East African Medical Journal Vol. 102. 8 August 2025
ASSESSMENT OF MAJOR TRAUMA CLINICAL PATHWAYS AND THEIR INFLUENCE ON PATIENT OUTCOMES IN HOSPITALS WITHIN THE LAKE REGION ECONOMIC BLOCK, KENYA

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ASSESSMENT OF MAJOR TRAUMA CLINICAL PATHWAYS AND THEIR INFLUENCE ON PATIENT OUTCOMES IN HOSPITALS WITHIN THE LAKE REGION ECONOMIC BLOCK, KENYA

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ABSTRACT

Background: **Major trauma remains a leading cause of morbidity and mortality globally, particularly in low- and middle-income countries where trauma care systems are often underdeveloped. In Kenya, trauma-related injuries account for a significant proportion of emergency department admissions and hospital mortalities, driven mainly by road traffic accidents, interpersonal violence, and occupational hazards. This study aimed to assess major trauma clinical pathways and their influence on patient outcomes in hospitals within the Lake Region Economic Block, Kenya.**

Methods: **The study employed a quasi-experimental design with non-equivalent control and intervention groups, using a multi-stage sampling approach. A total of 220 major trauma patients were recruited in this study. A Difference-in-Differences analysis was conducted to compare changes in Intensive Care Unit (ICU) length of stay between the intervention and control groups before and after the intervention. Statistical significance was set at $p < 0.05$.**

Results: **The minimum ICU stay for both groups was 2 days, with the longest stay of 15 days recorded in the control group. The mean ICU length of stay was 3.7 days in the intervention group and 9.5 days in the control group. In addition, Patients without airway intervention had 4.58 times higher odds of admission compared to those receiving advanced airway management (aOR = 4.58, 95% CI: 1.33-15.8, p = 0.016), while Burn injuries substantially increased admission odds compared to assault (aOR = 13.0, 95% CI: 1.86-91.1, p = 0.010).**

Conclusion: **The study demonstrated that the implementation of the Major Trauma Clinical Pathway significantly reduced ICU length of stay among trauma patients. Additionally, airway intervention and stab wounds were key predictors of ward admission. These findings highlight the importance of structured clinical pathways in improving trauma outcomes.**
Keywords: **Clinical pathway, Major trauma & Patient outcomes**

INTRODUCTION

Worldwide, trauma is a huge problem since it is a leading cause of disability and illness. Worldwide, trauma is responsible for around 4.4 million fatalities per year, or about 8 percent of all deaths [1]. Roughly 10% of the total disability years are attributable to injuries and violent incidents [2]. More precisely, about 1.35 million people lose their lives annually as a direct consequence of injuries sustained in traffic-related incidents [3]. Worldwide, trauma accounts for around 16% of all impairments [4]. A low quality of life, decreased productivity, extended hospital stays, and morbidity are all possible outcomes of these impairments [5]. Injuries sustained in motor vehicle accidents account for a disproportionately large share of trauma-related fatalities, 28% [6].

Patient outcomes and the efficiency of the health system are profoundly affected by trauma, which is among the top three causes of hospital admissions and mortality in Kenya [7,8]. Nearly half of the approximately 10,000 traffic accidents recorded in 2022 were fatal, with the remainder of individuals suffering a range of injuries, according to data from the 2019 economic survey [9]. Their study found that more than 80% of trauma patients in Western Kenya's emergency rooms were hospitalised due to trauma [10]. Another study found that the death rate for adults referred to emergency departments due to trauma was 1.8% [11]. To improve patient outcomes after trauma treatment, plans are being employed more and more to offer organised and prompt treatments [12]. This includes Integrated resuscitation methods, including pathway-based therapies, which are uncommon in low- and middle-income country hospitals [13,14]. The Major Trauma Clinical Pathway (MTCP) follows the guidelines laid out in the primary survey for Advanced Trauma Life Support (ATLS) in order to provide trauma treatment systematically [15].

Despite the high burden of trauma-related morbidity and mortality in Kenya, there is limited evidence on the effectiveness and implementation of major trauma clinical pathways in regional healthcare settings [16]. Specifically, hospitals within the Lake Region Economic Block lack standardized protocols for trauma care, and the impact of existing clinical pathways on patient outcomes remains unclear [16]. Most existing studies focus on trauma incidence rather than care processes or outcomes. This gap hinders efforts to optimize trauma care delivery, improve recovery times, and reduce complications or deaths. As a result, this study aimed to assess major trauma clinical pathways and their influence on patient outcomes in hospitals within the Lake Region Economic Block, Kenya.

METHODS

Study design

This study adopted a quasi-experimental, non-equivalent group design comprising intervention and control groups. Four Level 5 referral hospitals within the Lake Region Economic Block were purposively selected for participation. Kakamega and Vihiga County Referral Hospitals were assigned as the intervention sites, while Migori and Siaya County Referral Hospitals served as the control sites. In the intervention hospitals, a Major Trauma Clinical Pathway (MTCP) protocol was implemented to guide the management of major trauma patients in the Emergency Departments (EDs). Conversely, the control hospitals continued to provide trauma care based on their existing institutional Standard Operating Procedures (SOPs).

Study area

This study was conducted in Kakamega, Vihiga, Migori, and Siaya counties, which are part of the Lake Region Economic Block in western Kenya. Covering a combined land area of over 17,000 square kilometers, these counties are home to diverse populations across rural, urban, and peri-urban settings [9]. The region's major economic activities include agriculture, fishing, small-scale trade, and emerging industrial ventures. The study focused on four major hospitals, each representing the unique healthcare dynamics of its respective county. These hospitals serve as critical points for trauma care, making them ideal for assessing clinical pathways and their influence on patient outcomes across varied settings.

Study population

The study population comprises patients presenting with major trauma at selected referral hospitals in Kakamega, Vihiga, Migori, and Siaya counties within the Lake Region Economic Block, as well as the healthcare providers involved in the implementation of trauma clinical pathways in these facilities.

Sample size calculation

The sample size was calculated using the Modified Fisher's formula, resulting in a final sample of 220 patients, evenly divided between the intervention and control groups[17]. Patient matching was performed based on sociodemographic characteristics and injury mechanisms to ensure comparability between the two groups.

Sampling technique

In this study, a multi-stage sampling approach was used. Purposive sampling was applied to select Kakamega, Vihiga, Migori, and Siaya counties within the Lake Region Economic Block in western Kenya. From these counties, four level-five referral hospitals were also purposively selected based on their capacity to manage severe trauma cases defined by an Injury Severity Score (ISS) of 15 or higher and their availability of advanced resources and skilled personnel for comprehensive trauma care. Operational feasibility and comparability of facility characteristics were also considered. The hospitals were then randomly assigned to intervention and control groups. Sample size per facility was determined using probability proportional to size (PPS), based on the number of major trauma patients treated in the emergency department over the preceding three

months. To minimize confounding, participants in both groups were matched on key sociodemographic variables, including age, sex, and socioeconomic status.

Data collection tools and procedures

The data collection instruments included structured questionnaires, a skillset checklist, a chart review form, and an equipment and supplies checklist. The questionnaire consisted of two sections with ten questions covering personal and professional information. The skillset checklist assessed four core competencies in the clinical management of trauma patients: airway management with spinal control, ventilation support, hemorrhage control, and patient monitoring. The chart review form was designed to extract secondary data from patient records before and after the intervention. It captured personal information, injury details, emergency department (ED) presentation, clinical management, and final patient disposition to evaluate outcomes. The observation checklist was developed based on the WHO-recommended list of essential equipment and supplies for trauma care facilities.

Following recruitment, consent forms were administered to the sampled healthcare providers (HCPs) at each site. A self-administered questionnaire was then used to collect their personal and professional background information. As HCPs delivered care to trauma patients, their procedural performance in the EDs was observed over six months. These direct observations were conducted discreetly by trained research assistants or non-participating HCPs, without disrupting routine activities. Observers completed the checklists afterward, which were then collected by the research team. Additionally, a chart review was conducted by the principal investigator and research assistants after the patient's final disposition from each facility (endline).

Statistical analysis

Once data were collected, cleaned, and coded, they were entered into a computer and securely stored using cloud storage. The data management process involved importing trauma-related data from a CSV file into R (version 4.1.1), comprising 220 observations from four counties. Power calculations were performed using G*Power 3.1, and statistical significance was set at $p < 0.05$. A Difference-in-Differences (DiD) analysis was employed to assess the impact of the intervention over time by comparing changes in outcomes such as ICU length of stay between the intervention and control groups, before and after the intervention. The DiD model accounted for both time and intervention effects, isolating the true effect of the intervention while controlling for time-related variations. Additionally, effect sizes were calculated to measure the practical significance of the findings, with Cohen's d used to interpret the magnitude of the intervention's impact beyond statistical significance.

Ethical consideration

Approval to conduct the study was first sought from the university's graduate school, followed by ethical clearance from the Institutional Ethics and Review Committee (IERC) (MMUST/IERC/025/2022). The National Commission for Science, Technology, and Innovation (NACOSTI)

also granted authorization (NACOSTI/P/22/16647). Permissions were obtained from the respective county health departments, administrative heads, and ethical committees of Kakamega County Referral Hospital, Vihiga County Referral Hospital, Migori County Referral Hospital, and Siaya County Referral Hospital. Informed consent was obtained from participating healthcare professionals, who were free to withdraw from the study at any point without coercion or inducement. For patients, consent was sought directly or from next of kin post-stabilization, with implied consent applied where appropriate [18]. Confidentiality and anonymity were strictly maintained using coded identifiers known only to the research team. While the study posed no physical harm, potential psychological risks were minimized by ensuring participants' privacy and data protection throughout the research process.

RESULTS

Patient Demographics

Patient demographic data were collected on age, gender, marital status, education level, and occupation, as summarized in Table 1. The mean age of participants was 39.5 years at baseline and 46 years at endline. Of the total participants (n=220), 91 (41.4%) were female and 129 (58.6%) were male. The majority were married (n=159, 72.2%), followed by single (n=59, 26.8%) and widowed (n=2, 1%). Most participants had attained secondary education (n=104, 47.3%), while a smaller number had completed tertiary education (n=47, 21.4%). In terms of occupation, nearly half were business people (n=99, 45%), followed by students (n=61, 27.7%), with the remaining participants (n=121, 55%) engaged in farming, housework, or casual labor..

Table 1:
Patient Demographics

		Baseline		**Endline**	
		Control n (%)	**Intervention n (%)**	**Control n (%)**	**Intervention n (%)**
Age (years)	<20	1(2)	2(4)	0(0)	2(4)
	20-29	18(39)	15(26)	13(20)	15(28)
	30-39	6(13)	14(25)	17(27)	10(19)
	40-49	8(17)	7(12)	15(23)	11(21)
	50-59	7(15)	9(16)	9(14)	7(13)
	60-69	4(9)	8(14)	10(16)	7(13)

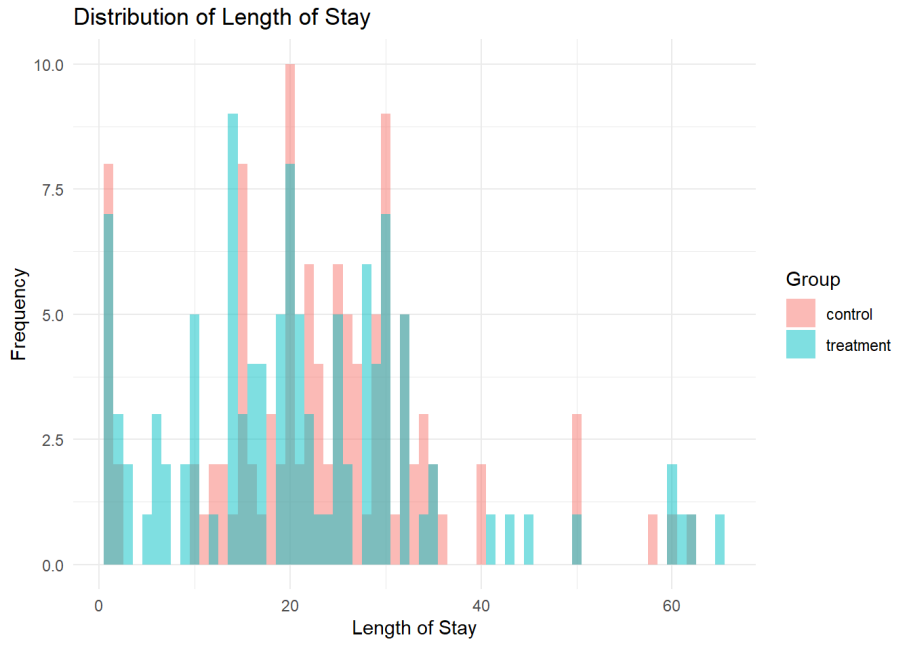
	70-79	2(4)	2(4)	0(0)	1(2)
Gender	Male	26(56.5)	33(57.9)	37(57.8)	33(62.3)
	Female	20(43.5)	24(42.1)	27(42.2)	20(37.7)
Marital status	Single	16(34.8)	17(29.8)	11(17.2)	15(28.3)
	Married	30(65.2)	39(68.4)	53(82.8)	37(69.8)
	Widowed	0(0)	1(1.8)	0(0)	1(1.9)
Education level	Primary	18(39.1)	25(43.9)	16(25.0)	10(18.9)
	Secondary	20(43.5)	19(33.3)	34(53.1)	31(58.5)
	Tertiary	8(3.6)	13(22.8)	14(21.9)	12(5.4)
Occupation	Business	14(3.4)	13(22.8)	19(29.7)	15(28.3)
	Student	8(17.4)	12(21.1)	7(1.9)	11(2.8)
	Farmer	6(13.0)	10(17.5)	4(6.3)	5(9.4)
	Casual work	5(1.9)	4(7.0)	4(6.3)	2(3.8)
	House wife	4(8.7)	7(12.3)	5(7.8)	5(9.4)
	Others	9(19.6)	11(19.3)	25(39)	15(28.3)

ICU Length of Stay (LOS)

The minimum length of stay in the ICU for both groups was 2 days, while the longest stay was among the control group at 15 days.

As provided in Figure 1, overall, the mean length of ICU stay for admitted trauma patients among the intervention and control groups was 3.7 and 9.5 days, respectively.

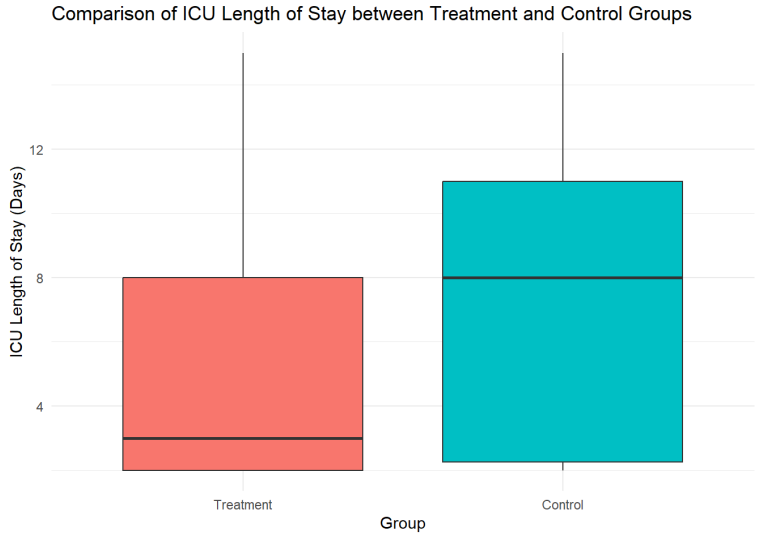
Figure 2:
Distribution of ICU Length of Stay



Comparison of ICU LOS between groups

The boxplot in Figure 2 compares the ICU length of stay (in days) between intervention and control groups. The intervention group has a median ICU stay of about 3.5 days, with an interquartile range (IQR) from about 3 to 8 days. The control group has a higher median ICU stay of approximately 8 days, with an IQR from about 3 to 10 days. These results indicate that the intervention group experienced a shorter median ICU stay compared to the control group. Therefore, the null hypothesis that the use of MTCP is not effective in the care of major trauma patients in the Lake Region Economic Block is rejected.

Figure 2:
Comparison of ICU LOS between groups



Effect of Major Trauma Clinical Pathway on ICU Length of Stay

A t-test was conducted to assess the impact of the Major Trauma Clinical Pathway (MTCP) on ICU length of stay (LOS). The analysis revealed a significant difference in length of stay between the intervention and control groups ($t(215.89) = 3.3028$, $p = .00112$, 95% CI [.722, 2.860]). Patients in the intervention group had a mean ICU length of stay of 5.40 days, while those in the control group had a mean length of stay of 7.19 days. Additionally, a Difference-in-Differences (DiD) regression model was fitted to further examine the effect (Table 2). The model indicated a significant interaction between intervention and time, suggesting differential changes in length of stay over time between the two groups ($\beta = 7.369$, $p = .0353$). However, the main effects of intervention and time were not statistically significant. Further analysis using Cohen's d to measure the effect size yielded a value of -2.483, indicating a large effect. This association demonstrates the effectiveness of MTCP, leading to the rejection of the null hypothesis that MTCP does not affect the care of major trauma patients in the Lake Region Economic Block.

Table 2:

Difference-in-Differences Regression Analysis of the Effect of the Intervention on ICU Length of Stay (LOS)

Coefficients	**Estimate**	**Std. Error**	**t-value**	**p-value**
Intercept	22.239	1.888	11.778	< .001
Interv_controltreatment	-5.906	2.379	-2.483	.014
Time_endline	2.214	2.476	.894	.372
interv_control_timeinterv.baseline	7.369	3.479	2.118	.035

Ward Admissions

The intervention group experienced a slight increase in the percentage of ward admissions from 42.11% at baseline to 52.83% at endline, representing a 1.72 percentage point increase. In contrast, the control group saw a decrease in the percentage of ward admissions from 63.04% at baseline to 53.13% at endline, a 9.91 percentage point decrease as shown in Table 3. Despite this improvement in the intervention group, the control group consistently had a higher percentage of ward admissions at both time points.

Table 3:
Comparison of Ward Admissions among the groups

Time	Intervention Control	Total Ward Admissions	Total Observations	Percent Ward Admissions
Baseline	Control	29	46	63.04%
Baseline	Intervention	24	57	42.11%
Endline	Control	34	64	53.13%
Endline	Intervention	28	53	52.83%

Association between specific predictors and ward admissions

Multivariable logistic regression using Firth's penalized likelihood method identified several predictors of ward admission (Table 4). Patients without airway intervention had 4.58 times higher odds of admission compared to those receiving advanced airway management (aOR = 4.58, 95% CI: 1.33-15.8, p = 0.016). Burn injuries substantially increased admission odds compared to assault (aOR = 13.0, 95% CI: 1.86-91.1, p = 0.010). Other predictors, including triage category and emergency department duration, showed no statistically significant associations with admission outcomes.

Table 4:
Predictors of Ward Admission

Characteristic	OR	95% CI	Level p-value
Airway intervention			**<0.001**
ETT	—	—	—
None	4.58	1.33, 15.8	**0.016**
Suction	0.80	0.21, 3.07	0.750

Triage category			**0.586**
Delayed	—	—	—
Immediate / Urgent	2.40	0.08, 68.5	0.620
ED duration			**0.393**
<1 hour	—	—	—
1-2 hours	0.82	0.42, 1.63	0.570
2+ hours	2.32	0.43, 12.6	0.330
Mechanism of injury			**0.012**
Assault	—	—	—
Burns	13.0	1.86, 91.1	**0.010**
RTI	1.12	0.38, 3.29	0.840

Abbreviations: CI = Confidence Interval, OR = Odds Ratio

Firth's regression; AIC = 274.7; AUC = 0.764; n = 220

DISCUSSION

The implementation of Major Trauma Clinical Pathways (MTCPs) demonstrated remarkable efficiency in streamlining patient care, evidenced by significant reductions in both ICU and overall hospital length of stay (LOS) [19]. Trauma patients admitted to the ICU in the intervention group (using MTCP) experienced a significantly shorter average length of stay of 3.7 days, compared to a mean of 9.5 days for the control group. Previous studies have demonstrated an average ICU length of stay of 6.5 days [20]. Similarly, a study on bowel resection patients found that pathway implementation lowered mean postoperative LOS from ≈10 days to ≈7.7 days, along with cost reductions [21].

The study also showed a significantly shorter hospital length of stay in the intervention group compared to the control (18.5 vs 24.4). This finding is consistent with that of a study conducted in the UK, which found a decrease in hospital length of stay for older trauma patients following the introduction of specific pathways of care [22]. The average length of stay was, however, slightly higher in contrast to a mean of 9.8 days and 11.6 days [11,23]. The significant difference in the length of stay in this study shows that MTCPs facilitate more timely interventions and standardized care processes, effectively reducing unnecessary delays in patient management, as demonstrated in previous studies [19,24].

The other important outcome of trauma patients that the study sought to find out was patient mortality. The study revealed a significant decrease in hospital mortality rates, with the intervention group experiencing a reduced proportion of mortality of 3.8% compared to 9.4% in the control group. These findings are consistent with similar studies that demonstrated a reduction in mortality in major trauma patients using trauma clinical pathways [25,26]. The substantial difference underscores the potential of MTCPs to save lives in trauma

care settings by addressing critical aspects of major trauma management that are vital to patient survival, ensuring timely and appropriate care at every stage of treatment. Their study reinforces the importance of implementing trauma clinical pathways, showing that adherence to these evidence-based protocols correlates with reduced mortality and shorter hospital stays across diverse populations [27]. Their study noted that there is a reduction in mortality for patients treated using a patient pathway-based intervention.

Longer ED duration was also positively associated with admission, with each additional minute in the ED increasing the likelihood of ward admission. Similarly, Korean data showed that an ED stay of six hours or more independently increased the odds of in-hospital mortality, highlighting the clinical importance of ED duration [28].

Limitations

One key limitation of the study was the use of purposive sampling to select the Lake Region Economic Block, which may affect generalizability. The sample was drawn from four Level 5 referral hospitals, whose resources and patient profiles may differ from lower-tier facilities. Consequently, the findings may not reflect outcomes in other regions or healthcare settings. However, random sampling was used to select counties and assign hospitals to intervention or control groups, and patient matching was done based on sociodemographic and injury characteristics. Additionally, reliance on self-reported data from healthcare providers posed a risk of recall and perception bias. This was mitigated through data triangulation, combining questionnaires with chart reviews and direct observations to enhance accuracy and reliability. Future studies should consider larger, more diverse samples to improve representativeness and generalizability.

Conclusion

The study revealed that implementation of the intervention significantly improved trauma care efficiency, with ICU length of stay reduced from an average of 9.5 days to 3.7 days among patients in the intervention group. Patients who did not receive airway intervention had higher odds of admission compared to those managed with advanced airway techniques, emphasizing the crucial role of airway management in patient stabilization and outcomes. Additionally, burn injuries were associated with markedly increased odds of admission compared to assault cases. It is therefore recommended that this approach be institutionalized and scaled up across trauma centers to strengthen emergency response systems, improve patient survival, and promote efficient use of critical care resources.

Acknowledgment

The authors express their gratitude to the research participants for their enthusiastic participation in this study.

Funding: No funding sources.

Conflict of interest. None declared.

Authors contribution: S.O.O played a key role in data analysis and manuscript writing, S.O.O, J.M.O & T.S. in the review of the manuscript. All authors read and approved the final manuscript draft.

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