International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

Enhancing Maternal and Child Healthcare Programme through Medical Laboratory Analytical Quality Control Systems; A Case Study of Homa Bay County

Kenneth Ochieng' Otieno[1], Dr. Dorothy Ndunge Kyalo[2], Dr. Elisha Opiyo. Omulo[3], Dr. Angeline Sabina Mulwa[4]

[1]University of Nairobi, School of Open and Distance Learning, P.O. BOX 30197- 00100

[2]Senior Lecturer, University of Nairobi, School of continuing and Distance Education, P.O. BOX 92-00902, KIKUYU

[3]Lecturer, University of Nairobi, School of Computing and Informatics, P.O. BOX 30197-00100 Nairobi

[4]Lecturer, University of Nairobi, School of continuing and Distance Education, P.O. BOX 92 -00902, KIKUYU

Abstract: ***The ultimate goal in a medical laboratory analytical procedure is to achieve error free results. However, sustainability is not often achieved due to presence of errors in laboratory practice which in turn have a negative impact on patient outcome. The paper advocates for the use of quality control systems to ensure credibility of laboratory results. The paper is based on the study conducted to examine the influence of analytical quality control systems on performance of maternal and child healthcare programme in Homa Bay County, Kenya. The study focused on specimen mix -up, specimen volume and equipment calibration as indicators. The study was guided by systems theory, pragmatism paradigm, cross sectional descriptive design and correlational research design in a mixed method approach. A simple random sampling technique was used to sample 208 respondents from a population of 505. A questionnaire with a five point Likert type scale was used to analyse qualitative data. Descriptive data was analysed using percentages, arithmetic mean, standard deviation, while inferential data was analysed using Pearson's product moment correlation. The results indicated that analytical quality control has a positive and significant influence on performance of maternal and child healthcare programme (R2=0.967, F=5444.220, P=0.00, r= 1.12). The study established that analytical quality control systems have influence on performance of maternal and child healthcare services in Homa - Bay County, Kenya. The study therefore recommends that the government through ministry of health should put in place quality control systems mechanism for medical laboratory to enhance the quality of laboratory results.***

Keywords: Laboratory, Analytical, Quality control, Performance, Maternal and Child healthcare

1. Introduction

Laboratory plays a pivotal role in providing timely diagnosis for patient management and disease surveillance. Up to about 80% of all clinical diagnosis is made on the basis of laboratory test (Agarwal et al., 2012). It is against this backdrop that the current trends in emerging and re-emerging diseases that there is need for accurate and prompt laboratory diagnosis. Achieving safe motherhood requires an element of laboratory services to support provision of universal health coverage. As a way of promoting safe motherhood and better outcome for infants, antenatal screening services such as haemoglobin level, HIV, Syphilis, blood grouping, random blood sugar, hepatitis B, hepatitis E and malaria test are essential antenatal care services. Health facilities without laboratory services may have blood specimen collected through the use of dry blood sample for analysis at higher laboratory setups. Performing these services will go a long way in reducing maternal and infant mortality(Olusegun, Ibe, and Micheal, 2012).

Medical laboratories are required to carry out validation of all analytical procedures to establish that the performance quality requirements are meet for the intended analytical application. Validation is a standard laboratory procedure that should be developed independently. However, laboratory technologists must perform a series of analysis designed to estimate analytical errors such as linearity and range of random errors. Quality control at analytical stage should look into; precision, verification, analytical accuracy, analytical sensitivity, analytical interference and reference limits. When the entire processes are put into consideration, the quality of laboratory assay will be guaranteed to meet international standards. There is need to embrace peer review to determine diagnostic accuracy and to prevent diagnostic errors in testing process.

A proficient laboratory service is the cornerstone of modern healthcare system and has an impact on medical decisions on admission and patient treatment. In recent years, there has been an increased awareness of the importance of error reduction in laboratory practice and their possible negative impact on patient outcomes.Despite all the automation, some study findings have showed that laboratories continue to be a source of errors which often translate to inappropriate patients' care and treatment (Howanitz, 2005). It is therefore recommended that laboratories introduce the element of internal and external quality control systems that will ensure results released from the laboratory are credible and are of the highest quality.

Improving maternal and child healthcare service is a global concern. An increasing number of women and children are at risk of health complications despite advances in medicine and medical technology. Maternal and child mortality is associated with lack of access to good quality healthcare and unhealthy living conditions. Currently the trend for maternal and child mortality rate are showing a declining trajectory. Expectant women are vulnerable due to risks associated with pregnancy and child birth. Diseases such as malaria, anaemia, hepatitis, tuberculosis and heart disease may be aggravated by pregnancy(Alkema et al., 2016). Maternal mortality ratio in developing countries in 2015 was estimated at 239 per 100,000 live births. In developed countries, it is estimated that 12 women per 100,000 live births die due to pregnancy related issues. In Kenya, an estimate of 488/100,000 women die as a result of pregnancy complications. Maternal mortality in Homa Bay county is estimated at 540/100,000 (KDHS, 2014). Large disparities have been documented between countries and within countries, between women with high and low income and between women living in rural areas versus those living in urban areas.

The analytical phase begins once the specimen has been collected and reached the laboratory. Steps at the analytic stage involve separating or mixing specimen and reference material with accurate amounts of appropriate reagent. In this phase, inadequate information system can lead to unnecessary duplication of laboratory test when clinician ordering the test is not aware of previous laboratory request or prior test results from other clinicians (Bates and Maitland, 2006a). In addition, there is a high dependency on clinical laboratory on testing and reporting. Laboratory report usually informs and influence clinical decisions hence report from laboratory need to be free of errors of any form, be it equipment generated or human error as this may result in fatality.

The misidentification of samples in the pathology laboratory poses a risk of misdiagnosis to thousands of patients annually. Figures obtained by the Freedom of Information act in the USA reveal that between 2008 and 2009 almost 366,000 specimens were mislabelled or 'mixed-up' in pathology laboratories. A total of 46 recorded cases during this period were uncovered where mislabelling was found to have been related to patient death or a serious delay in treatment (Agarwal et al., 2012). The common occurrence of specimen misidentification can be a consequence of the insufficient protocols that many health institutions have in place for labelling patient specimens. Errors can occur as a result of ineffective processes for identifying and tracking specimen cassettes and slides, leading to patients receiving incorrect diagnoses. This can result in patients undergoing unnecessary treatments or a failure to treat unreported conditions. To overcome these, laboratoriesneed to implement more advanced procedures for labelling and tracking specimens as they progress through laboratory workflows. Studies show that most of the laboratory errors occur at pre- analytical phase and mostly involve mislabelling specimen. In a study by Kahn, Jarosz, Webster (2009) identified some of the immeasurable costs such as patient anxiety, discomfort; delays in diagnosis and treatment have been cited. On the other hand, Valenstein, Raab, and Walsh, (2006)using the median identification error rate of 390 identification errors per million specimens estimated the cost of misidentified specimens to be approximately $280,000 per million specimens. Ensuring correct patient and sample identification is one of the most important goals of medical laboratory and is consistent with the Joint Commission's National Patient Safety Goals aimed at improving the accuracy of patient identification. Pre-analytical errors have been reported to be up to 70% in various studies. Since the quality is interconnected, precision and accuracy are not the only guarantors of the quality. The objective behind quality control is to minimize laboratory errors (Gupta et al., 2015; Aakre et al., 2013).

Improvements in the quality of diagnosis and treatment by the providers would help to readdress this inequity under short- and medium-term. Most patients in developing countries are treated based on the clinical assessment although laboratory services that are available but are not utilized by all patients(Onwujekwe et al., 2005). In developing countries, there are numerous diseases which require the use of blood transfusions, WHO reports that developing nations suffering from lapses in laboratory screening result where 31% of all transfusions are near fatality while one-third are not screened for HIV, Hepatitis B or Hepatitis C. The quality of HIV/AIDS case-detection and case-reporting system in Mozambique was assayed and several anomalies noted. The inherent flaws in the system are such that the testing performed on ground level may or may not obtain the correct analytical result of whether or not a certain patient is positive for HIV or not (Chilundo, Sahay, and Sundby, 2004). Distribution of laboratory services in Kenya differs from rural to urban areas. In rural areas, the laboratory assay to identify infection is routinely unavailable and clinicians frequently neglect the importance of diagnostic testing. However, laboratory diagnostics for common infections in Sub-Saharan Africa is not adequately sensitive of specific for tests (Ishengoma et al., 2010).

The objective of the study

To examine how analytical quality control systems influence the performance of maternal and child healthcare services in Homa - bay County, Kenya.

Research hypothesis

H_1: There is a significant relationship between analytical quality control systems influence the performance of maternal and child healthcare services in Homa - bay County, Kenya.

H_0: There is no significant relationship between analytical quality control systems influence the performance of maternal and child healthcare services in Homa - bay County, Kenya.

2. Theoretical Framework

The study was modelled around the Donabedian model

Donabedian Model

This is a conceptual model that provides a frame work for examining healthcare services and evaluating the quality of health care. The model was proposed by Avedis Donabedian, the model seek information about the quality

of care; structure, process, and outcome (Donabedian, 1966). The structure is a general term for the resources that are required to provide healthcare services while the process refers to the intermediate products of a diagnostic evaluation, access to care, rate of utilization and choice of a healthcare provider. The outcome is defined as the end product of care, health status of the patient, comfort and patient satisfaction

Research Methodology

This study adopted a pragmatic paradigm. Consequently, descriptive Cross-Sectional research design and Correlation design were used. The complementary capabilities of mixed method build the strength of this study by allowing a descriptive explanation of the study variable while showing the relationship among variables under the study through inferential statistics. A sample size of 226 respondents was sampled from a population of 505 using simple random techniques. The sample comprised of 126 nurses working in maternal and child welfare clinic, 93 laboratory technologists and 7 medical record personnel. Data was collected using three sets of structured and semi structured questionnaire. The data instruments addressed the research objective and were divided into sections.

Validity was enhanced through expert opinion and conducting a pilot study. Based on the results of the pilot study, content validity was achieved by examining objectives and comparing them to the content of the instrument. To ensure reliability, test and retest method at an interval of one month was done. Cronbach's Alphas reliability coefficient that ranges from 0 and 1 was generated to measure the reliability for the purpose of this study where $\alpha < 0.773$ was obtained.

The study used a mixture of descriptive and inferential data analysis techniques. Descriptive statistic such as mean scores, percentage, frequency distribution, and the standard deviation was used, while inferential statistics tested the hypothesis. Simple linear regression was adopted to establish the nature of the relation between variables under the study.

3. Findings

The section presents data analysis and findings on the variables comprising on frequencies, percentages, means and standard deviation. Different sets of questions were measured on a five point Likert type scale.

Questionnaires were administered to 226 health personnel and 186 questionnaires were satisfactorily filled and returned which gave 82.3% response rate. According to (Groves et al., 2011) a response rate of at least 50 per cent is adequate for analysis and reporting, a 60 per cent response rate is good and 70 per cent and above is very good. This implies that the response rate was adequate for analysis and reporting.

Performance of Maternal and Child Healthcare Programme

The performance of maternal and child healthcare programme is a measured that shows an increase or decrease of maternal and infants mortality recorded per 100 000 births over a period of time. It is considered in terms of absence or presence of infant infections at birth and infants born with ideal weight at birth. Increase in maternal and infant mortality has been identified as a global and human right concern. An increasing number of women are at risk of pregnancy-related complication or death despite advances in medicine and medical technology. Performance of maternal and child healthcare programme was identified as the dependent variable of this study.

The study sought to establish the performance of maternal and child healthcare programme in Homa Bay County measured using a number of factors on a five-point Likert scale.

The study findings indicated that respondents agreed with most of the statement concerning performance of maternal and child healthcare programme with a composite mean score was 2.595 and standard deviation of 0.513. The study finding also shows that respondents agreed with the statement that maternal mortality has been decreasing after the introduction of free maternal healthcare services with a mean of 4.516 and standard deviation of 0.642. In addition, they agreed with a mean of 4.274 and standard deviation of 0.677 that maternal and child healthcare programme has led to a decrease in infant mortality. The study findings are in agreement with world health organization (2015) which indicated that the universal strategy of ending preventable infant and maternal mortality should address inequality in accessing quality reproductive health, new born and maternal health and also strengthening healthcare system. Through the interview, respondents agreed that since the inception of free maternal healthcare services there has been a decrease in a number of women dying due to pregnancy-related complication as the majority of women are able to deliver in the hospital as compared to previous cases where a number were delivering at home with the assistance of traditional birth attendants.

Further, the participants agreed that infant infections at birth have been decreasing after the introduction of free maternal and child healthcare programme with a mean of 4.145 and standard deviation of 0.716. Respondents agreed with the statement that efficiency in disease diagnosis at maternal and child healthcare has increased as a result of the introduction of laboratory test accuracy with a mean of 4.096 and standard deviation of 0.799. Respondents also agreed that diseases at birth have been decreasing after the introduction of maternal and child healthcare program through the introduction of antenatal tests with a mean of 4.096 and standard deviation of 0 .799. The study findings are in agreement with Olusegun *et al* (2012) who indicated that performing quality laboratory test will go a long way in reducing maternal mortality. Similarly, Gershy-Damet et al 2010) indicated that strengthening health system in low and middle income countries are essential in reducing maternal and infant mortality.

Through interview respondents indicated that major achievement has been made through mandatory HIV testing, this has helped reduce the number of children born infected with HIV/AIDs. Most health facilities have made it

mandatory that all women visiting health facilities have to undergo voluntary testing for HIV/AIDs. In addition, they agreed that client satisfaction has been increasing with the reduced test turnaround time for patient visiting maternal and child healthcare department as shown by a mean of 3.693 and standard deviation of 1.012. From observation, it was noted that in some health facilities patients were still waiting for laboratory results longer due to a number of tests requested and in some facilities it was occasioned by a low number of staff. The findings are in in line with Kariuki *et al* (2010) argument that common reasons given by clinicians in Kenya concerning the use of laboratory services was long turnaround time for receiving laboratory results.

Respondents also agreed with the statement that the average child weight at birth has been increasing since the implementation of maternal and child healthcare programme the study findings were a mean of 3.677 and standard deviation of 1.046. Through interviews, respondents noted that this has been made possible due to increased number of births recorded in health facilities as compared to the situation where women used to give birth at home and were not recorded. The findings concurs with Baker *et al* (2010) argument that in low and middle income countries , nearly 50% of all birth take place at home through the assistance of tradition birth attendants .

Analysis of Maternal Mortality Rate in Homa-bay County

The study sought to establish the number of maternal mortality in Homa Bay County for a period for 2012-2016. Maternal mortality has been described as the number of female deaths per 100,000 live births form causes that can be attributed to pregnancy. The information was collected from secondary data as registered in Homa-Bay County health records

Table 4.1: Maternal Mortality in Homa Bay County

Year	Maternal mortality rate (100,000)
2012	531
2013	546
2014	610
2015	583
2016	540

The result in Table 4.1 shows that maternal mortality numbers in Homa Bay County has been fluctuating for the last five years. In 2012 maternal mortality in the County was 531 maternal deaths per 100,000 live births. In 2013 and 2014 recorded maternal deaths wereo 546 and 610 respectively. In the year 2015 maternal mortality decreased to 583, which was followed by a subsequent decrease in 2016 to 540. This shows that with more intervention programme maternal mortality issues will eventually reduce to acceptable levels.

Under 5 years Mortality Rate n Homa-Bay County

The study sought to establish under-five mortality numbers in Homa-Bay County. Under -five mortality refers to the probability of a child dying between birth and exactly five years of age, expressed per 1,000 live births. Table 4.13 shows the Under Five Mortality Rate in Homa Bay County for a period of five years (2012-2016).

Table 4.2: Analysis of Under-Five Mortality Rate in Homa Bay County

Year	Mortality rate
2012	126
2013	135
2014	133
2015	119
2016	82

The findings in Table 4.2 indicate generally mortality numbers in Homa-County. In the year 2012, under-five mortality in Homa Bay County was 126 deaths for 1,000 live births. This figure increased in 2013 to 135 deaths for 1,000 live births but a further decrease was recorded in the year 2014 to 133 deaths while in the year 2015, 119 deaths were reported. The study also established that in the year 2015 the number of deaths was 82. The study findings show a decreasing number of under-five mortality. As noted by Becquet *et al* (2012) infant mortality may be affected by geographical, socioeconomic factors and the HIV status of their mothers at the same time Homa-Bay County has been rated as one of the Counties with the greatest HIV burden in Kenya.

Causes of Neonatal Mortality in Homa Bay County

The study sought to establish major causes of neonatal mortality in Homa –Bay County as shown in Table 4.3. Data shows information gathered for three months (January – March 2018).

Table 4.3: Neonatal infection

Types of Infection affecting Neonates	Male	Female	Total	Percentage (%)
Neonatal sepsis	405	397	802	52.1
Neonatal jaundice	150	161	311	20.2
Respiratory distress	208	219	427	27.7

The study findings in Table 4.3 indicate that neonatal sepsis was the most common infection affecting neonate at 52.1 % while 27.7 % suffered from respiratory distress. The study findings also indicated that 20.2 % suffered from neonatal jaundice. It can therefore be assumed that medical laboratory quality control systems when put in place and applied will go a long way in detecting infection affecting neonates hence reducing mortality. The study findings are in agreement with Kourtis (2013) who indicated that one of the leading causes of infant mortality is neonatal sepsis, respiratory and gastrointestinal infections.

Under-five Mortality

The study sought to establish causes of death among children under the age of five years. The findings indicated that diarrheal disease contributed to 31.9% of infections, malaria contributed to 26.6 %, Anaemia 13.7 %, HIV and AIDs-related infections 12.2%, pneumonia 9.9 %, chicken pox 4.1 %, Meningitis, and Diabetes contributed to 0.7% while pulmonary TB contributed to 0.4% of all admissions during the period of the study. The findings reflect those of the Kenya National Bureau of statistics and ICF micro (2009) which indicated that Nyanza account for 33% mortality for children below the age of 5 and common illnesses cited were malaria, Diarrhoea, Pneumonia HIV and Aids.

Analytical Quality Control Systems and Performance of Maternal and Child Healthcare Programme

The second objective of this study was to examine how analytical quality control systems influence the performance of maternal and child healthcare programme in Homa-Bay county.

Influence of Analytical Quality Control System on Performance of Maternal and Child Healthcare Programme

The study sought to examine the influence of analytical quality control systems on the performance of maternal and child healthcare programme in Homa- bay county. Variables were measured based on specimen mix up, specimen volume and equipment calibration.

Influence of Specimen Acceptance Protocol on performance of maternal and child healthcare programme

The study sought to find out how specimen acceptance protocol influences analytical quality control systems and performance of maternal and child healthcare programme. As such respondents were asked to indicate their level of agreement or disagreement on the statements as provided in Table 4.4.

Table 4.4: Influence of Specimen Acceptance Protocol on performance of maternal and child healthcare programme

	Frequency	Percentage %
Yes	183	98.4
No	3	1.6
Total	186	100.0

The finding Table 4.4 shows that majority of the respondents 193 (98.4%) indicate that most health facilities had put in place sample acceptance protocol while (3) 1.6% indicated that their health facilities had not put in place sample acceptance protocol. This shows that most of the health facilities in Homa-Bay County had put in place sample acceptance protocol. As noted by Lippi *et al* (2006), development of guidelines and standard operating procedures aimed at improving sample identification and sample acceptance or rejection always translate into higher quality standards.

Influence of Specimen Mix Up on performance of maternal and child healthcare programme

The study sought to find out the influence of specimen mix up on analytical quality control systems and performance of maternal and child healthcare programme. The study findings indicated that respondents agreed that specimen mix-up affect the quality of laboratory services analytical quality control systems and performance of maternal and child healthcare programme with a composite mean score of 2.919 and standard deviation of 1.0108. Respondents also agreed that there are cases of specimen mix up in their laboratories with a mean of 3.112 and standard deviation of 1.222. Respondents also agreed that there are cases of unnecessary duplication of laboratory specimen with a mean of 2.548 and standard deviation of 1.105. In addition, respondents also agreed that there are cases of incorrect sample labelling in their health facilities with a mean of 3.096 and standard deviation of 0.997. The study findings is in agreement with a similar study carried out by Andrew and Hough (2009) that major causes of specimen mix up is mislabelling.

Key informants indicate sometimes patients are forced to repeat test due to lack of specimen identifier of mislabelling of specimen container. Error generated by laboratory technologist R03

Influence of specimen Volume on performance of maternal and child healthcare programme

Respondents were asked to indicate their level of agreement or disagreement with statement related to specimen volume. The study findings indicated that respondents agreed that specimen volume influence performance of maternal and child healthcare programme with a composite mean score of 3.521 and standard deviation of 1.019. Respondent also agreed that enough specimen volume is received in their laboratory with a mean of 3.564 and standard deviation of 0.856. Further respondents also agreed that specimen volume is one of the factors leading to specimen rejection in the laboratory with a mean score of 3.725 and standard deviation 0.856.

Further respondents also agreed that inadequate samples find their way to the laboratory for testing with a mean of 3.274 and standard deviation of 1.005. However, from observation it was noted that inadequate samples are sometimes registered in the laboratory and patients requested for additional specimen. The study findings is in agreement with a study conducted by Julie A. (2012) which indicated that inadequate sample volume contribute to 46-68% of all errors generated in the laboratory at analytical phase.

From the interviews carried out, researcher sought to find out measures put in place to ensure specimen received in the laboratory were always adequate for analysis. Respondents in some health facilities indicated that they had standard operating procedure to guide specimen collection. It was also noted that most of blood collecting bottles / tube were calibrated and specimen volumes indicated.

Influence of Equipment Calibration on performance of maternal and child healthcare programme

The study sought to establish how equipment calibration influence performance of maternal and child healthcare programme. Respondents were requested to indicate their level of agreement or disagreement with statements related to equipment calibration in their health facilities. The study findings shows that the respondents agreed that medical equipment calibration affect the quality of laboratory services with a composite mean of 3.908 and standard deviation of 0.966. They also agreed that equipment calibration affects the quality of laboratory analysis with a mean of 3.935 and standard deviation of 1.032. Respondents also agreed that medical equipment in their facility is always calibrated with a mean of 3.887 and standard deviation of 0.902. They also agreed that the equipment in their laboratory undergo regular maintenance with mean of 3.903 and standard deviation of 9.64. This implies that health facilities in Homa-bay County take quality control mechanisms seriously. These findings agree with Ramamohan *et al* (2012) argument that instrument

calibration in clinical laboratory testing process significantly contribute to certainty of the final results.

During interview, respondents indicated that their facility carry out both internal and external quality control process to ensure quality of laboratory results are maintained. Quantity control mechanisms performed in their health facilities include precision pipetting, use of Standard Operating Procedures (SOPs) at processing, strict follow up of SOPs when conducting a test, regular performance of quality control, ensuring sample quality and quantity, regular calibration of machines, proper sample labelling with at least two identifiers, running internal quality control before sample analysis and consistency in conducting quality control before sample analysis. The respondents were also asked to indicate how analytical quality control systems in their health facility affect the performance of maternal and child health care programme. From the findings, they indicated that analytical control; if not frequently carried out may lead to inaccurate laboratory results resulting which may intern compromise patient treatment / care.

Testing of Hypothesis

The study sought to establish the influence of Analytical Quality Control Systems on Performance of Maternal and Child Healthcare Programme in Homa- Bay County. The tested hypothesis was;

$2H_0$: There is no significant relationship between analytical quality control systems and the performance of maternal and child healthcare programme in Homa- Bay County.

The hypothesis was tested using correlation analysis and regression analysis. Using 95 percent level of confidence the significance level was 0.967. Therefore, the alternative hypothesis was accepted when the P-value was more than the significance level 0.05.

Correlation analysis for analytical quality control systems and Performance of maternal and child healthcare programme

The study sought to establish the existence of an association between analytical quality control systems and Performance of maternal and child healthcare programme in Homa-Bay County. A Pearson correlation analysis was used and the findings shows that there was a strong positive association between analytical quality control systems and performance of Maternal and child healthcare programme in Homa-Bay County(r = 0.984) .The relationship was significant because the P-value 0.000 was less than the alpha value 0.05 at 95% confidence level . Therefore, the alternate hypothesis is accepted indicating that “analytical quality control systems has a significant influence on the performance of maternal and child healthcare programme in Homa- Bay County”.

Regression analysis for Analytical Quality Control Systems and the performance of maternal and child healthcare programme

The study sought to establish how the performance of maternal and child healthcare programme can be explained by analytical quality control systems. The study finding shows that the r-squared for the relationship between analytical quality control systems and performance of maternal and child healthcare programme was 0.967. The findings implies that analytical quality control systems can explain 96.7% of the performance of maternal and child healthcare programme in Homa- Bay County.

Analysis of variance was used to determine whether the model was a good fit for the data in determining the influence of analytical quality control system om performance of maternal and child healthcare programme. The finding shows that the *P*-value obtained was 0.000 and the value is less than the significance level of 0.05. Also the F-calculated of 5444.220 was obtained and greater than the F-critical of 3.94. This implies that the model is a good fit for the data and hence can be used in predicting the influence of analytical quality control systems on the performance of maternal and child healthcare programme in Homa- Bay County.

The study findings of the regression coefficient for the influence of Analytical Quality Control Systems and maternal and child healthcare programme in Homa-Bay County shows that analytical quality control systems indicate has a positive and significant influence on the performance of maternal and child healthcare programme in Homa- Bay County with a regression coefficient of 0.984 and *P*-value = 0.000. This implies that with improved analytical quality control systems will significantly contribute to improved performance of maternal and child healthcare programme in Homa Bay County. These findings agree with Howanitz (2005) which indicated that analytical quality control system influence diagnostic accuracy and prevent diagnostic errors in the testing process.

The study found that there were few cases of specimen mix-up in the laboratories. In addition, the study found that the cases of health facilities experiencing unnecessary duplication of specimens were low. Bates and Maitland (2006) had earlier argued that in the analytical phase of a laboratory test inadequate information system can lead to unnecessary duplication of laboratory test when clinician ordering the test is not aware of previous laboratory request misidentification of samples in the pathology laboratory poses a risk of misdiagnosis to thousands of patients annually or prior test results from other clinicians.

The study also found that there were cases of incorrect sample labeling in the health facilities. These findings agree with Kahn, Jarosz and Webster 2009: Nichols, 2011) findings that most of the laboratory errors occur at preanalytical phase and mostly involve mislabelling specimen. The study found that specimen volume is one of the factors leading to specimen rejection in the lab. The findings agree with Hyman (2014) findings that the volume of a specimen can affect the accuracy of analytical results. However, the volume of the specimen used in the laboratory analysis is always enough. Nevertheless, inadequate samples at times found their way to the laboratories for testing.

The study revealed that equipment calibration affects the quality of laboratory analysis. However, equipment in the laboratories of health facilities in Homa-Bay County underwent regular maintenance and was always calibrated.

This is in line with Hyman, (2014) that medical equipment management should also aim at ensuring that equipment in the clinical laboratory is well calibrated with known standards within a given interval in order to identify assay deviation.

The study established that quantity control mechanisms that can improve quality of result at the analytical phase include internal controls, external quality control, precision pipetting and correct specimen/ sample. Other quantity control mechanisms include precision pipetting, use of qualified personnel, use of Standard Operating Procedures (SOPs) at processing, strict follow up of SOPS when conducting a test, regular performance of quality control, ensuring sample quality and quantity, regular calibration of machines, good labelling of samples, running internal quality control before sample analysis and consistency in conducting quality control before sample analysis. The study found that analytical control, if not run daily, may lead to inaccurate results resulting in wrong diagnosis hence wrong treatment. Analytical quality control systems ensure the release of quality lab results that conform to international standards.

4. Conclusion

The findings of the study indicated that analytical quality control positively influence performance of maternal and child healthcare programme. Specimen mix up, specimen volume and equipment calibration were found to have a strong and positive influence in performance of maternal and child healthcare programme. Therefore, it can be concluded that analytical quality control systems play a significant role in ensuring safe mother hood, better health for children under the age of five.

5. Implication of the Study

The study explored the influence of analytical quality control systems on performance of maternal and child healthcare programme in Homa-Bay County, Kenya. The study revealed that a statistically significant relationship between analytical quality control and performance of maternal and child healthcare programme. This implies that for health institutions to effectively reduce laboratory error at analytical phase there was need to adopt quality control in specimen collection, specimen labeling and equipment management to ensure production of quality laboratory results.

References

[1] Aakre, Kristin M, Langlois, Michel R, Watine, Joseph, Barth, Julian H, Baum, Hannsjörg, Collinson, Paul, . . . Oosterhuis, Wytze P. (2013). Critical review of laboratory investigations in clinical practice guidelines: proposals for the description of investigation. *Clinical chemistry and laboratory medicine*, *51*(6), 1217-1226.

[2] Agarwal, Banwari, Wright, Gavin, Gatt, Alex, Riddell, Anne, Vemala, Vishwaraj, Mallett, Susan, . . . Burroughs, Andrew. (2012). Evaluation of coagulation abnormalities in acute liver failure. *Journal of hepatology*, *57*(4), 780-786.

[3] Alkema, Leontine, Chou, Doris, Hogan, Daniel, Zhang, Sanqian, Moller, Ann-Beth, Gemmill, Alison, . . . Mathers, Colin. (2016). Global, regional, and national levels and trends in maternal mortality between 1990 and 2015, with scenario-based projections to 2030: a systematic analysis by the UN Maternal Mortality Estimation Inter-Agency Group. *The Lancet*, *387*(10017), 462-474.

[4] Bates, Imelda, & Maitland, Kathryn. (2006a). Are laboratory services coming of age in sub-Saharan Africa? *Clinical Infectious Diseases*, *42*(3), 383-384.

[5] Bates, Imelda, & Maitland, Kathryn. (2006b). Are laboratory services coming of age in sub-Saharan Africa? : The University of Chicago Press.

[6] Chilundo, Baltazar, Sahay, Sundeep, & Sundby, Johanne. (2004). The quality of HIV/AIDS case-detection and case-reporting systems in Mozambique. *African Journal of AIDS Research*, *3*(2), 145-155.

[7] Demographic, Kenya. (2014). Health Survey 2014: key indicators. *Kenya National Bureau of Statistics (KNBS) and ICF Macro*.

[8] Donabedian, Avedis. (1966). Evaluating the quality of medical care. *The Milbank memorial fund quarterly*, *44*(3), 166-206.

[9] Groves, Robert M, Fowler Jr, Floyd J, Couper, Mick P, Lepkowski, James M, Singer, Eleanor, & Tourangeau, Roger. (2011). *Survey methodology* (Vol. 561): John Wiley & Sons.

[10] Gupta, Vibha, Negi, Gita, Harsh, Meena, Chandra, Harish, Agarwal, Amit, & Shrivastava, Vikas. (2015). Utility of sample rejection rate as a quality indicator in developing countries. *The Journal of National Accreditation Board for Hospitals & Healthcare Providers*, *2*(1), 30.

[11] Howanitz, Peter J. (2005). Errors in laboratory medicine: practical lessons to improve patient safety. *Archives of Pathology and Laboratory Medicine*, *129*(10), 1252-1261.

[12] Ishengoma, DRS, Derua, YA, Rwegoshora, RT, Tenu, F, Massaga, JJ, Mboera, LEG, & Magesa, SM. (2010). The performance of health laboratories and the quality of malaria diagnosis in six districts of Tanzania. *Annals of Tropical Medicine & Parasitology*, *104*(2), 123-135.

[13] Olusegun, Ogunjimi Lucas, Ibe, Rosemary Thomas, & Micheal, Ikorok Maria. (2012). Curbing maternal and child mortality: The Nigerian experience. *International Journal of Nursing and Midwifery*, *4*(3), 33-39.

[14] Onwujekwe, O, Ojukwu, J, Uzochukwu, B, Dike, N, Ikeme, A, & Shu, E. (2005). Where do people from different socio–economic groups receive diagnosis and treatment for presumptive malaria, in south–eastern Nigeria? *Annals of Tropical Medicine & Parasitology*, *99*(5), 473-481.

[15] Parker, Steven. (2010). Conflict of Interest. *Cogeneration and Distributed Generation Journal*, *25*(2), 5.

[16] Robinson, Ronnie J, Wilson, Mark S, Ronsick, Christopher S, Walsh, John D, Hyman, Jones M, & Clay, Bradford G. (2014). System for rapid identification and/or characterization of a microbial agent in a sample: Google Patents.

[17] Unterhalter, Elaine. (2007). Gender equality, education, and the capability approach *Amartya Sen's capability*

approach and social justice in education (pp. 87-107): Springer.

[18] Valenstein, Paul N, Raab, Stephen S, & Walsh, Molly K. (2006). Identification errors involving clinical laboratories: a College of American Pathologists Q-Probes study of patient and specimen identification errors at 120 institutions. *Archives of pathology & laboratory medicine, 130*(8), 1106-1113.