Assessment of Adequacy and Appropriateness of Pain Management Practice among Traumatic Patients at Addis Ababa Burn, Emergency and Trauma Hospital, Addis Ababa, Ethiopia: A Prospective Observational Study

By

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This is to certify that the thesis prepared by Wondwossen Alemu, entitled: ***"Assessment of Adequacy and Appropriateness of Pain Management Practice among Traumatic Patients at Aabet Hospital, Addis Ababa, Ethiopia: A Prospective Observational Study"*** and submitted in partial fulfillment of the requirements for the Degree of Master of Pharmacy in Pharmacy Practice complies with the regulations of the University and meets the accepted standards concerning originality and quality.

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Abstract

Assessment of Adequacy and Appropriateness of Pain Management Practice in Traumatic Patients at Aabet Hospital Addis Ababa, Ethiopia: A Prospective Observational Study

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Acute pain is the most common and prevalent reason for emergency department (ED) visits with a prevalence of over 70% in the world. The study aimed to assess the adequacy and appropriateness of pain management practice at Aabet Hospital. An observational prospective study was conducted at Aabet hospital from December 1, 2020 to March 30, 2021. Adult traumatic patients having pain (at least score 1 on the Numeric Rating Scale) with a Glasgow Coma Scale score >13 were eligible to participate in the study. The pain intensity was evaluated at the time of admission, at 60, 120, 180, and 240 minutes. The time of first analgesics was registered. The adequacy and the appropriateness of the pain management practice were calculated through the pain management index (PMI) and Pain Medication Appropriateness Scale (PMAS), respectively. Two hundred thirty- two (232) participants were included in this study after obtaining their consent. The majority of the participants 126 (54.3%) were admitted due to road traffic accident followed by falls 44(19%). Only 21 (9.1%) study participants received the first analgesic treatment within 30 minutes while 27(11.6%) participants had no treatment. Among the study participants 72 (31%) received non opioids, 59 (25.6%) received weak opioids, and 37 (15.9%) received strong opioids. Nearly half 110 (47.4%) of the study participants were treated inadequately (PMI (-) score) and nearly two-third (140 (60.3 %)) of the participants were treated inappropriately. The type of analgesia administered, time to analgesia and pain intensity could predict 65% of variance in PMI score (R^2= 0.65, P= .001). From this study it can be concluded that acute pain in traumatic patients was under and inappropriately treated. Thus, the clinical practitioners should to stay vigilant towards acute pain management in the trauma center.

Key words: Pain intensity, time to analgesia, adequacy and appropriateness of pain management, observational study

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List of Abbreviations and Acronyms

AaBET	Addis Ababa Burn, Emergency and Trauma Hospital
AAU	Addis Ababa University
ED	Emergency Department
ER	Emergency Room
EMS	Emergency Medical Services
GCS	Glasgow Coma Scale
IASP	International Associations for the Study of Pain
IQR	Inter Quartile Range
LOS	Length of Emergency Stay
NRS	Numeric Rating Scale
NSAIDs	Non-Steroidal Anti-Inflammatory Drugs
PMAS	Pain Medication Appropriateness Scale
PMI	Pain Management Index
PMI (-)	Pain Management Index Negative Value
RTA	Road Traffic Accident
SD	Standard Deviation
SPHMMC	St Paul's Hospital Millennium Medical College
SPSS	Statistical Package for Social Science
TASH	Tikur Anbessa Specialized Hospital
US	United States of America
VRS	Verbal Rating Scale
WHO	World Health Organization

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1. Introduction

1.1. Background

Pain is "an unpleasant sensory and emotional experience associated with, or resembling that associated with, actual and/or potential tissue damage" (1). It is the most common and prevalent reason for emergency departments (ED) visits with very high prevalence all over the world. Painful conditions cause over 70% of all ED visits in the United States of America (USA) and Canada. They were traumatic pain followed by urologic pain, abdominal pain, and non-traumatic musculoskeletal pain (2, 3). Pain prevalence in ED in sub-Saharan Africa has been as high as 83% (4, 5).

Acute traumatic pain has been the most neglected but yet the most deleterious to the health and well-being of injured patients (6). It's to curb this negligence towards pain in an emergency setting that the guidelines and researchers recommend pain as a vital sign in emergency care (3).

Guidelines and experts recommend the management of acute pain in less than 30 min (time to analgesia) but the mean time to analgesia for most settings in ER was 78 minutes in the US and greater in low-income countries (5, 7-10). Appropriate acute pain management depends on the accuracy of interpreting patients self-reported measures of pain with one-dimensional pain intensity evaluation scales like the Numerical Rating Scale (NRS) and the clinical decisions about which drug to administer to the patients depends on the assessment of the acute pain (11, 12). The adequacy and appropriateness of pain management could be assessed through validated tools. Pain Management Index (PMI) is a tool that is used to compare a specific patient's pain intensity to the adequacy of the prescribed analgesics according to the WHO (World Health Organization) pain management ladder (13, 14**).** The pain medication appropriateness scale (PMAS) is another tool designed for improving pain management practices and follows the appropriateness of pain management (15, 16).

The right pain management requires knowledge about the pharmacological properties of non-opioids and opioids analgesics as well as, the assessment of risks related to opioid diversion, abuse, and misuse (2, 7**).** A systematic review and meta-analysis showed that pharmacist-led intervention in pain management contribute substantially to pain management, ensuring the rational use of medicine and resulting in reduced pain intensity

(17). Clinical pharmacists perform pain assessments, assess for substance use disorders, and develop individualized treatment plans in pain management which increase the quality of care (18, 19).

This study was therefore aimed at assessing the pain intensity of traumatic patients, time to analgesia of the traumatic patients, adequacy and appropriateness of the pain management. It would be an important milestone in informing all concerned bodies about device interventions and conducting further research regarding in acute pain management practice in an emergency setting in Ethiopia.

1.2. Statements of the Problem

Emergency medical service has several presenting complaints and the most frequent are trauma, followed by general unspecified symptoms (chest pain, myocardial infarction, and heart disease), abdominal problems, shortness of breath, coughing, and epistaxis (20, 21). Acute traumatic pain is the most reported complain in the ED. Despite being the most frequently reported compliant, acute pain has not been treated adequately and appropriately (22).

Early analgesia to traumatic patients has been another challenges in the emergency setting in that pain has not been considered as urgent as the injury (23). Painful conditions cause over 70% of all ED visits in the US and Canada with the most common being traumatic pain (40.44%), urologic pain (13.52%), abdominal pain (13.39%), and non-traumatic musculoskeletal pain (7.10%) (2, 20). Those numbers are even higher in African countries and resource-limited countries like Ethiopia. Moreover, most African countries have no acute pain management guidelines for pain relief with the exception of South Africa (24-27)**.** The provision of early analgesia (time to analgesia) to emergency and traumatic patients has been a setback to acute pain management. Pain should be treated in less than 30 minutes but the mean time for most setting in ER is 78 minutes and the median time from triage to analgesia was 107 minutes in the US (28, 29). In Australian ED, the median time to analgesia was 60.5 minutes (IQR 30-87) (30). In developing nations like Africa, where the use of pain management protocols is lacking, patients should have to wait for a lengthy delay for analgesia administrations (5, 25, 26).

The appropriate and adequate treatment of acute pain at the emergency visit is important to minimize persistent pain after discharge (15, 31). Inadequate pain management could result in delayed return to work, psychological stress, disability, and chronic pain (22)**.** In Iran, a study showed that pain management was inadequate in 30% of traumatic patients though patients had severe pain after 240 minutes of the following-up with a mean pain score of 4.3 (p=0.039). Inadequate pain relief is marked by a discharge with low pain or moderate pain (32). A study conducted at Yekatit 12 hospital in Ethiopia showed 87.1% of burn patients in the hospital were feeling severe pain and only receiving non-opioids (33). The finding observational prospective study from Gondar University Hospital showed that 57% of patients reported that the analgesic was not adequate and needed

additional analgesia. It also revealed that pain was inadequately managed according to the WHO pain ladder (5, 14, 33).

Pain management studies in emergency medicine are among the recent, which came to appear in the literature in early 1990 in which most were retrospective studies (34, 35). It was yet until 2007 that a groundbreaking, multicenter prospective study was done on pain management in the ED of the United States and Canada (9). Pain management researches in general, particularly in the ED were scarce to non-existent in most Africa countries (4, 36). In an Ethiopian scenario, there were only a few studies done in pain management as a whole and as of our knowledge, acute pain in ED was only studied in emergency surgical patients in Gondar. It merely observed the participants for 2 hours in ED and didn't follow the full timing of the triage category to four hours unlike the current study. Moreover, it summarized the result for both trauma and non-trauma emergency surgical patients (5).

Thus, the present study aimed to identify adequacy, appropriateness and time to analgesia of acute pain management by assessing pain intensity before and after administration of analgesia to traumatic patients, assessing the adequacy of acute pain management following the WHO pain management ladder and assessing time to analgesia of trauma patients admitted to Aabet hospital.

1.3. Significance of the Study

This study is important in improving pain management adequacy, appropriateness, and early analgesia at trauma centers and emergency medical services in general. It sheds light on the acute traumatic pain patients in an emergency is more of a priority and has equal acuity with the trauma in emergency medical services.

The finding of this study might magnify pain as the fifth vital sign that should be assessed and treated properly. It is a breakthrough study of acute pain management in traumatic patient in an Ethiopia trauma center.

2. Literature Review

2.1. Prevalence of Pain and Pain Intensity Assessments in Emergency

Trauma is an injury to tissue and organs resulting from mechanical, thermal, chemical, or electrical mechanisms beyond the body's resilience to tolerate. Traumatic injuries were responsible for the death of more than 5.8 million people annually and many more were left physically and emotionally injured due to injuries. Road traffic accidents (RTA), falls and burns are the most common mechanism of injury (22, 37). Trauma is the main etiology of acute pain and traumatic pain prevalence is greater than 70% worldwide (21, 25)**.**

Painful conditions prompting over 70% of all ED visits and traumatic pain (40.44%), urologic pain (13.52%), abdominal pain (13.39%), and non-traumatic musculoskeletal pain (7.10%) were among the pain conditions overwhelming emergency department in the US and Canada (2). In 2015, there were 136 million ED visits in the US, among which 45% of them complain about pain and increasing to 78 % in 2018 (20, 28, 31, 38). Pain prevalence in sub-Saharan Africa could be as high as 83% due to the scarce availability of opioids(4).

Moreover, pain is one of most common reason for admission and readmission. Emergency room visits and advice seeking were higher in participants reporting pain, suggesting that poorly managed pain following discharge may have a significant impact on healthcare utilization (22).

Hospital-based cross-sectional study conducted at Yekatit 12 hospital in Addis Ababa showed that the severity of burn pain depends on the degree of the burn and the percentage of total burns surface area (TBSA). It indicated that higher percentage of TBSA burnt is associated with the higher feeling of pain (33). An Observational prospective study in Gondar University Hospital also showed that 57% of patients reported that the analgesic was not adequate and needed additional analgesia while 71.9% of the patients admitted to the emergency felt severe pain (5).

Pain assessments were often done by expert opinion and clinical observation rather than validated pain assessment tools (39). There are several pain assessment tools that could be divided into two major groups, one-dimensional assessment tools and multidimensional assessment tools. The former one is designed for quick, easy to use and

repeated measure but they don't measure all aspects of pain and holistic pain management. Visual Analogue Scale (VAS), Numerical Rating Scale (NRS), and Verbal Rating Scale (VRS) are grouped here. The latter is used to measure an in-depth pain assessment and holistic pain assessments including the interferences of pain with daily activities. It's generally used for assessments of chronic pain and the current study is using the one-dimensional pain assessment for acute pain study (2, 12). Under evaluation and scarce accuracy during the assessment of pain resulted in under-treatment and inadequate management of pain therapy in ED (2, 40).

The revised American pain society pain outcome questionnaires (APS-POQ-R) measures six important dimensions of the patient pain experience. These six aspects include (1) pain severity and relief, (2) impact of pain on activity, sleep, and negative emotions, (3) side effects of treatment, (4) helpfulness of information about pain treatment, (5) ability to participate in pain treatment decisions and (6) use of non-pharmacological strategies. However, the revised American pain society pain outcome questionnaire (APS-POQ-R) needs more quality improvement research to address quality pain management in pediatrics and outpatient settings (41)**.**

The Amharic language version of the Brief Pain Inventory (BPI-Am) was validated in Tikur Anbessa Specialized Hospital among patient treated for cancer. Validation of the BPI in different languages, using a similar factor analysis technique, has consistently identified a 2-factor construct with pain severity items and interference items (13).

2.2. Time to Analgesia

Acute painful conditions should be treated immediately in less than 30 min (time to analgesia) but the mean time for most settings in ER is 78 minutes in the US (1, 12)

A groundbreaking prospective multicenter study conducted in the US and Canada by Todd et al., (2017) indicated that pain and oligoanalgesia were very rampant and only 60% got analgesia after 90 minutes of delay (9)**.** Another prospective study conducted at ED in the US showed that the median time to analgesia from triage to analgesia was 107 minutes (29)**.**

A retrospective chart review of patients with pain in Australian ED revealed that the median time to analgesia was 60.5 minutes (IQR 30-87) and 61.3% of the patients received analgesia within 30 minutes (30). Likewise, another retrospective study of ER

patients with pain in Australia revealed that only 19.2% of patients received early analgesia (42). A post hoc analysis in Canada showed the impact of pain relief on ED length of stay and rapid administration of analgesia. Pain relief was not associated with time to analgesia but it had an association with emergency length of stay (43**).** The mean time to the first analgesia was 60.98 ± 34.05 minutes for all emergency surgical patients according to a study in Gondar university hospital in Ethiopia (5).

Documentation of pain scores and time to analgesia is the important clinical indicators of pain management in the emergency department. However, the delivery of analgesic timely to emergency patients with pain has been challenging. The proposed reasons for the lengthy delay of pain management in ED are the growing number of chronic diseases in the community and reduced access to primary healthcare and ED overcrowding (30). Implementation of acute pain protocol would significantly improve pain management by decreasing the time of analgesia (8, 44).

2.3. Adequacy and Appropriateness of Pain Management in Traumatic Patients

Pain is the most common presenting symptoms in an emergency setting but it turns out to be under-treated in most setting. In addition to making the patient comfortable, analgesia has a significant impact on early ambulation, adequate oxygenation, early wound healing, reduces stress response to surgery, and decreases the progression of the pain to chronic pain (22, 28).

Inadequately treated pain has a universal and profound effect on the quality of life Even though pain management is simple medical practice; it resulted in several untoward health outcomes. In addition to the physical burden, chronic pain has a significant impact on the socio-economic status of the patients in interference of general work activities. Moreover, the overall cost of chronic pain to the patients and the government is estimated to be costly (6, 45). The appropriate and adequate treatment of acute pain at the emergency visit is important to minimize the persistent pain after discharge (31). The persistent pain developed would lead to ED overcrowding and health care burden (46).

A reduction of approximately 30% in a NRS in acute pain has been considered as a clinically important difference (41). Under evaluation and scarce accuracy during the assessment of pain resulted in under treatment and inadequate management of pain therapy in ED (2, 47). A study in Iran on pain management of trauma patients in the

emergency department showed that only 13.3% of the patients were given pain intervention (32).

Advances in pain management have been increasing over years including procedural sedation and analgesia, simple procedural pain management, and abdominal pain management in primary emergency care (48-50)**.** Pharmacologic pain managements are divided into three main categories; opioids include Codeine, Fentanyl, Morphine, Oxycodone and Tramadol; non-opioids/non-steroidal anti-inflammatories including paracetamol, aspirin, ibuprofen, naproxen, diclofenac and adjuvants/co-analgesics like Gabapentin, Pregabalin, Duloxetine, Ketamine, and Amitriptyline) (3, 12, 38). A worldwide survey showed that the preferred analgesia were morphine, fentanyl and paracetamol with or without combination (47). The WHO analgesic ladder follows that step one is non-opioid with or without adjuvants, step two is a weak opioid with or without non-opioid and adjuvants, and step three is a strong opioid with and without non-opioid and adjuvants (12, 14).

Multimodal pain management protocols have consistently been shown to improve pain control while reducing reliance on opioids and the use of non-opioids as first-line treatment for acute pain in EMS is recommended as the opioids crisis has been overwhelming the health care (38). Many of the common agents used in multimodal therapy are supported by high-quality evidence (7, 51). Due to the current opioid crisis alternative pain therapies (opioids sparing therapies) have been developing like novel non-opioid therapy as brain stimulation or gene therapy (52).

In several studies, the use of pain management protocols and guidelines in emergency departments have a significant outcome in improving pain management and pain reduction (8, 53-56).

Pain management in Africa has several unmet needs and only less than 5% of those in needs had access to pain management. The availability of opioids has been imposing a significant challenge to the affordability of African pain management (36). Opioids are not easily available and/or Access is restricted through laws and bureaucratic red tape or prejudices in Ethiopia and other African countries while opioids were freely available and accessible in the US. Uganda and Kenya have strong strategies for developing palliative care which would be a model for other resource-limited setting in Africa (4, 10, 26).

South African acute pain guidelines stated that acute pain is not a thing of luxury but a human right. It's when only acute pain is treated effectively that chronic pain could be addressed (24). A retrospective chart review of 2401 traumatic patients in the Western Cape Province, South Africa showed only 435 (18.1%) had pain recorded of which 92.7% experienced pain in pre-hospital trauma care. Only 68 patients (2.8%) received medication with analgesic effect in pre-hospital care (25).

The PMI is a tool that used to compare specific patients' pain management using the WHO pain management ladder. Negative scores on the PMI will be considered as indicators of inadequate pain management, and scores of 0 and greater are indicators of adequate pain management (13, 14, 32). PMAS is another valid tool to analyze the pharmacological treatment of pain. PMAS score $\leq 67\%$ is considered inappropriate pain management (15, 16, 57, 58).

In general, appropriate and adequate pain management needs adequate knowledge of pharmacologic treatment ranging from oral, intravenous, and intramuscular medications; topical agents; and peripheral nerve blocks. Moreover, pain management needs clinicians and pharmacists with knowledge of the pharmacology of analgesics, anesthetics, contraindications, precautions, Side effects, administrations and monitoring requirement (18, 28, 57).

2.4. Barriers and Facilitators of Pain Management in Traumatic Patients

Several studies have confirmed that pain has been undertreated for a variety of reasons that emanate from culture, attitude, education, legal and system-related issues (6). The several reasons why patients were undertreated in ED were the concern of masking symptoms, poor communication between clinician and patient, lack of documentation and assessment of pain, and fear of causing addiction (28, 54, 59).

Opioid misuse and availability are the barriers and challenges of pain management in the emergency department (60, 61). The availability of opioids has been imposing significant challenges to the affordability of African pain management (4, 26, 36).

Guidelines and protocols were the main enablers of pain management (38, 53, 54, 62) The implementation of an evidence-based model of care and protocol for pain enhances emergency care by reducing inappropriate overuse of tests and treatments and improving patient outcomes (23, 55, 56).

Generally, pain management in Africa has several unmet needs and barriers in that less than 5% of those in needs had access to pain management. Opioids are not easily available and/or access is restricted through laws and bureaucratic red tape in Ethiopia and freely available and accessible in the US. Uganda and Kenya have strong strategies for developing palliative care which would be a model for other resource-limited setting in Africa (4, 25, 26, 63, 64). In 2014, the Federal Ministry of Health (FMOH) with the American Cancer Society treat the pain program launched the Pain-Free Hospital Initiative (PFHI), as a one-year hospital-wide quality improvement initiative to integrate pain treatment into service delivery by providing education for hospital staff, raising motivation and awareness, measuring and documenting pain levels, and improving medicine supply (65).

3. Objective

3.1. General Objective

The study aimed to assess the adequacy and appropriateness of pain management at Aabet Hospital, Addis Ababa, Ethiopia.

3.2. Specific Objectives

- To assess time to analgesia for traumatic patients admitted to Aabet hospital.
- To assess pain intensity before and after analgesia administration to traumatic patients admitted to Aabet hospital.
- To assess the adequacy of acute pain management in accordance with the WHO pain management ladder among traumatic patients admitted to Aabet hospital.
- To assess the appropriateness of pain management among traumatic patients admitted to Aabet Hospital.

4. Methods

4.1. Study Setting

This study was conducted at the triage of emergency medicine and critical care department of Aabet hospital in Addis Ababa, Ethiopia. AaBET hospital is part of St. Paul's Hospital Millennium Medical College. It is an emergency dedicated center with level 3 trauma care. It provides emergency and critical care services, orthopedic, neuro-surgery, general surgery, and plastics surgery services. The emergency department has 60 beds and the overall hospital bed is 300. The hospital serves about 400,000 populations in Addis Ababa and surrounding. The rate of admission at the hospital's ED is 41–55 patients per day (about 15,000 to 20,000 patients per year)(66).

4.2. Study Design and Period

A hospital-based prospective cross-sectional study design was employed. The data were collected for a period of four months (from December 1, 2020, to March 30, 2021).

4.3. Source Population

All adult patients admitted to triage of Aabet Hospital during the study period.

4.4. Study Population

All adult patients were admitted to triage of ED of Aabet Hospital during the study period that fulfills the eligibility criteria.

4.5. Eligibility Criteria

4.5.1. Inclusion Criteria

- Patients presented with injuries due to trauma,
- Patients $\geq$ 18 years of age,
- Stable patients (stabilized Airway, Breathing, and Circulation),
- Glasgow Coma Scale score>13 (on a 3–15-scale where 3 indicates no sign of neurological function and 15 is a full neurological function),
- Patients having pain (at least score 1 on NRS) according to verbal rating scale, and
- Patients willing to participate in the study.

4.5.2. Exclusion Criteria

- Cognitive and mental disabilities (identified in patients' clinical records)

- Patients who require cardiopulmonary resuscitation, endotracheal intubation or transferring to intensive care units during data collection
- Patients who were addicted, alcoholic and had opiate abuse

4.6. Sample Size Determination and Sampling Technique

The sample size required was calculated by using single proportion sample size formula ($n = z^2 pq / E^2$) and the assumption is that the prevalence of the patients reporting pain in the ED is 80.1% (67) , as well as 95% confidence interval, and 5% error.

$$n=\frac{(Za/2)2P(1-P)}{d2}= \quad 245$$

(Where, n= minimum sample size required for the study, Z= standard normal distribution (Z=1.96) with a confidence interval of 95% and a=0.05, P= prevalence of pain in the emergency department in Ethiopia (80.1%) (67) and d= level of precision or tolerable margin of error=5%)

Three months prior to this study there were 1542 (denoted by "N") traumatic patients admitted to the triage of the Aabet Hospital which was <10,000 for which correction formula was used and the sample size calculated to be ($n_f = \frac{n*N}{n+N} \approx 211$). Considering 10% contingency, the total sample size would be 232. A Convenience sampling technique was used to recruit the study participants.

4.7. Study Variables

4.7.1. Dependent Variables

- Adequacy of pain management
- Appropriateness of pain management

4.7.2. Independent Variables

- **Patient-related factors:** Age, sex, educational status, occupational status, and ethnicity.
- **Disease-related factors:** site of pain, causes of trauma, and kinds of trauma.
- **Drug-related factors**: types of analgesia prescribed, time of the first analgesia administered, and the number of pain medications administered.

4.8. Data Collection Instruments and Procedures

A carefully designed data collection tool that was derived from American Pain Society Patient Outcome Questionnaire (APS-POQ-R) for quality improvement of pain management in hospitalized patients was used to meet the designed objective (13, 41). Numerical Rating Scale (NRS) was used to assess the pain intensity. Each patient was asked severity of their pain on a scale from 0 to 10, where 0 is no pain and 10 the worst pain. Pain intensity evaluated at triage was indicated as "t0". The pain intensity was evaluated at the time of admission in the ED (t0) and then at 60, 120, 180, and 240 minutes by the selected nurses.

The time sections were derived from the Emergency Severity Index (ESI) of the triage category where severe cases were admitted to the red area (should be treated immediately), orange area (treat the patient in less than 10 minutes), moderate to yellow (treat the patients in less than 60 minutes) and mild cases to green area (treat the patient within 240 minutes). The data collectors rated and recorded the pain intensity of the traumatic patient. The time of the administration of the first analgesic was recorded; if the second dose of analgesia was administered, it should also been recorded.

Appropriateness of pain management was processed by using PMAS (Pain Medication Appropriateness Scale) which is a valid tool to analyze the pharmacological treatment of pain. PMAS consists of ten components under five domain namely; appropriate medication for pain syndrome, scheduled dose interval, titration of medication to the severity of pain including the PMI, constipation prevention, and exclusion of geriatric high-risk drugs (15)**.** PMAS score cut-point of 67% or less is considered inappropriate for pain management (15, 16, 57).

The PMI has been proposed as an auditable measure of the appropriateness of analgesic therapy. The PMI is a tool that tries to correlate an individual patient's pain intensity to the appropriateness of the prescribed analgesics according to the WHO pain management ladder. The PMI is calculated by first giving scores to both the patient's pain intensity and the class of the analgesic prescribed. Based on previous studies, the cut off points used for pain intensity were 0 for no pain, 1 to 4 for mild pain, 5 to 6 for moderate pain, and 7 to 10 for severe pain (13, 14). Accordingly, the absence of pain was scored as 0, mild pain as 1, moderate pain as 2 and severe pain as 3. Similarly, different potency of

analgesic drugs prescribed was categorized as 0 if no analgesic drug was prescribed, 1 if a non-opioid analgesic was prescribed (e.g., NSAIDs), 2 if a weak opioid analgesic was prescribed (e.g., tramadol), and 3 if a strong opioid was prescribed (e.g., morphine).

The PMI was calculated by subtracting the pain intensity or score from the analgesic level and ranged from -3 (patient had severe pain but no analgesic used) to +3 (patient experienced no pain but was taking morphine). Negative scores on the PMI were considered as indicators of inadequate pain management, and scores of 0 and greater were labeled as conservative indicators of adequate pain management (14).

4.9. Data Processing and Analysis

Variables and database were coded, set and entered, cleaned, and analyzed using Statistical Package for Social Science (SPSS) version 26.0. Descriptive statistics included mean and standard deviation for continuous variables and frequency and percentage for categorical data were used to summarize socio-demographic and relevant characteristics of the study participants. The normality of data on pain intensity was measured by Kolmogorov-Smirnov tests. The pain intensity was analyzed in different sub-groups using one-way analysis of variance (ANOVA) repeated measures test. To compare the time to analgesia of different pain score categories in the ED the Kaplan Meier survival analysis was used. The pain intensity in different time sections will be analyzed by the repeated measure.

Pearson correlations were conducted to check the relationship between patients' characteristics and adequacy of pain. Multiples linear regression analysis of PMI as dependent variable and type of analgesia administered, time to analgesia and pain intensity at admission as independent variables were used to assess the adequacy of pain management ($p<.05$).

Independent-samples Kruskal-Wallis test was performed for comparing associations of PMAS with pain intensity at the end of 240 minutes and a box plot of pain level at the end of 240 minutes was used against the PMAS. chi-square test was done to identify the significance of PMAS with age of the patients, pain intensity at admission, pain intensity at the end of 240 minutes, pain management index(PMI), and time to analgesia ($p <0.05$).

4.10. Data Quality Assurance

The reliability of the pain assessment scale was tested by Cronbach's Alpha coefficient and found to be reliable with a value of 0.96. Before the actual data collection process, a pretest was done on 20 (in about 10 % of the participants) traumatic patients two weeks before the day of actual data collection and based on the results obtained from the pre-test, the amendment was made on the assessment tools and way of assessment based on the inputs found on the pre-test. Eight data collectors (two Bachelors of pharmacy, five Bachelors of Science nurses and one Clinical nurse) were recruited who were previously trained pain-free hospital initiatives by the Federal Ministry of Health of Ethiopia. The data collectors, a supervisor (Emergency medicine critical care resident) and four card room workers were hired and the principal investigator provided two days of training to the data collectors and supervisor to familiarize them with data collection instruments and on how to collect the necessary data from patient medical charts and how to conduct patient interviews. The supervisor was supervising data collectors and facilitates the daily activities. All filled checklists were reviewed for completeness and consistency on daily basis by the supervisor and principal investigator.

4.11. Ethical Consideration

Before data collection, the full protocol of this study was submitted to the Ethical Review Committee of AAU, School of Pharmacy, College of Health Sciences and received ethical clearance with reference number ERB/SOP/205/10/2020, and also permission for data collection was obtained from Aabet hospital. Each study participant was informed about the purpose of the study and its potential risk (time to be spent) and those willing to participate were included. Confidentiality and privacy of study participants were ensured during the interview and all information accessed were kept and restricted from any access. Thus, identifiers like the name and address of the patient were not recorded in the data abstraction formats. Written or verbal informed consent was obtained from study participants for the interview and to extract data from their medical charts.

4.12. Operational Definition

Acute pain: Pain that is of short duration (less than three months) and is reversible. It's of sudden onset, occurs immediately after an injury which is usually severe in nature.

Adequacy of pain management: scores of zero or greater on PMI or a decrease in pain score to < 4 and a decrease from triage pain score of ≥ 2 (13, 68)

Appropriateness of pain management: PMAS score > 67% (15, 16, 57, 58).

Chronic pain: Pain that is persistent and has been experienced for more than three months

Oligoanalgesia: describe the lack of adequate treatment of pain in terms of dosages and rapidity of administration of analgesics for ED patients.

Opiophobia: the fear of the use of opioids by health care professionals when the patient is eligible for the administration of opioids.

Pain intensity: the severity of pain in traumatic patients, which would be assessed by a numerical rating scale.

Pain management Index (PMI): a tool that tries to correlate an individual patient's pain intensity to the appropriateness of the prescribed analgesics according to the WHO pain management ladder.

Survival event: the administration of the first analgesics within the observed 240 minutes

Time to analgesia: time between admissions (0 hrs) of the patient to the hospital (from triage) and the first dose of analgesia.

Trauma: physical injury due to road traffic accident, burn, falls, gunshot wounds, fight, collision or any other emergency that results in physical injury.

Trauma Center: a specialized hospital facility that is designed to provide diagnostic and therapeutic services for patients with major traumatic injuries. It's an emergency department with specialized services.

5. Results

5.1. Sociodemographic Characteristics of the Study Participants

From 1252 patients encountered during the study period, a total of 232 were included in the study and also for analysis. Nearly three-fourths (69.8%) of the study participants were males. The mean age of the study participants was 35.53 years and more than half (55.6%) of them were in middle adulthood age (36-59 years). Nearly half (45.26%) of the study participants had a primary level of education and nearly half (46.1%) of the study participants were civil servants (Error! Reference source not found.**)**.

Table 1: Socio-demographic characteristics of traumatic patients admitted at Aabet Hospital, Addis Ababa, Ethiopia from December 2020 to March 2021 (n=232)

Variables		Frequency (n)	Percent (%)
Sex	Female	70	30.2
	Male	162	69.8
Age	18-35	76	32.7
	36-59	129	55.6
	≥60	27	11.6
Education status	Illiterate	34	14.6
	Primary	105	45.26
	Secondary	60	25.86
	Tertiary	33	14.22
Occupation	Civil servant	107	46.1
	Military	4	1.7
	Retired	16	6.9
	Self employed	80	34.4
	unemployed	25	10.7
Ethnicity	Oromo	74	31.9
	Amhara	56	24.1
	Tigrayan	18	7.8
	Other[1]	84	36.2

[1] Other: Guraghe, Wolaita, Haddiya, Somale, Afar

5.2. Baseline Disease Characteristics of the Study Participants

More than half of the study participants 126 (54.3%) were admitted in the trauma center due to road traffic accidents followed by falling down accidents 44 (19.0%) and fighting 22 (9.5%) while other causes of trauma were reported in 34 (14.7%) of the study participants. The type of trauma mainly found during this study was a fracture in 39.2% of the study participants, followed by contusion and stretching in 27.2% of the study

participants, laceration and wounds in 22.4% of the study participants, burn in 9.9% of the study participants and other injures in 1.3% of the study participants. Upper and lower limbs were the most parts of the body where the feeling of pain was observed in 126 (54.3%) of the participants followed by the trunk and head, 72 (31%) and 31 (13.4%) of the participants, respectively (**Table 2**).

Table 2: Baseline disease characteristics of the traumatic patients admitted at Aabet Hospital, Addis Ababa, Ethiopia from December 2020 to March 2021 (n=232)

Variables		Frequency	%
The kind of trauma	Fracture	91	39.2
	Contusion and stretching	63	27.2
	Laceration and wounds	52	22.4
	Burn	23	9.9
	Other[1]	3	1.3
The cause of trauma	Road traffic accident (RTA)	126	54.3
	Fall	44	19.0
	Fight	22	9.5
	Collision	6	2.6
	Other[2]	34	14.7
The site of pain	Upper and lower limbs	126	54.3
	Trunk	72	31.0
	Head	31	13.4
	Other[3]	3	1.3

[1]Deep cuts, pierces on the skin, concussions
[2]Fire, building collapse, operating machine
[3]Neck, ear, eye

5.3. Pain Management Practices

Among the 232 participants in this study only 21 (9.1%) patients had received the first analgesic treatment within 30 minutes while 27(11.6%) had no treatment at all within the study duration (240 minutes). Furthermore, only 3 (1.3%) patients were treated non-pharmacologically. Most of the study participants 72 (31%) received non-opioids 59 (25.6%) participants received weak opioids, and 37 (15.9%) participants received strong opioids. Concerning the dual treatment approach, only 25 (10.8%) participants received non-opioids and weak opioids followed by 6 (2.6%) participants who were treated with non-pharmacologic pain management method with non-opioids, and 3 (1.3%) patients received non-opioids and strong opioids in the four hours follow up.

As summarized in Table 3, the most commonly prescribed analgesic was tramadol 87 (37.5%) followed by diclofenac 65 (31.9%) and paracetamol 41 (17.7%). The mean time of receiving the first analgesic was 94.7 minutes, with a range of 20-240 minutes.

Table 3: Specific types of analgesics drug given to the patients during the study period from December 2020 to March 2021 at Aabet hospital, Addis Ababa, Ethiopia (n=232)

Type of specific drug given	Frequency (n)	Percent %
No Drug	30	12.9
Paracetamol	10	4.3
Diclofenac	59	25.4
Tramadol	56	24.1
Morphine	17	7.3
Pethidine	20	8.6
Paracetamol and Diclofenac	6	2.6
Paracetamol and Tramadol	22	9.5
Paracetamol and Morphine	3	1.3
Diclofinac and Tramadol	9	3.9

On the other hand, 17 (7.3 %) participants with mild pain and 13 (5.6%) participants with moderate pain received no analgesia, 55 (23.7%) participants with severe pain received weak opioids and 3 (1.3 %) participants with moderate pain received strong opioids as depicted (**Figure 1).**

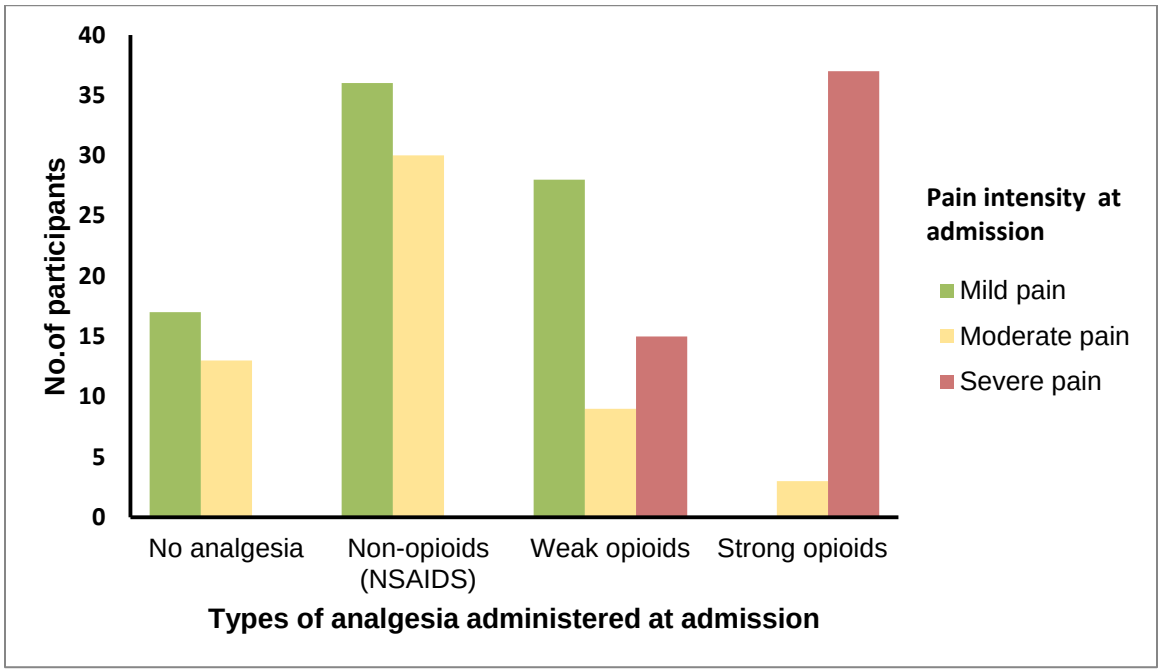

Figure 1: Types of analgesics administered according to pain score at admission at Aabet Hospital, Addis Ababa, Ethiopia, December 2020 (n= 232)

5.4. Changes in Pain Intensity in Trauma Center

The mean pain intensity score at admission was 5.55±2.32 while, it was reduced to 4.09±2.69 at 240 minutes. Out of 232 patients encountered at admission, two-fifth of participants 95 (40.9%) were in severe pain while nearly a quarter 55 (23.7%) of the study participants were in moderate pain, and 81 (34.9%) participants were in mild pain. At the end of follow up (at 240 minutes), only 21 (9.1%) participants were in pain-free while 103 (44.4%) participants were in mild pain, 44 (19%) and 64 (27.6%) were in moderate pain and in severe pain, respectively (Table 4 and Figure 2).

Table 4: Trends of Pain intensity of the traumatic patients over 240 minutes at Aabet hospital, Addis Ababa, Ethiopia from December 2020 to March 2021 (n=232)

		Time pain intensity measured				
		0 min	60 min	120 min	180 min	240 min
		N (%)	N (%)	N (%)	N (%)	N (%)
Pain intensity	No pain (0)	0	0	6 (2.6)	9 (3.9)	21 (9.1)
	Mild pain (≤ 3)	81 (34.9)	103(44.4)	101 (43.5)	118(50.9)	103 (44.4)
	Moderate pain (4-6)	55 (23.7)	88 (37.9)	73 (31.5)	47 (2.2)	44 (19)
	Severe pain (7-10)	96 (41.4)	41 (17.7)	52 (22.4)	58 (25)	64 (27.6)
	mean±SD	5.55±2.32	4.10±2.10	4.16±2.3	4.09±2.51	4.09±2.69

One-way ANOVA repeated measure test compared means of pain intensity for each of analgesic type administered over 240 minutes. It showed that the mean pain intensity of those receiving no analgesia increased from 3.93 to 4.33 and those receiving non-opioids, weak opioids and strong opioids decreased from 3.97 to 2.81, 6.28 to 5.27, and 7.78 to 3.38, respectively as illustrated in the following diagram (Figure 2).

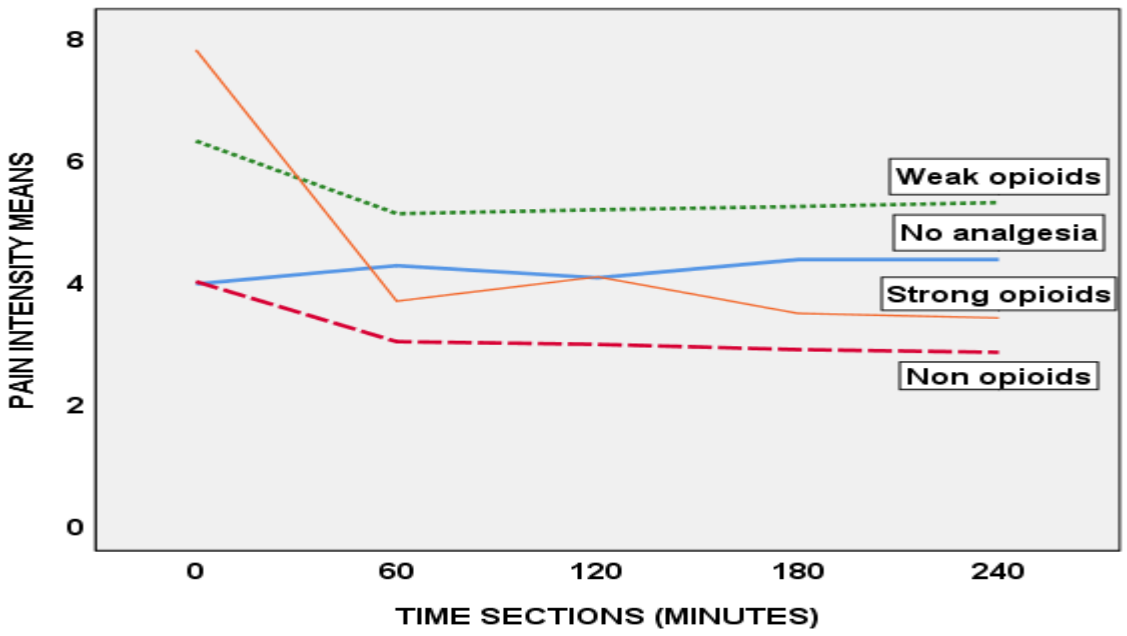

Figure 2: Mean pain Intensity trends of participants according to the analgesics given over 240 minutes at Aabet hospital, Addis Ababa, Ethiopia from December 2020 to March 2021 (n=232**)**

According to survival plot by Kaplan Meier method and log-rank (mantel-cox) test shown in **Figure** 3 there were significant differences in mild pain, moderate pain and severe pain to time to analgesia (survival time) indicating time to analgesia were different for each of the categorical pain score (P= 0.001). The mean survival time (time to analgesia) of mild pain, moderate pain and severe pain were 107.33, 110.71, and 74.21 minutes respectively. Having severe pain had the highest probability of receiving the first analgesic while mild and moderate pain had almost equivalent chance of receiving the first analgesics. There were also censored data, which were not given any analgesics in the observed time shown by small vertical lines on the interpolation lines.

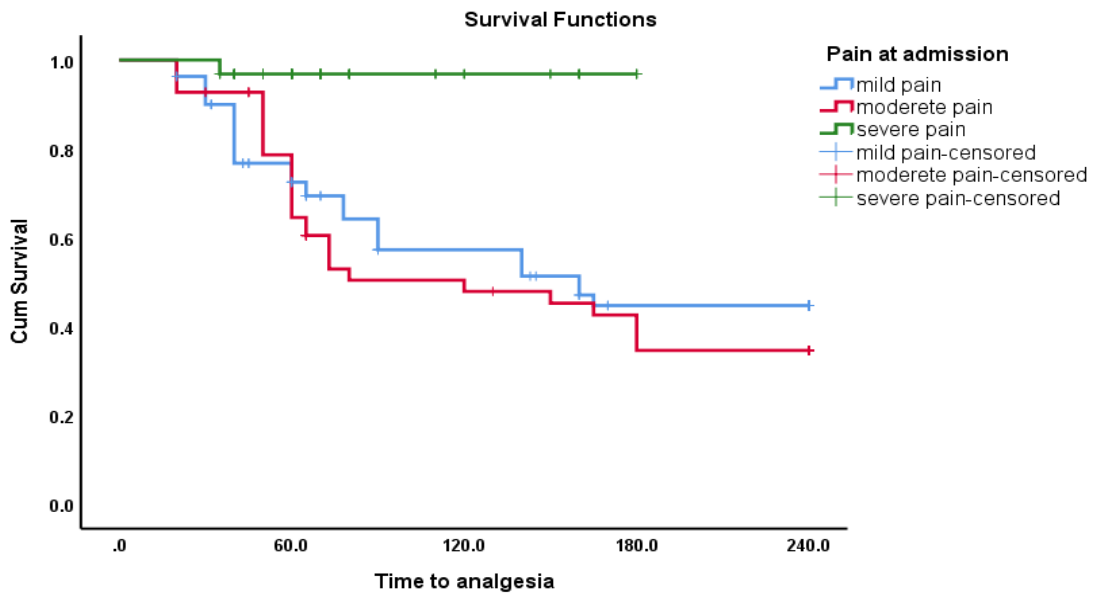

Figure 1: Survival plot of pain intensity where the event was the first administered analgesia for a traumatic patient at Aabet Hospital, Addis Ababa, Ethiopia from December 2020 to March 2021 (n=232)

5.5. Adequacy of Pain Management and Predictors of Pain Reduction

Among the patients admitted in the ED of Aabet hospital, almost half (110 (47.4%)) of them were treated inadequately having a PMI (-) score, of which nearly two-thirds (37.9 %) were in moderate or severe pain. Pearson correlations were conducted to check associations between patients' characteristics and adequacy of pain management. Statistical significance was determined at $p<0.05$.

Table 5 showed the linear correlations of PMI with different variables as all variables had statistically significant correlation except sex and age. There was a weak and negative correlation between PMI and time to analgesia. (Pearson correlation r= -.159, p=0.0001). Correlation analysis revealed that Pearson correlation r was found to be -0.159 which was between -0.01 and -0.29, i.e. Weak relationship. The negative r value of Pearson correlation indicated that as time to analgesia was increasing, the PMI was decreasing, i.e. negative relationship.

Table 5: Associations of Pain Management Index (PMI) of patients at Aabet Hospital, Addis Ababa, Ethiopia from December 2020 to March 2021 with respect to the independent variables (n=232)

Variable	Adequate Pain Management n(%)	Inadequate Pain Management n(%)	Total	P-value[1]
Age(years)				0.225
18-35	53(22.8)	76(32.8)	129	
36-59	45(19.4)	31(13.4)	76	
>59	14(6)	13(5.6)	27	
Sex				0.953
Male	78(33.6)	84(36.2)	162	
Female	34(14.7)	36(15.5)	70	
Pain Intensity at admission				0.001
Mild	23(9.9)	58(21.1)	81	
Moderate	30(12.9)	25(10.8)	55	
Severe	59(25.4)	37(15.9)	96	
Type of treatment given				0.001
No treatment	27(24.1)	0	27	
Nonpharmacologic	3(2.7)	0	3	
Non opioids	20(17.9)	52(43.3)	72	
Weak opioids	37(33)	22(18.3)	59	
Strong opioids	0	37(30.8)	37	
Appropriateness of the treatment				0.001
Appropriate	109(97.3)	28(23.3)	137	
Inappropriate	3(2.7)	92(76.7)	95	
Time to analgesia				0.015
0-30 min	3(2.7)	13(10.8)	16	
31-60 min	44(39.3)	51(42.5)	95	
61-90 min	31(27.7)	24(20)	55	
91-120 min	3(2.7)	4(3.6)	7	
121-180 min	4(3.6)	25(20.8)	29	
181-240 min	27(24.1)	3(2.5)	30	

[1] Pearson correlation

As depicted on Figure 4, the first analgesia type administered had a significant difference in pain outcome (Chi square= 95.29, P=0.0001). Even though strong opioids were late to be administered to the patients, they had greater pain relief than other treatment groups.

For instance, at 180 minutes strong opioids had the probability of 0.1 (10%) pain relief or 10% of the population taking strong opioids were pain free at 180 minutes of observation while at the same time patients taking NSAIDs and weak opioids had less than 10% pain relief.

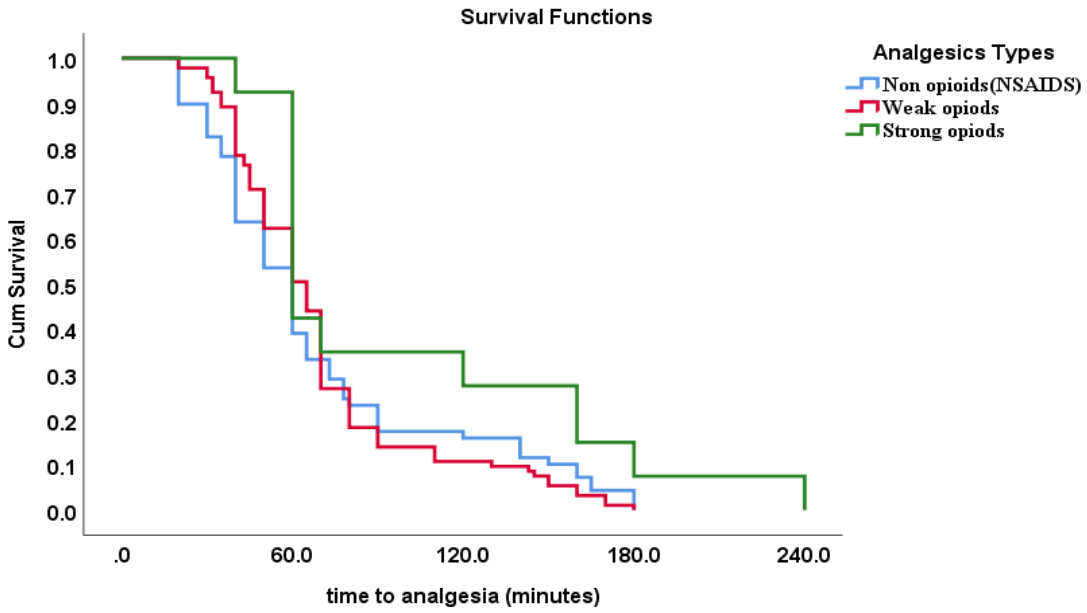

Figure 4: Survival plot of pain intensity according to the analgesia given whereas pain reduction as the event at Aabet hospital, Addis Ababa, Ethiopia from December 2020 to March 2021

In this study, multiple linear regression analysis (as depicted in table 6) was employed and showed the type of analgesia administered, time to analgesia and pain intensity at admission had a fairly strong relationship with PMI (R^2=0.65, Adjusted R^2= 0.651, p=0.0001) while the types of treatment (non-pharmacologic and pharmacologic) and the number of analgesia used were not significant at $p<0.05$. The type of analgesia administered, time to analgesia and pain intensity could predict 65% of the variance in PMI score. As the time to analgesia increases by 1 minute, the PMI decreases by -0.001 when all other independent variables are held constant and as the pain at admission increases by one unit, the PMI decreases by -0.191 unit when all other independent variables are held constant and as one unit increase unit in the type of analgesic used or as the patient switched from weak opioids to strong opioids, the PMI increase by .514 units.

Table 6: Multiple linear regression Analysis of pain management index as dependent variable at Aabet hospital, Addis Ababa, Ethiopia, March 2021 (n=232)

Variables	B[1]	Beta[2]	t	p-value	95 % CI for B	
					Lower	Upper
Constant	.964		11.54	.0001	.616	1.034
Treatment given	-.024	-081.	-.966	.325	-.093	.034
Time to analgesia	-.001	-.101	-2.14	.034	-.053	.015
Pain at admission	-.191	-.884	-17.75	.0001	-.489	-.053
No. of analgesia	-.069	-.075	-1.10	.269	-.192	.095
Type of Analgesia	.514	.941	14.98	.0001	.397	.558

[1]Unstandardized Coefficients

[2] Standardized Coefficients

The type of analgesia administered, time to analgesia, pain intensity at 0 min(admission), PMAS and number of analgesia could predict 76.1% of the variance in the individuals' pain score at the end of 240 minutes (R^2=0.761,Adjusted R^2=0.755,P=0.0001) from multiple linear regression analysis as depicted in **table 7**. When all these independent variables were taken together and compared with the dependent variable (pain score at the end of 240 minutes) showed a strong correlation between the dependent and independent variables was found (r=0.873, P=.0001). As the number of analgesics increase by one unit, the pain score decreases by -0.232 at the end of 240 minutes supporting multimodal pain management (p=0.037). As the time to analgesia increases by one minute, the pain score at the end of 240 minutes decreases by -0.002 units. In addition, an increases of one percent of PMAS, decreases the pain at 240 minutes by -0.025. But the contribution of each independent variable to dependent variable (pain at the end of 240 minutes) was different as shown in standardized coefficient beta. Accordingly, pain at admission had strongest unique contribution to pain at the end of 240 minutes (Beta= 0.821, 67%) while time to analgesia had the weakest and almost insignificant contribution to pain at the end of 240 minutes (Beta=0.56, 0.31%). Other variables like age, sex, kind of trauma, cause of trauma and site of pain couldn't predict pain reduction ($p<0.05$).

Table 7: Multiple linear regression analysis of pain score at the end of 240 minutes as dependent at Aabet hospital, Addis Ababa, Ethiopia (n=232)

Variables	B[1]	Beta[2]	t	p-value	95 % CI for B	
					Lower	upper
Constant	1.987		5.79	0.0001	1.309	2.665
Age of the patient	-.002	-.021	-.614	0.540	-.007	.004
Analgesic given	-.159	-.138	-2.42	0.016	-.289	-.030
Time to analgesia	-.002	.056	1.26	0.015	-.003	-.001
Pain at admission	.375	.821	16.30	0.0001	.330	.420
PMAS[1]	-.025	-.274	-6.21	0.0001	-.032	-.017
No.of analgesics	-.232	0.134	2.05	0.037	-.449	-.014

[1]Unstandardized Coefficients

[2] Standardized Coefficients

[3]Pain medication Appropriateness Scale

5.6. Appropriateness of Pain Management in Trauma Center

The observed median score of PMAS was 61.2 (IQR 49-83) and its mean was 65.2. According to the cut of point ≤ 67, PMAS showed that in more than half (140(60.3%) of the study participants, the pain was inappropriately treated while the pain was both inappropriately and inadequately treated in nearly half (109(46.9%) of the study participants. PMAS was significantly affected by pain intensity at admission and at the end of 240 minutes, age of the patients and pain management index while time to analgesia and the time the patients stayed in pain didn't affect the PMAS score ($p < 0.05$). At the end of the 240 minutes, independent samples Kruskal–Wallis test generated that patients with no pain (median: 80, range [65-85]) had the highest PMAS score; followed by mild pain (median: 77 ,range [62-84], moderate pain (median:55, range [53-58]) and sever pain (median:55) (Kruskal-Wallis H =105.9,chi square=104.9 ,$p<0.001$) as observed in figure 6.

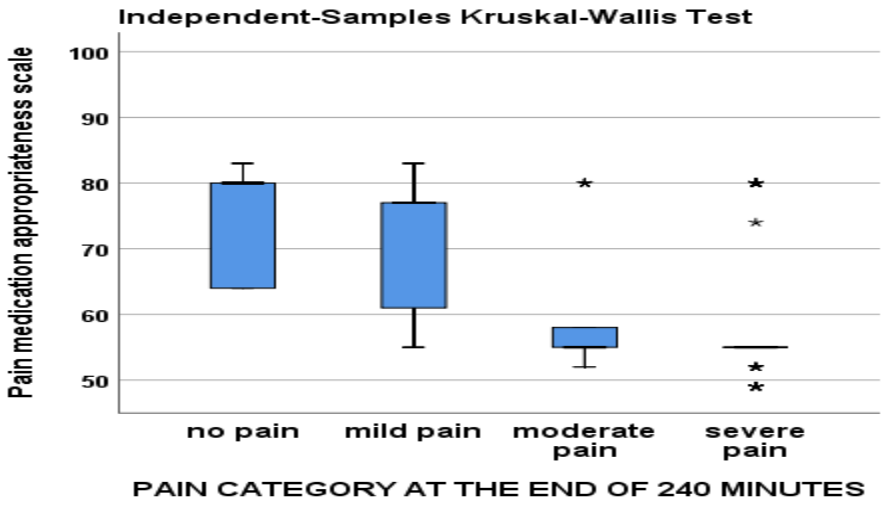

Figure 5: Boxplot of pain medication Appropriateness Scale (PMAS) with respect to Pain score at the end of 240 minutes at Aabet Hospital, Addis Ababa, Ethiopia from December 2020 to March 2021 (n= 232)

6. Discussion

Despite being the most frequently reported compliant, acute pain had not been treated adequately and appropriately in ED (22). Therefore, this study was carried out in the ED of Aabet hospital to assess acute traumatic pain intensity, the time for the first analgesia after admission to the hospital, and the adequacy and appropriateness of pain management. Most (126 (54.3%), of the participants admitted to the trauma center were due to Road traffic accidents followed by falling down accidents (44 (19%), fighting (22 (9.5%), and other kinds of trauma (34 (14.7%). This was in line with studies done in Australia, South Africa, Italy, and the United States of America (2, 20, 22, 25, 37)**.**

The finding of this work revealed 11.6% of participants had no treatment at all within the 240 minutes. A Study conducted in Nigeria showed that no preoperative analgesia was prescribed for 45.2% of trauma and non-trauma patients and 77% of the patients considered the doses inadequate (10). A multicenter study in US and Canada showed that about 40% of the study participants didn't get analgesia after admission to ED (9). Similarly, a study conducted in Iran showed that 60.8% of the ED patients had not received pain analgesia within a four-hour follow-up (32). Such variation could be due to the fact that the present study was only among traumatic patients at ED of trauma center where acute pain prevalence would be higher than in other ED departments and increased the likelihood of receiving analgesia.

The present study showed that of all participants 31% had been prescribed with non-opioids, 25.4% had been prescribed weak opioids, and 15.9% had been prescribed strong opioids. The most commonly prescribed analgesia was tramadol 87 (37.5%) followed by diclofenac 65 (31.9%), paracetamol 41 (17.7%), and morphine 17(7.3%). Consistent with the findings of this study, other research conducted in Gondar, Ethiopia revealed that, 39.9% of patients received tramadol, 19.7% received diclofenac and less than 4.5% of the patients received any strong opioids (5). Similarly, a study conducted in Yekatit 12 hospital, in Ethiopia showed that 87.1% of the patients were feeling severe pain but the patients were taking only non-opioids for their severe pain and none of them received strong opioids (33). Likewise, in a study conducted in a western Kenyan hospital, 54.5% had been prescribed non-opioids, 17% had been prescribed weak opioids, and 14% had

been prescribed strong opioids of all participants. But in contrast to our finding the most commonly prescribed analgesia was paracetamol 30.9% % followed by tramadol 15.5% and diclofenac 14.5% (69). A worldwide survey showed that the preferred analgesia for the management of acute pain were morphine, fentanyl and paracetamol with or without combination (47). Accordingly, a lower frequency of opioid analgesia was reported in this study and this discrepancy could be due to the fear of addiction (opiophobia), the costs and availability of strong opioids (4, 36, 59, 65).

The multimodal pain management approach can better control pain and reduces opioid consumptions and complements opioid, thereby opioid-sparing (7, 51, 70). Similarly, in this study, as the number of analgesics (combination of analgesia) administered to the participants increased, the pain score at the end of the 240 minutes decreased significantly ($r= -0.871$, $p= .0001$).

The present study showed that nearly half (110 (47.4%) of the participants were treated inadequately though 88 (37.9 %) were in moderate or severe pain. A study done in Gondar, Ethiopia had a comparable findings with the current study in that 57 % of the patients reported that the analgesic was not adequate (5). Study conducted in Nigeria showed that no preoperative analgesia was prescribed for 45.2% of trauma and non-trauma patients and in patients who had preoperative analgesia, 40% of the patients considered the doses inadequate(10). Consistent with this study prevalence of pain at discharge and inadequate pain control were found to be prevalent in studies done in Australia, the US and Canada (6, 22, 28, 45). The finding of this work that revealed the prevalence of adequate analgesia to be 52.6% was consistent with the study in Australia which showed 58.7% of the participants got adequate analgesia (68**).** Similarly, a prospective multicenter study in the US and Canada by Todd et al indicated that pain and oligoanalgesia were very rampant and only 60% got analgesia (9). In contrast, a prospective study in Iran on pain management of trauma patients in the emergency department showed that only 13.3% of the patients were given adequate analgesia (32).

Psychometric evaluation of the American Pain Society Patient Outcome Questionnaire showed a reduction of approximately 30% in a Numeric Rating Scale in acute pain has been considered a clinically important difference (41). Accordingly, the current study showed a reduction of pain intensity from 5.55 ± 2.32 (at admission) to 4.09 ± 2.69 at

240 minutes and revealed clinically important difference but yet inadequacy. A similar study in Iran showed the reduction of the average pain intensity score at admission was 6.16 ± 2.63 to 5.27 ± 2 (32).

The inadequate pain management may emanate from several barriers in a resource-limited setting. The limited availability and unaffordability of opioids are the major ones that pose a significant challenges to pain management (36)**.** Accesses to opioids have been restricted through bureaucratic laws despite the rational and appropriate need for opioids (26, 65). Additionally, the knowledge and attitudes of the patient and the practitioners have an impact on pain management (63)**.**

The finding of this study revealed that the prevalence of inappropriate treatment of pain was 60.3 % and the prevalence of inappropriate and inadequate treatment was 46.9 % according to PMAS cut-off point ≤ 67 (15, 16). This may be due to a lack of pain management protocols which plays a vital role in appropriate pain management (54, 57).

It is generally recommended that patients in ED should get their first analgesia within 30 minutes (1, 7, 9)**.** However, the prevalence of patients who received the first analgesia within 30 minutes in this study was only 9.1%. A study in Gondar, Ethiopia in trauma and non-trauma patients also revealed that only 12.3% of patients received analgesia within 30 minutes of ED presentation (5). A relatively higher finding (19.2%) was reported from a study done in Australia (42). Nevertheless, a higher prevalence (61.3%) than the current study was obtained from another study done in Australia (43).

The present study found that the mean time of the first analgesia was 94.7 minutes which was much higher than studies done in the US, Canada, Australia, Iran and Netherlands in which the mean time of analgesia for most setting in ER was 78 minutes (7, 9, 32, 42, 43, 71). A study in Gondar, Ethiopia in trauma and non-trauma patients revealed the mean time to delivery of analgesia was 61minutes(5). This disparity may be due to the fact that more than half of the participants (54.3%) in this study were admitted due because of road traffic accident where the participants were requested to provide insurance information to get free analgesia hence that process took a longer time in addition to the registration process for admission. In addition there existed pain management protocol in the study setting but there was no implementation of acute pain protocol. The

implementation of acute pain protocol shortened the time to analgesia of emergency patients (8, 44).

In contrast to this study setting which was an emergency department of the trauma center**,** in other hospital emergency settings proposed reason for the lengthy delay of pain management in ED was the growing numbers of chronic diseases in the community and reduced access to primary healthcare and ED overcrowding which also holds to current study setting (30)**.**

Pain relief was not associated with time to analgesia but it had an association with ED length of stay (42, 43, 68)**.** However, this study found that pain score at the end of 240 minutes was significantly related to the time to analgesia (p=0.034). Multiple linear regression showed that the time to analgesia, the type of analgesia used, pain intensity at 0 min (admission), PMAS and numbers of analgesia could predict 76.1% of the variance in the individuals' pain score at the end of 240 minutes (R2=0.761, Adjusted R2=0.755, P=0.0001). When the other variables held constant one minute increase in time of analgesia would decrease the pain assessment score by 0.02 %. The disparity could be explained by the fact that when analgesics were administered near the pain assessment minutes, the less pain was reported, as in this study analgesia was administered recently near the 240-minute pain assessment. Moreover, the value under standardized beta coefficient showed time to analgesia had the weakest and almost insignificant contribution to pain at the end of 240 minutes (Beta=0.56, 0.31%).

This study found that time to analgesia had a negative and weak correlation with PMI. Multiple linear regressions also revealed that time to analgesia, the type of analgesia used, and pain intensity at admission could predict 65% of PMI (R^2=0.65, Adjusted R^2= 0.651, p=0.0001). As the time to analgesia increased by 1 minute, the PMI decreased by -0.001 units when all other independent variables are held constant. That means when the analgesics were given near the pain assessment minutes, the lesser the reports of pain but the overall pain management adequacy was improved as early as the first analgesia as shown on the PMI. This study had also addressed the gap that strong opioids were not administered as early as NSAIDs and weak opioids despite the patients being in severe pain. This might be due to misconception and the fear of strong opioids for addiction

(opiophobia), the lengthy bureaucracy to get strong opioids, costs and availability of strong opioids (36, 54, 59, 72).

The present study found that being in severe pain had the highest probability of getting early analgesia. A prospective study conducted in the emergency department in northwest Ethiopia, Gondar had a similar outcome to our finding where it revealed a patient presenting at ED with severe pain was 3.5 times more likely to receive analgesia compared to those with mild pain (AOR= 3.5, 95% CI 1.42-8.54) and traumatic patients had higher probability of receiving early analgesia than non-traumatic patients (AOR= 3.99, 95% CI 2.01-7.94)(5) Similarly, a retrospective study done in Australia revealed that time to analgesia was associated with moderate (OR=2.73, 95% CI 2.13-3.49) and severe pain score (OR= 8.74, CI 5.63 to 13.57)(42)**.**

This study found that acute pain in traumatic patient admitted in ED were undertreated and ignored as the fifth component of vital signs. Several studies in Ethiopia, confirmed that pain in cancer, preoperative and postoperative, and in burn patients had not been treated adequately or had not received pain intervention (5, 13, 33, 64, 67).

This paper sheds light on the importance of time to analgesia and appropriateness of pain management in traumatic patients. Indeed, this study may help in filling the gaps in ED's pain management practices by stimulating appropriate analgesic agent prescribing patterns and promoting adherence to good clinical practices set by the WHO.

7. Limitations of the Study

This study has some limitations. This was a single-centered study, based on a nonconsecutive convenience sample of patients. As such, the results of this study were found from traumatic patients admitted to the ED of the trauma center and may not be generalizable to other ED settings with different staffing profiles and case mixes.

Moreover, discharge pain medication information was unknown due to a shortage of study period over a single patient and the patient were not completing the treatment in the hospital within the four-hour period which was helpful to know the length of hospital stay due to pain. Additionally, as the study was in the trauma center, the traumatic patient was most likely transferred to the orthopedic surgical room, neurosurgery room, plastic and reconstructive surgery unit, or intensive care unit after getting emergency medical service for a longer stay and there may be a loss to follow up in the process.

8. Conclusion

From the findings of this study, it can be concluded that acute pain was undertreated and ignored as the fifth vital sign in trauma patients in the emergency department. Furthermore, the present study revealed the significance of time to analgesia and the adequacy and appropriateness of pain management among traumatic patients.

9. Recommendation

Clinicians should assess the pain severity of traumatic patients and treat them according to the WHO pain ladder for its appropriateness and adequacy. Moreover, clinicians should be aware of pain as the fifth vital sign and a human right to be pain-free.

Traumatic patients should know that the feeling of their pain should be treated with appropriate analgesia within 30 minutes of admission to the triage of emergency department.

Aabet hospital management and directorates should work on Pain Free Hospital Initiative and arrange short-term trainings for staffs. The hospital should recognize that adequate treatment of acute pain in an emergency could significantly decrease the hospital crowding by patients complaining of chronic pain.

The Federal Ministry of Health of Ethiopia should strengthen and follow the commencement Pain free hospital initiative implementation manual and its operational standards.

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Appendices

1. Data Collection Tool

PART-1	
a) Socio demographic characteristics of the patient	**Tel.**
C.N:_____ **1. Age (years):____** **2. Sex:** ☐ M ☐ F **3. Wt.(kg):_____** **4. Ht. (cm):_____** **5. Admission date:_____** **6. Time at arrival:_____** **7. Residence** ☐ Urban ☐ Rural **8. Marital status:** ☐ Single ☐ Married ☐ Divorced ☐ Widowed	**9. Ethnicity:** ☐ Oromo ☐ Tigray ☐ Amhara ☐ Other, please specify_____ **10. Educational status** ☐ Informal ☐ Primary ☐ Secondary ☐ Tertiary ☐unable to read and write **11. Occupation** ☐Civil servant ☐Military ☐Health worker ☐Retired ☐ Self-employed ☐No work **12. Smoking habits:** ☐ Smoker ☐ Nonsmoker ☐ Denied **13. History of chronic pain:** ☐ Yes ☐ No
b) Baseline disease characteristics of the patient	
11. The kind of trauma	
☐ Contusion and stretching Other_____ ☐ Laceration and wounds ☐ Fracture ☐ Burn	

12. The cause of the trauma

- ☐ Collision
- ☐ Road traffic accident (RTA)
- ☐ Fall
- ☐ Fight
- ☐ Other_____

13. The site of pain

- ☐ Upper and lower limbs
- ☐ Trunk
- ☐ Head
- ☐ Other_____

14. Previous hospitalization history	☐ Yes ☐ No		
15. If the answer is yes to no.14, reason(s) for previous hospitalization	**☐medical problem**	**☐ trauma**	
	☐ Other(s), please specify_____		
16. Is the patient take pain killer within 24 hour?	**☐ Yes** ☐ No		
17. If yes to no. 16, what kind of pain killer did he/she take?	**☐ NSAIDS** **☐ paracetamol** **☐ Opiods** **☐ Other_____**		

C. In-hospital and short term outcomes during follow-up

18. Pain intensity

Time(min)	**0**	**60**	**120**	**180**	**240**
Score					
Intensity					

19. The time of the first analgesic in minutes(t1) ___ pain intensity after 30 min_____

20. The time of the second analgesic in minutes(t2) ___ pain intensity after 60 min_____

21. The time of discharge(t3) _____ pain intensity at discharge_____

22. The type of intervention or pain management

- ☐ **Pharmacologic**
  - ☐ **No analgesic**
  - ☐ **Non opiods eg. NSAIDS, paracetamol _____**
  - ☐ **Weak Opiods eg. Codeine, Tramadol_____**
  - ☐ **Strong opiods eg, morphine, pethidene_____**
  - ☐ **Other_____**
- ☐ **Non pharmacologic_____**

23. Any adverse effect during analgesic treatment _____

<table>
<tr><td rowspan="3">☐ Patient improved and discharged</td><td>Time of discharge _____</td><td rowspan="3">Pain Medication(s) at discharge (Dose, frequency and duration)
☐ Opioids_____
☐ NSAID_____
☐ Paracetamol_____
☐Other(s),_____</td></tr>
<tr><td></td></tr>
<tr><td>Remark</td></tr>
<tr><td>☐ Referred</td><td>Time of referral___</td><td>Remark</td></tr>
<tr><td>☐ Patient Left against medical advice</td><td>Time the patient left ___</td><td>Remark</td></tr>
<tr><td>☐ patient lost on follow-up</td><td>Time of the patient lost ___</td><td>Remark</td></tr>
<tr><td>☐ Patient passed away</td><td>Time of the patient died ___</td><td>Reason(s) for death
☐ due to trauma
☐ couldn`t be established
☐other(s)(mention),_____</td></tr>
<tr><td>☐ Patient is still in-hospital at the end of the study period</td><td colspan="2">Remark:</td></tr>
</table>

PART-2

Pain Medication Appropriateness Scale (PMAS)

Criterion	Score	Possible
1. Appropriate Medication for Pain Syndrome **E.g. score 3 if non opioids and 3 possible points if mild pain**		
• Mild pain		
• Moderate pain		
• Severe pain		
2. Appropriately Scheduled Dose Interval **3 possible points if patients has trauma in the past in the past 3 months**		
• Score 2 if scheduled (around-the-clock) dosing plus • Score 1 if prescribed at appropriate intervals for drug		
3. Appropriate titration of medication to severity of pain • 3 possible points if pain assessed		
Score of pain medication		
• Score 1 if non-opioid and NSAID, • Score 2 if weak opioid • Score 3 strong opioid		
Score of worst pain		
• Score 0 if no pain • Score 1 if mild pain (NRS: 1–3) • Score 2 if moderate pain (NRS: 4–7) • Score 3 if severe pain (NRS: 8–10)		
Calculate PMI = Score of pain medication - Score of worst pain		
• If PMI is 0, +1, +2, +3, score 3 • If PMI is _1, score 2 • If PMI is _2 score 1 • If PMI is _3, score 0		
4. Degree of Pain Relief from Medication (3 possible points if patients answered)		
• Score 1 if pain medication ‘‘helped some’’ • Score 2 if the medication ‘‘helped enough’’ • Score 3 if medication ‘‘took away all the pain’’		
5. Appropriate Constipation Prevention		
• With PRN Opioids (1 possible point if opioid ordered PRN and administered ≤2 times in 72 h) o Score 1 for laxative of choice or stool softener/laxative PRN or daily		

• With Scheduled Opioids (3 possible points if scheduled opioids or opioid administered ≥3 times in 72 hours) o Score 1 if only PRN laxative of choice order o Score 1 if daily/regular stool softener order o Score 2 if daily/regular stimulant laxative or lactulose		
6. Appropriate Exclusion of Geriatric High Risk Drugs		
Drugs to avoid in elderly patients o Score minus 1 for any order for the following, if patient ≥65 years or very debilitated (bed bound; unable to transfer) o -1 point for routine dosing of NSAID (excluding cyclo-oxygenase-2 selective and aspirin 81mg daily for cardioprotection) o -1 point for indomethacin o -1 point for ketorolac o -1 point for amitriptyline o -1 point for more than single dose meperidine (pethidine) o -1 point for promethazine o -1 point for bulk laxative if on a opioid o -1 point for anticholinergic muscle relaxants or antispasmodics (cyclobenzaprine, hyoscyamine, dicyclomine, belladonna) o -1 for 4gm paracetamol/day o -1 for any long-acting benzodiazepine: diazepam, chlordiazepoxide,		
Total		
Final score: Divide total Score by total Possible points and multiply result by 100 **Cut-off point: if ≤ 67% it is inappropriately treated**		

2. Informed Consent

Research title: Assessment of Adequacy and Appropriateness of Pain Management in Traumatic Patients at Aabet Hospital: A Prospective Observational Study

Consent to take part in pain management research

 I…… voluntarily agree to participate in this research study.

 I understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question without any consequences of any kind.

 I understand that I can withdraw permission to use data from my interview within two weeks after the interview, in which case the material will be deleted.

 I have had the purpose and nature of the study explained to me in writing and I have had the opportunity to ask questions about the study.

 I understand that participation involve how I feel about my pain and the medication I received for my pain.

 I understand that I will not benefit directly from participating in this research.

 I understand that all information I provide for this study will be treated confidentially.

 I understand that in any report on the results of this research my identity will remain anonymous. This will be done by changing my name and disguising any details of my interview which may reveal my identity or the identity of people I speak about.

Signature of research participant

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Signature of participant Date

I believe the participant is giving informed consent to participate in this study

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Signature of researcher Date