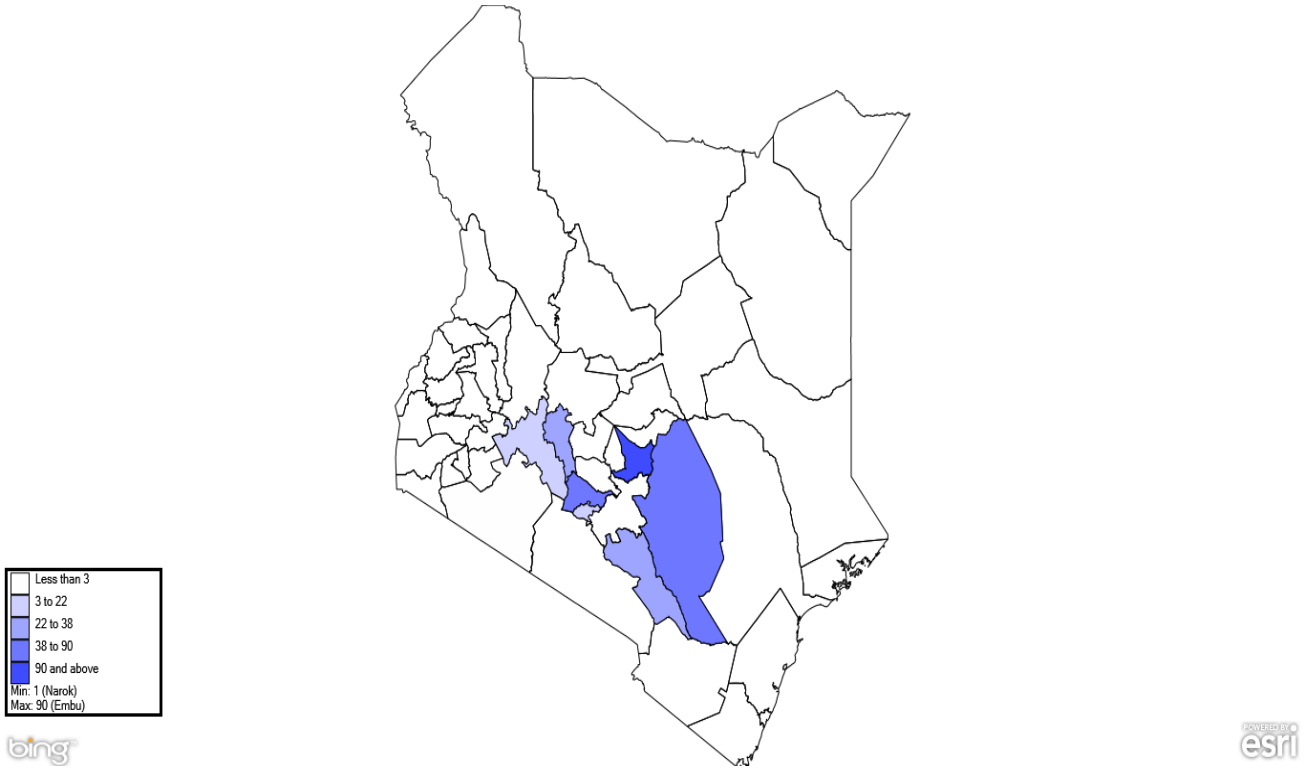
During methanol poisoning outbreaks, occurrence of more than three cases in one area within 24 hours is considered an outbreak. Rapid diagnosis of methanol poisoning incidence and public information through local media is important in prevention of methanol poisoning morbidities and mortalities. Active case finding is necessary to access at risk patients who, otherwise, would not access a hospital. This is performed in consultation with the patients and their relatives (9).

Methanol poisoning is a problem of public health concern in Kenya. It occurs frequently among young adult single males who are primary school dropouts, mainly casual manual workers whose main aim of drinking is to release stress. Several outbreaks have occurred often with fatal mortality and other associated complications. In August 1998, more than 80 people died in Nairobi after drinking ‘chang’aa’; in November 2000, 512 people were admitted in Kenyatta National Hospital, of whom 137 died, 20 lost sight; in July 2005, 50 people in Machakos died after consuming Chang’aa. These episodes have occurred especially when desperate brewers intentionally substitute methanol containing substances for ethanol (10). Twelve people died in Nairobi’s *Shaurimoyo* estate in April 2010, 5 died in *Thindigua*, Kiambu County in July 2010, 23 died in *Kibera*, Nairobi in August 2010, and 5 died in Laikipia County in August 2010. In Kenya, alcohol is regulated by NACADA authority under the Alcoholic drinks control Act of 2010. The body regulates production, manufacture, sale, labelling, promotion, sponsorship and consumption of alcoholic drinks (11).

One of the largest outbreaks occurred in the month of May 2014 after consumption of illicit brew in Embu, Kitui, Makueni, Nakuru, Nyandarua and Kiambu counties, where 155 cases were reported. The directorate of preventive and promotive health services through Disease surveillance and response unit was notified of the outbreak. The unit requested FELTP team to carry out the investigation. The aim of the investigation was to describe the methanol poisoning cases, assess the case management of victims, and evaluate the emergency and disaster preparedness of affected counties.

II. MATERIALS AND METHODS

Study sites



Study design: A cross-sectional study was carried out involving a retrospective review of medical records and administration of questionnaire to key informants including health workers, friends, relatives of cases that had died and survivors.

Case definition: During the investigation, a case was defined as follows: A person who had consumed illicit brew or presented with signs and symptoms clinically compatible with methanol poisoning in Embu, Makueni, Kitui, Nakuru, Narok, Nyandarua and Kiambu Counties within 72 hours after consuming illicit brew in the month of May 2014.

Sampling

All cases meeting the case definition criteria were included in the study.

Data collection

A semi structured questionnaire with three sections was used to collect data. The first section constituted retrospective records review; where data was extracted regarding onset of illness after consumption of illicit brew, the clinical presentation of the patient, the provisional diagnosis that was made by the clinician, the type of laboratory investigations carried out and their results, the case management and the outcome. The next section was a key informant interview; where health providers particularly in charge of disaster preparedness and response or heads of health management teams were asked questions relating to disaster preparedness and response. The questions entailed outbreak detection methods and criteria, interventions made during the previous outbreak and assessment of existing emergency preparedness and response plans. Lastly, methanol case tracing; was conducted to interview survivors and proxies in situations where the case patients had died or migrated to a far location. The area public health officer, coupled with the chief and the community health workers (CHWs) were used to trace the households of the cases. Data was collected on alcohol consumption preceeding the incident, whether the victim became ill after consumption of the illicit brew, the quantity consumed and the type of brand that had been consumed.

Data analysis

Data was entered in preformed Epi Info version 7 make views daily. The resulting database was cleaned for inconsistencies then analysed. Descriptive analysis was done using count and summarized by proportions.

III. RESULTS

1.0 Descriptive epidemiology of the cases enrolled

A total of 278 cases were enrolled in the study during the investigation in the period between 28th May and 12th June 2014. A hundred and six (38%) of the cases were traced, these were distributed as follows: 15 (19%) in Kiambu, 49(54%) in Embu, 14(39%) in Makueni, 15(39%) in Kitui, 4(50%) in Nakuru and 9(41%) in Nyandarua County. Of the cases enrolled, males constituted 91% (n=253). The contributions of the counties was as follows: 90 (32%) were from Embu County, 77 (28%) Kiambu County, 38 (14%) Makueni County, 36 (13%) Kitui County and 22 (8%) were from Nyandarua County. The mean age of the enrolled cases was 37±12

years. Eighty (53%) were married, 52 (34%) single. A total of 68 deaths occurred among 256 cases whose outcome was verifiable making a case fatality rate of 27%. Majority of the deaths occurred in Embu (40%, n=36) and Kiambu (23%, n=18) counties. Majority deaths (26%, n=59) were males, the married constituted 28% (n=22) and single 36% (n=18) mortality. The highest number of deaths occurred in the age group 30-39 years (40%, n=104), the highest case fatality however, was among those aged 50 years and above (43%, n=17). **Table 1**

1.1. Epi curve of Methanol poisoning cases in various counties of Kenya, 2014

The Epi curves from different counties show single peaks except Kiambu County. Kiambu County may have had 2 sources of exposure, while others had a single source of exposure. The exposure occurred at different times in the Counties in the month of May 2014. The highest number of cases occurred on 5th May 2014. **Figure 1-6**

1.2 Clinical presentation of the cases enrolled

The cases presented mainly with abdominal pains (41%, n=105), visual loss (35%, n=91), headache (15%, n=39), nausea and vomiting (10%, n=25), drowsiness (9%, n=24) and general body weakness (9%, n=23). **Table 2**

2.0 Methanol poisoning case management

Two hundred and fifty six (92%) of the cases sought medical attention from various facilities in the respective counties. Medical care was sought in the following hospitals; Embu level 5 hospital (32%, n=90), Makueni County referral hospital (21%, n=57), Kiambu district hospital (13%, n=36), Tigoni hospital (12%, n=34), Naivasha district hospital (10%, n=27), Mutomo mission hospital (6%, n=17), Nazareth mission hospital (2%, n=6), Thika level 5 hospital (1%, n=3). Five (2%) of the cases had not been reported in any hospital.

A hundred and sixty-eight cases (71%) were diagnosed as alcohol intoxication and 62 (26%) as Methanol poisoning. Laboratory tests were performed for 31% (n=85) of the case patients. **Table 3**. Two hundred forty-two (87%) of the cases were admitted in hospital. Medical treatment differed in various health facilities. However, the main treatment provided across facilities constituted the following; intravenous fluids (75%, n=193), ethanol (53%, n=138), pabrinex i&ii (39%, n=100), omeprazole (38%, n=98), ranitidine (30%, n=76), folic acid (27%, n=68), antibiotic (14%, n=35), carbamazepine (9%, n=23), sodium bicarbonate (8%, n=20) and Paracetamol (6%, n=16). Other treatments constituted 18% (n=46). Sixty seven percent (n=164) recovered fully after treatment. Among those who did not achieve full recovery, 86% (n=68) died, 8% (n=6) became totally blind while 6% (n=5) developed partial blindness. Four percent (n=11) were referred to Kenyatta National Hospital for further management, 3% (n=8) absconded treatment while 1% (n=3) were transferred to another health facility. **Table 4**

3.0 Emergency preparedness and response

Twelve facilities were assessed for their preparedness towards emergencies and disaster, 4(33%) were health centers, 6(50%) district hospitals, while 2(17%) were regional referral hospitals. Six (50%) facilities had a disaster and emergency preparedness team. Eleven (92%) had experienced Methanol poisoning as their last disaster, where mainly (25%, n=3) the response was led by the medical superintendent. Information regarding the methanol poisoning event was first acquired through abnormal number of cases or deaths received at casualty (67%, n=8) followed by concerns from the community (58%, n=7), media (17%, n=2), laboratory (8%, n=1), and 8 %(n=1) was detected through surveillance system. Other sources (42%, n=5) included presentation of the first cases at casualty, report by nurses on night duty, provincial administration and public health officers. Eleven facilities (92%) had used a criterion for line listing of cases, mainly the clinical presentation and linking of cases by brand consumed and the location. Two facilities (40%) sought laboratory confirmation from a private laboratory, 1(20%) from a reference laboratory, while others (40%, n=2) sought from the government chemist. Samples were mainly blood (60%, n=3), others included liquor and urine samples (40%, n=2). A laboratory report was obtained by 2(17%) facilities from a private laboratory.

A team coordinated the response in 10 (83%) of the facilities assessed. The team consisted mainly of medical superintendent, sub county medical officer of health, nursing officer in charge, disease surveillance coordinator, public health officer, provincial administration and the police. However, minutes were available in only 1(8%) facility. The main responses involved health education campaigns (67%, n=8), mobilization of emergency supplies (50%, n=6), coordination (42%, n=5), information campaigns and use of media (33%, n=4), provision of technical and resource support (25%, n=3), training on case management (17%, n=2), other measures (33%, n=4) included mainly quarantine of suspected brews.

An emergency preparedness plan was present in 2(17%) of the facilities assessed. The preparedness plan included all types of emergencies. Flow charts and protocols regarding management of methanol poisoning were observed in 2(17%) facilities. Linkage to rehabilitation services was reported in 6(50%) facilities. The services included ophthalmology (67%, n=4), counseling (17%, n=1) and psychiatry (17%, n=1). Availability of medicines for management of cases varied across facilities; i.v. fluids (83%, n=10), ethanol (58%, n=7), sodium bicarbonate (58%, n=7), folic acid (42%, n=5), other medications (33%, n=4) included pabrinexi&ii, vitamin b complex, ranitidine and omeprazole. It is important to note however, that intravenous ethanol (ethyl alcohol) was observed in only 1 facility (8%). The rest of the facilities administered oral ethanol purchased locally, mainly as *Vodka* or *Ritchot brandy*. Those unable to take oral medication were referred.

IV. DISCUSSION

This study shows that the Methanol poisoning event was of high magnitude similar to other events reported in Kenya (10)(11). The highest numbers of cases were observed in Embu County. This could have been due to delay in seeking care, the quantity of

adulterated beverages supplied to the County or the concentration of methanol contained in the brews. Late presentation contributes to severity and high number of deaths (5). The prognosis of methanol poisoning is dependent on the amount ingested and the subsequent degree of metabolic acidosis (2). Highest deaths occurred among male cases, the married and those aged 30-39 years. The highest case fatality rate was observed in the age group 50 years and above.

Cases mainly presented with abdominal pain and loss of vision. Majority sought medical attention, where they were mainly diagnosed of alcohol intoxication. Treatment constituted mainly of intravenous fluids, ethanol, pabrinex i&ii and omeprazole.

Preparedness and response to emergencies was fair across facilities. Information regarding the Methanol poisoning incident was first obtained through abnormal number of cases and deaths presenting at casualty and concerns from the community. Clinical presentation, linking of cases by alcohol brand consumed and location was the main criteria used for line listing of cases. The emergency teams mainly responded by conducting health education campaigns, mobilizing emergency supplies and coordinating the response. Emergency preparedness plans, flow charts and protocols regarding case management and intravenous ethanol (ethyl alcohol) were not readily available. Similarly, there were no clear linkages to rehabilitation services.

This study was subject to some limitations. The study was conducted approximately three weeks after the event. The interviewed key informants, the victims and the proxies experienced difficulties recalling events accurately. Data extraction from health records faced the challenge of illegible data, missing files, missing vital data e.g. dates, diagnosis, treatment and difficulties in file retrieval. Case tracing was affected by fear of victim reprisal by police and provincial administration, migration of victims after the event, belief by victims and their relatives that the exercise would result to compensation leading to false declaration of cases, and difficult interviews where a family had lost a relative.

V. CONCLUSIONS

Methanol poisoning is a problem of public health concern in Kenya. Males are more affected, those married and those aged 30-39 years. Abdominal pain and loss of vision are important early warning signs of methanol poisoning, whereas unconsciousness or coma, breathlessness and hyperventilation are important danger signs. Those 50 years and above are particularly at risk. Examination by a clinician, hospital admission, proper diagnosis and treatment improves outcome.There are no guidelines, flow charts and protocols regarding case detection, diagnosis and management and linkages to rehabilitation services. Preparedness and response to disasters is fair across facilities.

VI. RECOMMENDATIONS AND PUBLIC HEALTH ACTIONSN

We recommend the following: health education and behavior change communication in affected counties; technical support from the disaster preparedness unit during disasters and emergencies to mentor and improve capacity of counties during such events; establishment of guidelines, flow charts and protocols to harmonize case detection, diagnosis, management and rehabilitation of cases; establish or strengthen structures, functions and plans of emergency and response team and establishment of public health surveillance of methanol concentration in alcoholic drinks.

APPENDIX

Table 1: Demographic characteristics of Methanol poisoning cases in various counties of Kenya, 2014

Variable	Number of cases		Number of deaths	
	n	(%)	n	%
Embu	90	32.37	36	40
Kiambu	77	27.70	18	23
Kitui	38	13.67	5	13
Makueni	36	12.95	2	6
Nyandarua	22	7.91	3	14
Nakuru	8	2.88	4	50
Nairobi	3	1.08	0	0
Unknown	2	0.72	0	0
Murang'a	1	0.36	0	0
Narok	1	0.36	0	0
Sex				
Male	253	91	59	26
Female	25	9	9	36
Age				
<20	3	1.15	1	33
20-29	6	26.05	9	15.79
30-39	104	39.85	30	30.61
40-49	43	16.48	9	21.43
50+	43	16.48	17	42.50
Marital status				
Married	80	52.98	22	28.21
Single	52	34.44	18	33.29
Cohabiting	9	5.96	3	33.33
Divorced/separated	7	4.64	5	71.43
Widower	2	1.32	1	50
Widow	1	0.66	0	0

TABLE 2: CLINICAL PRESENTATION OF METHANOL POISONING CASES IN VARIOUS COUNTIES OF KENYA,

CLINICAL PRESENTATION	N	%
ABDOMINAL PAIN	105	40.7
VISUAL LOSS	91	35.27
HEADACHE	39	15.12
NAUSEA AND VOMITING	25	9.73
DROWSINESS	24	9.3
GENERAL BODY WEAKNESS	23	8.91
CONSUMED SUSPECTED BREW	19	7.4
COMA	17	6.59
DIZZINESS	12	4.65
CONFUSION	9	3.49
MOVEMENT DISORDERS/UNSTEADY GAIT	8	3.09
DYSPNEA/ HYPERVENTILATION	7	2.72
COUGH	6	2.33
LOSS OF SPEECH/HEARING	5	1.95
CHEST PAIN	5	1.95
CONVULSIONS	4	1.55
TREMOR/CHILLS	4	1.55
ANOREXIA	3	1.17

Table 3: Management of methanol poisoning cases in various counties of Kenya, 2014

Case management	n	%
Seeking medical attention	256	92
Hospital visited		
Embu level 5	90	32.37
Tigoni hospital	34	12.23
Makueni CRH	57	20.50
Kiambu hospital	36	12.95
Nazareth hospital	6	2.16
Thika level 5	3	1.08
Naivasha district hospital	27	9.71
Narok County hospital	3	1.08
Mutomo mission hospital	17	6.12
Hospital admission		
Embu level 5	86	96.56
Tigoni hospital	19	55.88
Makueni CRH	56	98.25
Kiambu hospital	36	100
Nazareth hospital	3	50
Thika level 5	3	100
Naivasha district hospital	22	81.48
Narok County hospital	0	0
Mutomo mission hospital	17	100
Provisional diagnosis		
Alcohol intoxication	168	71
Methanol poisoning	62	26
Alcohol induced gastritis	3	1
Alcohol withdrawal syndrome	1	<1
Alcoholic coma	1	<1
Tuberculosis	1	<1

Table 4: Treatment of Methanol poisoning cases in various counties of Kenya, 2014

Treatment	n	%
I.V. fluids	193	74.52
Ethanol	138	53.28
Pabrinexi&ii	100	38.91
Omeprazole	98	38.28
Ranitidine	76	29.69
Folic acid	68	26.56
Other treatment	46	17.97
Antibiotic	35	13.67
Carbamazepine	23	8.95
Sodium bicarbonate	20	7.81
Paracetamol	16	6.3

FIGURE 1: EPI CURVE OF METHANOL POISONING CASES IN EMBU COUNTY, KENYA, 2014

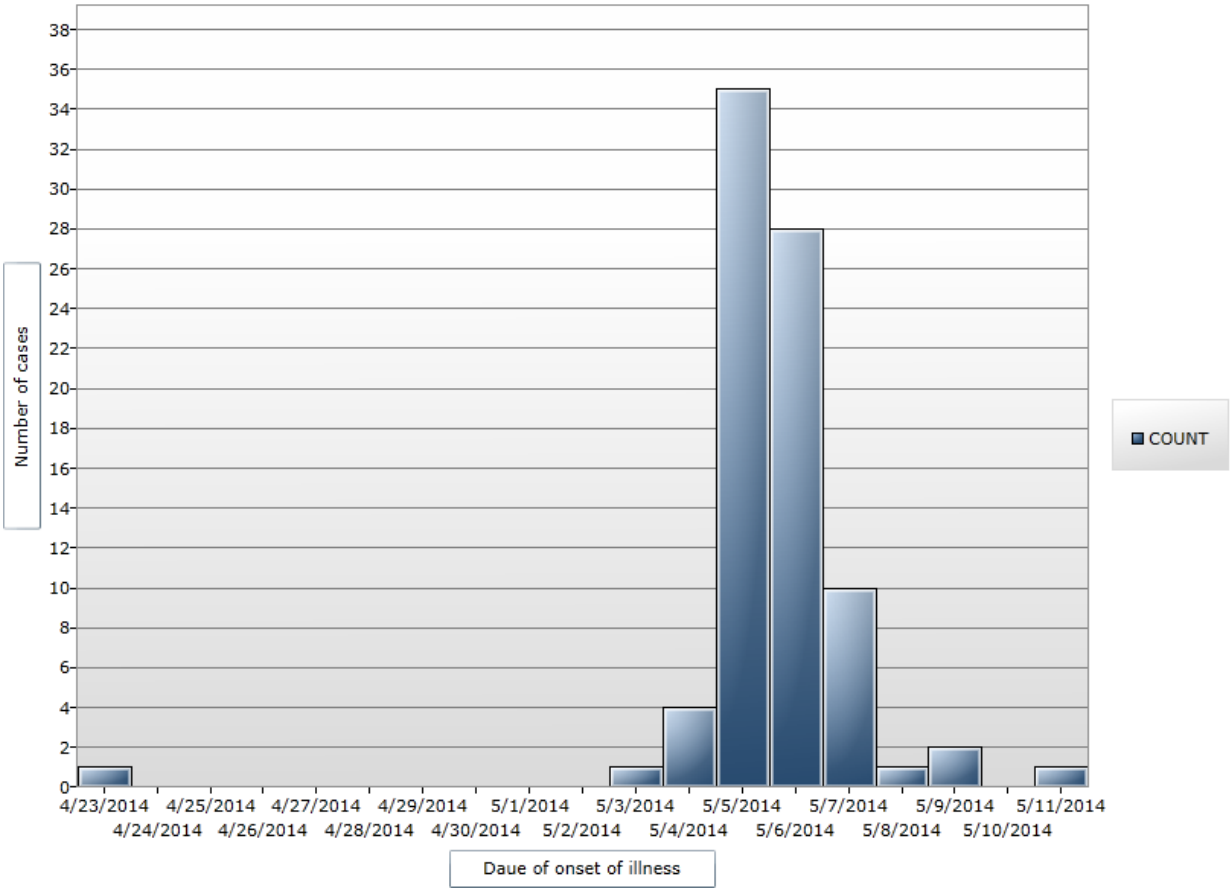


FIGURE 2: EPI CURVE OF METHANOL POISONING CASES IN MAKUENI COUNTY, KENYA, 2014

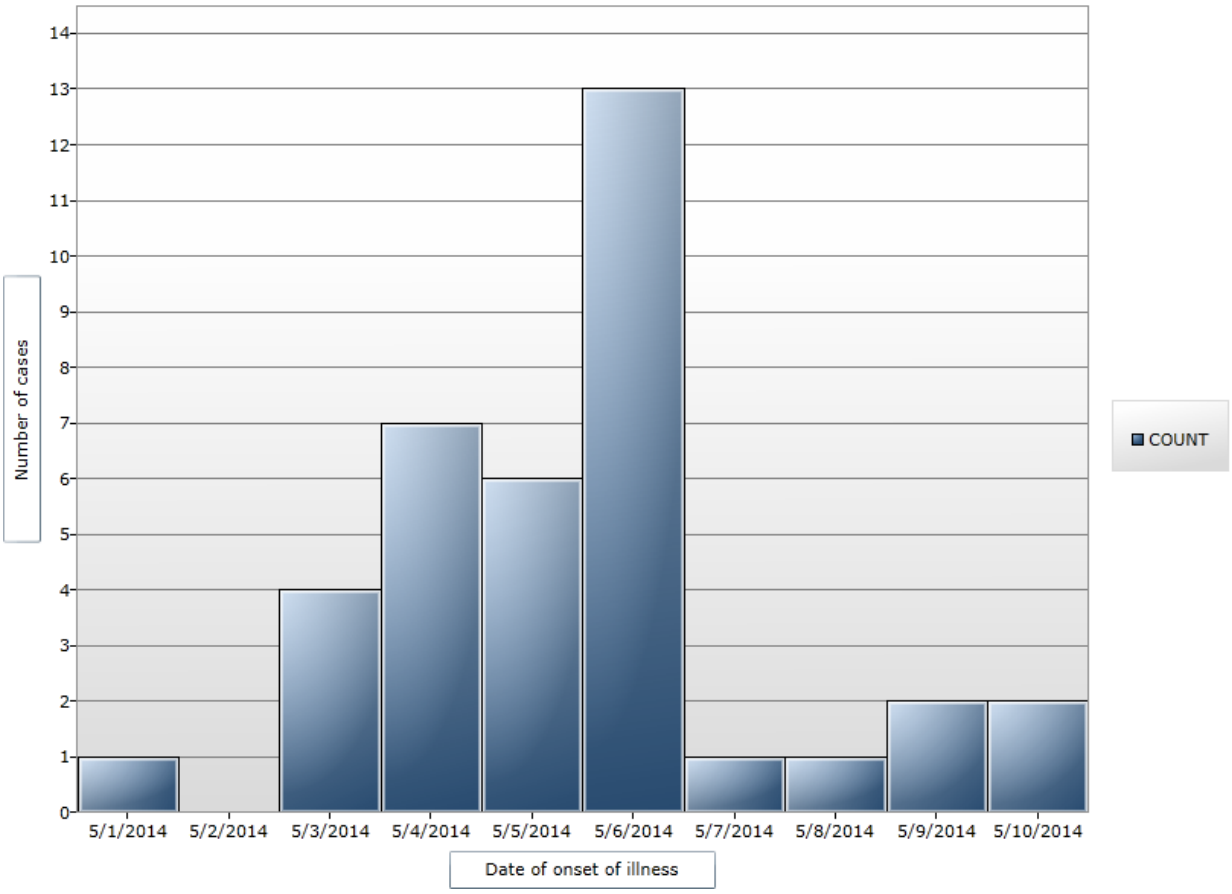


FIGURE 3: EPI CURVE OF METHANOL POISONING CASES IN NYANDARUA COUNTY, KENYA, 2014

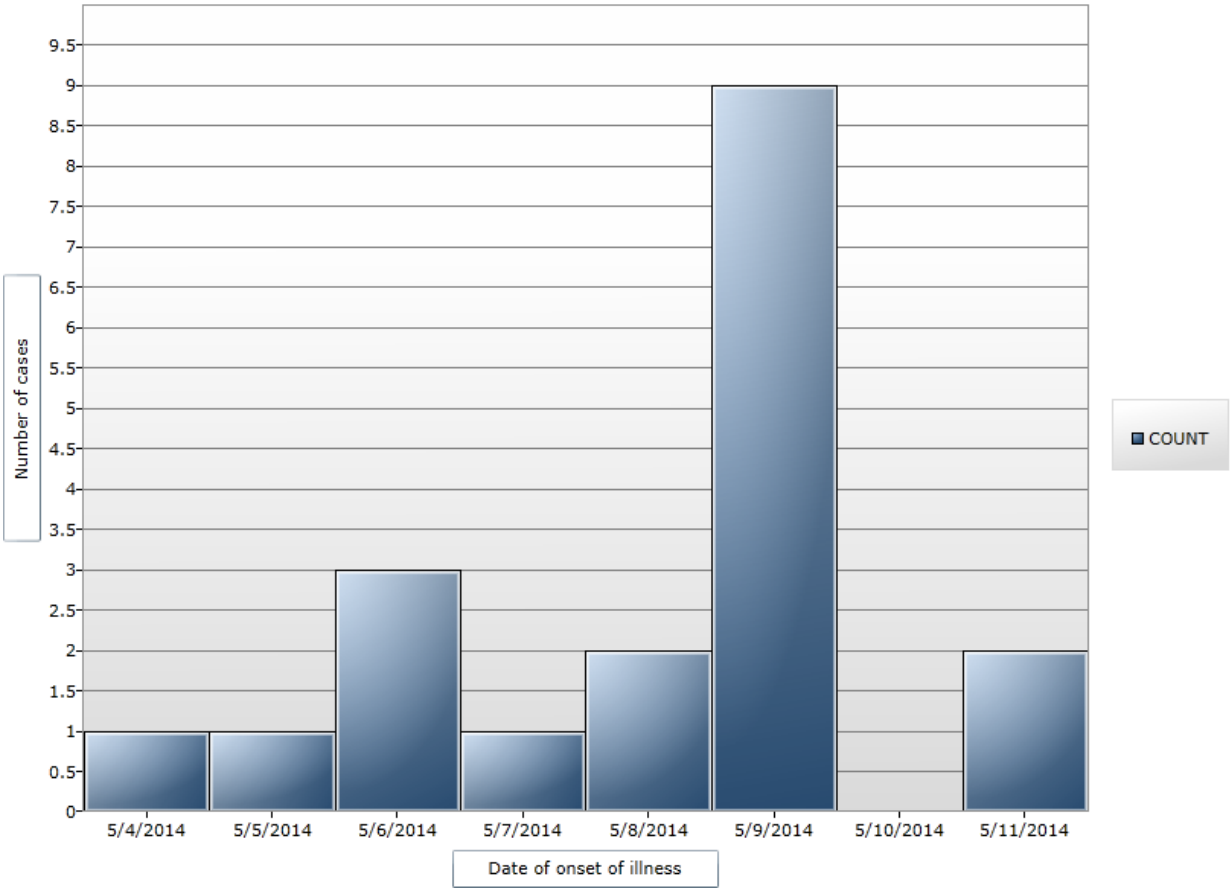


FIGURE 4: EPI CURVE OF METHANOL POISONING CASES IN KITUI COUNTY, KENYA, 2014

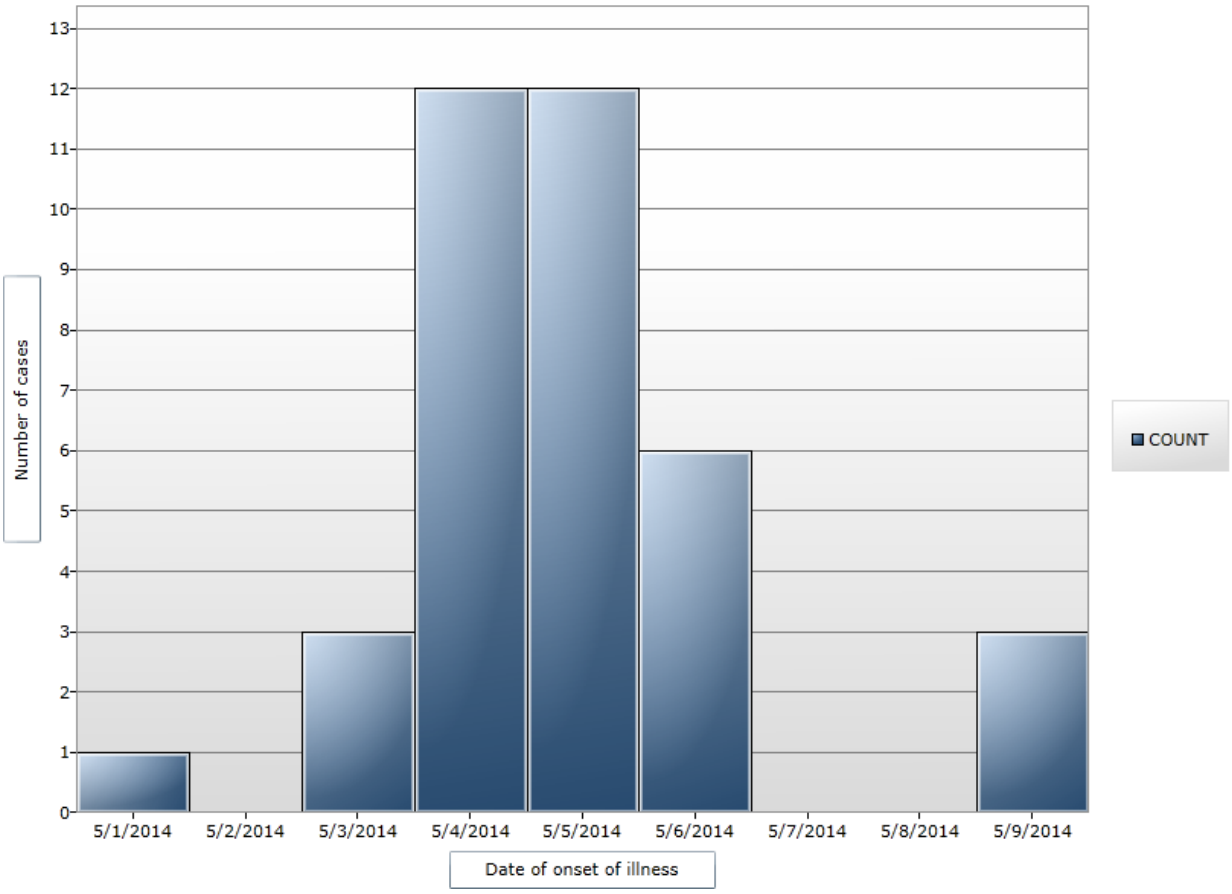


FIGURE 5: EPI CURVE OF METHANOL POISONING CASES IN KIAMBU COUNTY, KENYA, 2014

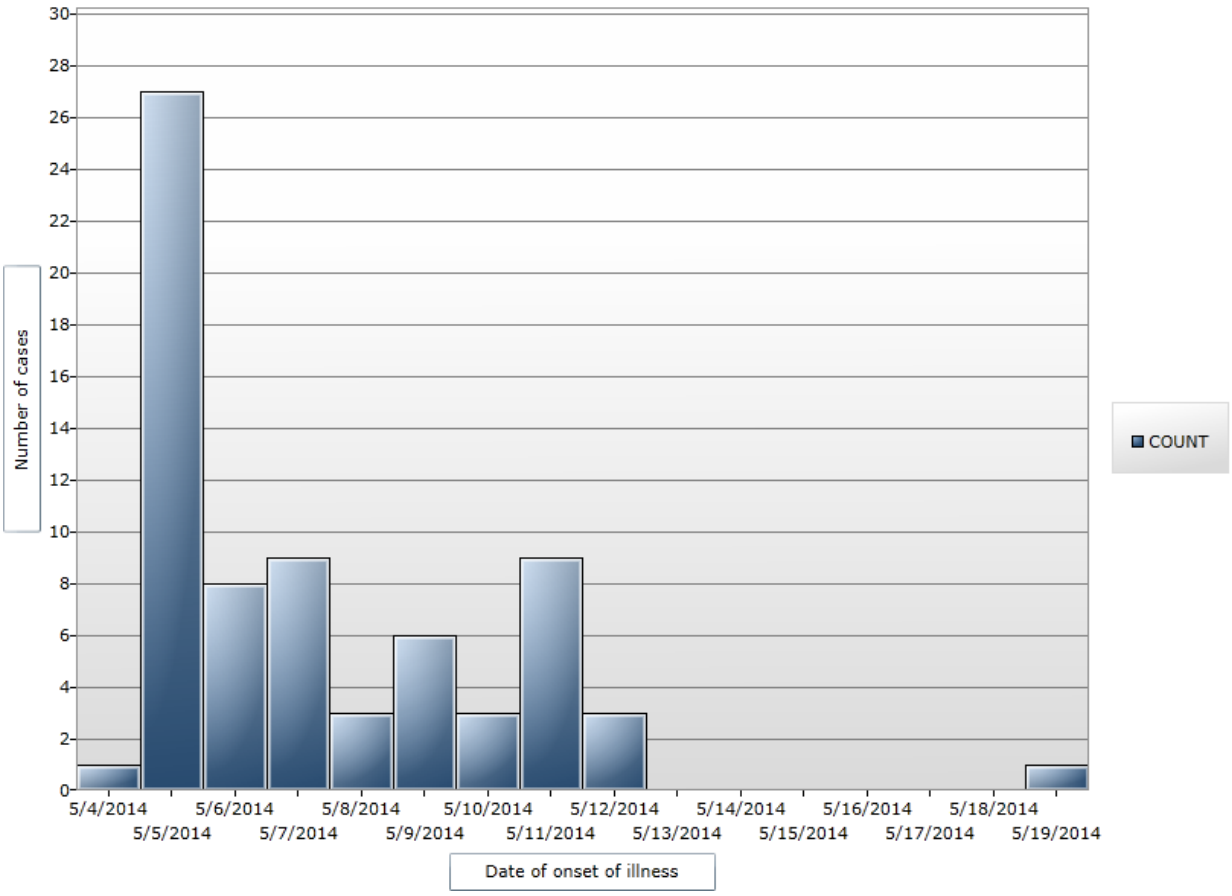


FIGURE 6: EPI CURVE OF METHANOL POISONING CASES IN NAKURU COUNTY, KENYA, 2014

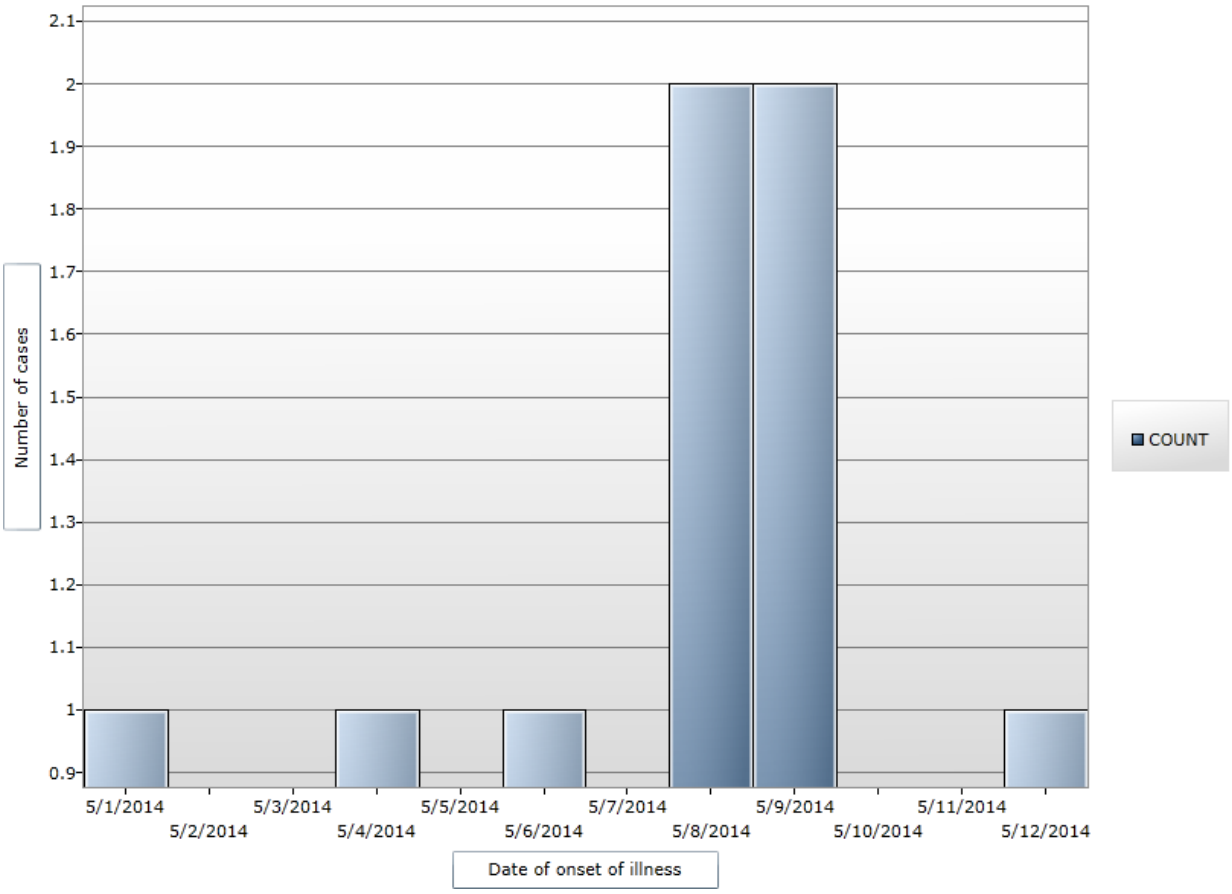
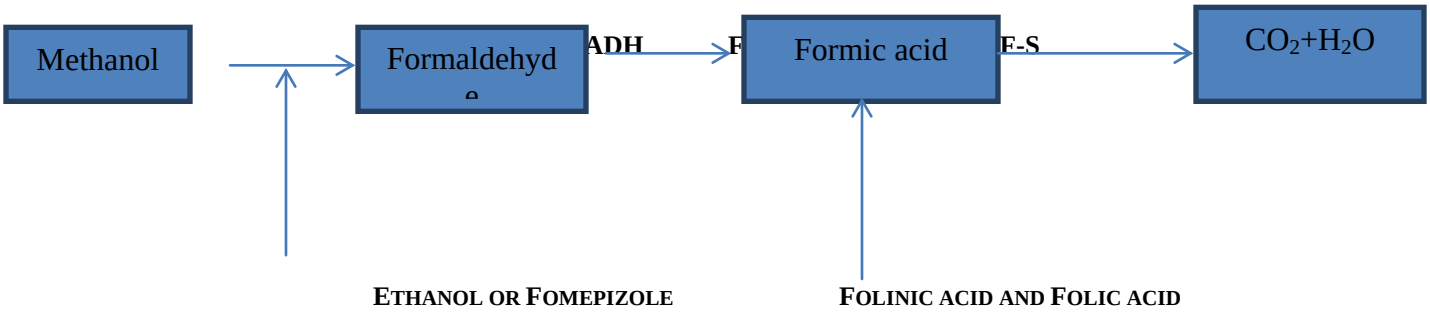


FIGURE 7: THE DIAGRAM SHOWS THE ACTION OF BASIC ANTIDOTES AT DIFFERENT PHASES OF METHANOL METABOLISM



***ADH**: ALCOHOL DEHYDROGENASE; **FDH**: FORMALDEHYDE DEHYDROGENASE; **F-THF-S**: 10-FORMYL TETRAHYDROFOLATE SYNTHETASE

SOURCE: HASSANIAN-MOGADDAM ET AL,.2009

ACKNOWLEDGMENT

We would like to acknowledge the Ministry of health, Kenya, the management teams of the involved counties, the medical superintendents, sub-county medical officers of health, nursing officers in charge, disease surveillance coordinators, public health officers, health records and information officers, health care providers, the provincial administration and community health workers for their invaluable support during the exercise.

In addition, we would like to sincerely thank the FELTP faculty, the disaster preparedness and response unit and WHO, Kenya, for the mentorship and financial support in carrying out the investigation.

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AUTHORS

First Author – Author name, qualifications, associated institute (if any) and email address.
Second Author – Author name, qualifications, associated institute (if any) and email address.
Third Author – Author name, qualifications, associated institute (if any) and email address.

Correspondence Author – Author name, email address, alternate email address (if any), contact number.