Journal Syifa Sciences and Clinical Research (JSSCR)
Volume 8 Number 1, 2026
Journal Homepage: http://ejurnal.ung.ac.id/index.php/jsscr, E-ISSN: 2656-9612 P-ISSN:2656-8187
DOI: https://doi.org/10.37311/jsscr.v8i1.35141

# Emergency Drug Use Profile in an Indonesian ICU: Dr. M. M. Dunda Hospital

**Teti Sutriyati Tuloli[1*], Andi Makkulawu[2], Dizky Ramadani Putri Papeo[3], Mohamad Reski Manno[4], Hidayat Ahmad[5], Talitha Djumeida Ano[6]**

[1,2,3,4,6] *Department of Pharmacy, Faculty Of Sports and Health, Gorontalo State University, Jl. Jenderal Sudirman No. 06 Gorontalo City 96128, Indonesia*
[5] *Instalasi Farmasi, RSUD Dr. M. M. Dunda Limboto, Jl. Achmad A Wahab No. 53 Kabupaten Gorontalo 96181, Indonesia*

** Corresponding author. Email: teti@ung.ac.id*

## ABSTRACT

Emergency medications are critical for rapid stabilisation of life-threatening conditions in intensive care units (ICUs), yet local utilisation profiles are often underreported and may limit evidence-informed procurement and protocol standardisation. This study aimed to describe the pattern of emergency medication use among ICU patients at Dr. M. M. Dunda Hospital, Limboto. A descriptive retrospective review of ICU medical records was conducted for the study period reported in the hospital database. Patient demographics and clinical characteristics were summarised using frequencies and percentages. For diagnoses, percentages were calculated based on recorded diagnosis entries because individual patients could have more than one diagnosis. For medications, utilisation was summarised as the frequency of emergency-medication items recorded during the observation period and presented by individual drug, therapeutic class, and route of administration. Among 25 ICU patients, the most frequently recorded clinical condition was acute respiratory failure, followed by other cardiopulmonary and neurological conditions. A total of 73 emergency-medication items were documented; norepinephrine was the most frequently used individual drug (26%), and cardiovascular agents constituted the largest therapeutic class (74%). Intravenous administration predominated, largely through syringe pump delivery, reflecting the need for continuous titration in critically ill patients. These findings provide a baseline description of emergency medication utilisation in this ICU and may support hospital-level planning for stock prioritisation, syringe-pump readiness, and medication-use governance for high-alert emergency drugs.



**Keywords:** Emergency drug use; drug utilization; intensive care unit; norepinephrine; syringe pump

| *Received:* | *Accepted:* | *Online:* |
|---|---|---|
| *2025-11-04* | *2026-01-11* | *2026-01-31* |

## 1. Introduction

The intensive care unit (ICU) is a specialised hospital ward that manages patients with life-threatening disease, trauma, or complications requiring continuous monitoring and rapid therapeutic intervention. In addition to advanced organ-support technologies, ICU outcomes depend on timely access to emergency pharmacotherapy to stabilise haemodynamics, protect organ function, and prevent further deterioration. Because

critically ill trajectories can shift within minutes, delays in medication availability, preparation, or administration may translate into preventable morbidity [1,2]

The global demand for intensive care remains substantial and is associated with considerable in-hospital mortality across diverse settings. Reports from Asia and Indonesia highlight that critically ill patients frequently require prolonged organ support and face high mortality risk, reinforcing the need for prompt and protocolised pharmacotherapy in routine ICU care [3,4].

In this context, an emergency refers to any situation that can imminently threaten life or cause disability if not managed quickly and appropriately, including compromise of airway, breathing, or circulation. Hospitals must therefore ensure continuous availability and easy accessibility of essential emergency medications, with prioritisation in high-risk locations where emergencies occur most frequently [5,6]. Many emergency drugs used for shock, arrhythmias, seizures, severe respiratory compromise, and acute hypersensitivity are high-alert agents, requiring safeguards against look-alike/sound-alike errors, incompatibilities, and infusion miscalculations [7].

Profiling emergency medication utilisation in the ICU serves several purposes. First, it informs evidence-based procurement and stocking to reduce stock-outs and wastage from expiry [8,9]. Second, utilisation data provide an empirical basis for protocol development—such as vasopressor titration guides, rapid sequence intubation kits, and anaphylaxis management bundles—ensuring that the right drug, dose, and route are immediately available [10,11]. Third, it supports quality and safety initiatives (e.g., medication reconciliation, antimicrobial stewardship, compatibility guidance for multi-lumen infusions, and simulation-based training) and enables monitoring of performance indicators for continuous improvement [12,13].

Against this backdrop, mapping the local pattern of emergency drug use in the ICU is essential to align inventory with real-world case-mix, optimise syringe-pump and concentration standardisation, and strengthen policies for emergency pharmacotherapy [14,15]. Therefore, this study aimed to describe the utilisation profile of emergency medications in the ICU of Dr. M. M. Dunda Hospital, Limboto.

## 2. Methods

### Study Design

This study used a non-experimental, observational, retrospective descriptive design to characterise emergency-medication utilisation among patients treated in the Intensive Care Unit (ICU) of Dr. M. M. Dunda Regional General Hospital, Limboto. The analysis was based on secondary data extracted from ICU medical records. The original protocol describes this as a retrospective descriptive study using ICU medical-record data.

### Population and Sample

The study population comprised all medical records of patients treated in the Intensive Care Unit of Dr. M. M. Dunda Regional General Hospital, Limboto, between October and December 2024. A total sampling strategy was employed, yielding 25 patients who met eligibility criteria. Inclusion criteria were: receipt of emergency pharmacotherapy during October–December 2024 and availability of complete records, including patient demographics, primary diagnosis, and details of emergency medication use. The exclusion criterion was ICU medical records that were illegible or insufficiently clear for data extraction [16,17].

### Instruments and Data Collection

The research instruments consisted of a patient data collection form and an ICU emergency-medication utilization form at Dr. M. M. Dunda Regional General Hospital, Limboto. Data were obtained as secondary data from ICU patient medical records, with data abstraction conducted in the Medical Records Unit from March to May 2025. The variables captured included patient demographics (name, age, sex) and treatment details for emergency pharmacotherapy (drug name, administered dose, and route of administration)[18,19].

### Data Processing and Analysis

Data were processed and analyzed descriptively to profile emergency-medication utilization. After collection, records were checked for completeness, de-identified, and coded with a predefined abstraction sheet. Variables captured demographics, primary diagnosis, drug name, dose, route, and administration mode Frequencies and percentages were computed for categorical variables; medians and interquartile ranges were planned for skewed continuous data. Tabulations and bar charts were generated in Microsoft Excel to facilitate interpretation. Data quality was ensured through double entry for a subset and resolution of discrepancies by consensus. Missing or unreadable fields were excluded. Findings are presented as tables with narrative summaries [20,21].

### Ethical approval and confidentiality

Ethical clearance was obtained from the Health Research Ethics Committee (exempt review), Recommendation of Ethical Approval No. 018A/UN47.B7/KE/2025 (28 April 2025). Patient identifiers were removed during abstraction, and the dataset was analysed in coded form.

## 3. Results and Discussion

Based on the results of the study conducted in the ICU of Dr. M. M. Dunda Limboto Regional Public Hospital, it was found that ICU patients consisted of 13 females (52%) and 12 males (48%). As shown in **Table 1**, the gender distribution in the ICU was nearly equal. This finding indicates that the need for intensive care is not solely influenced by gender, and both males and females have an equal likelihood of being admitted to the ICU.

**Table 1.** Baseline characteristics of ICU patients (n = 25)

| Variable | Category | n | % |
|---|---|---|---|
| **Sex** | Male | 12 | 48 |
| | Female | 13 | 52 |
| **Age group (years)** | 19–44 | 7 | 28 |
| | 45–59 | 9 | 36 |
| | ≥60 | 9 | 36 |

The results of this study indicate that gender distribution in the ICU is nearly equal. Males often present with risk factors such as smoking, unhealthy diet patterns, and low levels of high-density lipoprotein (HDL) cholesterol. In contrast, females more commonly exhibit risk factors such as low physical activity, mental-emotional disorders, obesity, hypertension, diabetes, high total cholesterol, and elevated low-density lipoprotein (LDL) cholesterol [22,23]. These differing risk factor profiles may balance each other out, resulting in approximately equal numbers of ICU admissions between males and female. This is consistent with a study conducted by Oktadiani et al. (2024)

on ICU patients at Arifin Achmad Regional Public Hospital, Riau Province, which reported that the proportion of male and female patients was comparable, at 48.7% and 51.3%, respectively. This indicates that both males and females have an equal risk of requiring intensive care treatment in the ICU [24,25].

The results of this study showed that the age distribution of patients treated in the ICU was dominated by those aged 45–59 years and ≥60 years, with each group consisting of 9 patients (36%). Meanwhile, the age group of 19–44 years accounted for 7 patients (28%), **as shown in Table 1.**

**Table 3.** Distribution of Disease Diagnosis

| Disease Diagnosis | Amount | Percentage |
|---|---|---|
| Acute respiratory failure | 18 | 19% |
| Pneumonia | 6 | 6% |
| Hemorrhagic stroke | 5 | 5% |
| Chronic kidney disease (CKD) | 5 | 5% |
| Hypertensive emergency | 4 | 4% |
| Ischemic stroke | 4 | 4% |
| Anemia | 4 | 4% |
| Hypertension | 4 | 4% |
| Acute pulmonary edema | 4 | 4% |
| Impending respiratory failure | 3 | 3% |
| Hypovolemic shock | 3 | 3% |
| Sepsis | 3 | 3% |
| Septic shock | 3 | 3% |
| Cardiac arrest | 2 | 2% |
| Uremic encephalopathy | 2 | 2% |
| Acute exacerbation of COPD | 2 | 2% |
| Cardiomegaly | 2 | 2% |
| Bronchopneumonia | 2 | 2% |
| Previous pulmonary TB | 2 | 2% |
| Pressure ulcer | 2 | 2% |
| Others | 13 | 14% |
| **Total** | **93** | **100%** |

In terms of age distribution, the age groups most frequently treated in the ICU were the pre-elderly and elderly categories. This is because increasing age is often associated with changes in immune function, including a reduced ability of leukocytes to eliminate antigens and alterations in the expression of pro-inflammatory cytokines [26,27]. In another study, it was stated that older patients have a higher risk of developing complications that require special attention in treatment planning, which

leads to a higher rate of ICU admissions in this age group. Increasing age results in a decline in physiological functions and a greater susceptibility to various diseases [28,29].

The disease data in the ICU are presented in **Table 2** and **Figure 1**. The most commonly found condition was acute respiratory failure, with a total of 18 cases (19%). The next most common diagnosis was pneumonia with 6 cases (6%), followed by hemorrhagic stroke and chronic kidney disease, each with 5 cases (5%). Other diagnoses with a frequency of 4 cases (4%) included hypertensive emergency, non-hemorrhagic stroke, anemia, hypertension, and acute pulmonary edema. There were also several other diagnoses with lower frequencies. Acute respiratory failure (19%) was the most dominant cause of ICU admission at Dr. M. M. Dunda Limboto Hospital during October–December 2024. The next most common diagnoses were pneumonia with 6 cases (6%), followed by hemorrhagic stroke and chronic kidney disease (CKD), each with 5 cases (5%). Most critically ill patients in the ICU experience dysfunction or failure of one or more organs, requiring close hemodynamic monitoring and intensive medical therapy. On average, each patient had 3–4 different diagnoses. This condition is associated with an increased presence of comorbidities and even multimorbidity, which refers to the coexistence of two or more chronic conditions simultaneously [30,31].

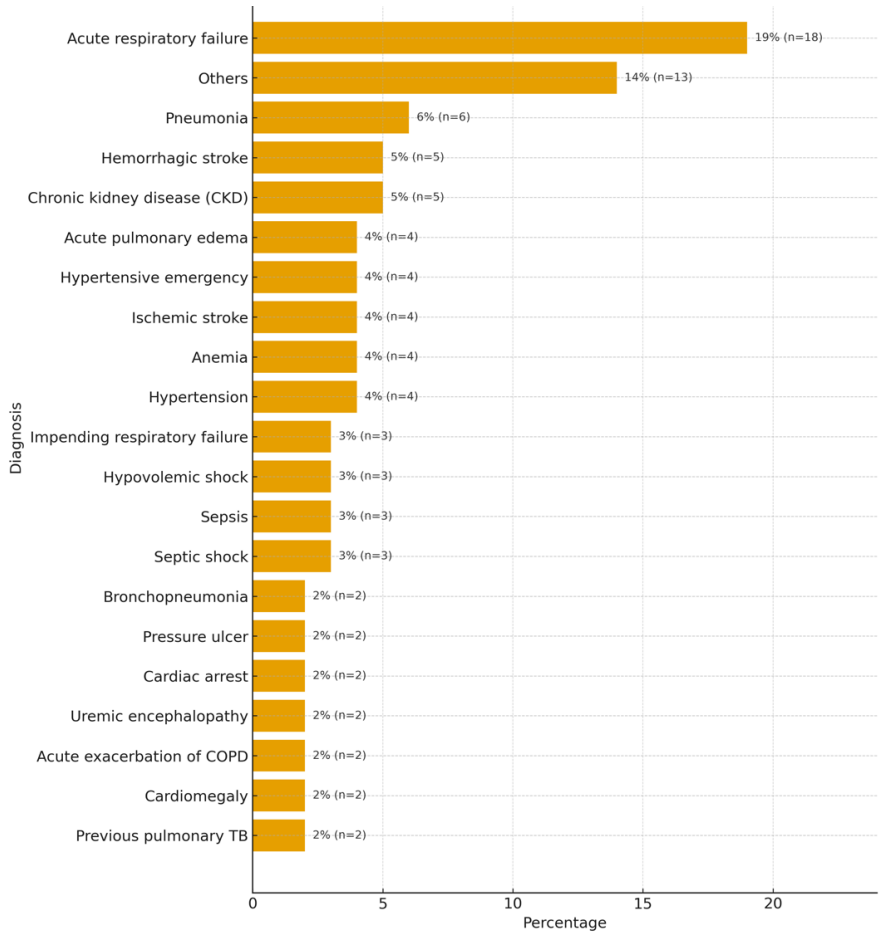


**Figure 1.** Graph Distribution of Disease Diagnosis

Acute respiratory failure can be defined as a significant impairment of gas exchange in the respiratory system, or a syndrome resulting from respiratory system failure to carry out one or both gas exchange functions namely oxygenation or carbon

dioxide elimination. It is typically characterized by a $PaO_2$ less than 60 mmHg (hypoxemia) or a $PaCO_2$ greater than 50 mmHg (hypercapnia). Acute respiratory failure is among the most common critical conditions requiring intensive care, often necessitating mechanical ventilation or oxygen support under strict monitoring, and it is a leading cause of mortality in adult patients [32].

The condition is marked by sudden and severe breathing difficulty, frequently arising within 12–48 hours after a triggering event such as trauma, sepsis, or aspiration of gastric contents or foreign bodies into the lungs. Complications resulting from acute respiratory failure include increased vulnerability to congestive heart failure, elevated risk of pneumonia, and progression to multi-organ failure. The management of respiratory failure is based on treating the underlying cause by providing oxygenation and ventilation support when necessary. Management of respiratory failure can include supportive measures, medication, and correction of blood gas analysis [33,34].

Pneumonia is an acute respiratory infection (ARI) and a communicable infectious disease that remains a leading cause of mortality among all age groups worldwide, including children, adults, and the elderly. Pneumonia is also associated with various complications, such as pleuritis, lung abscess, septicemia, and cardiovascular diseases. The risk of pneumonia and related mortality increases significantly with advancing age; therefore, the burden of pneumonia is projected to rise due to the aging population. Pneumonia is not only a precipitating factor leading to ICU admission but also the most common secondary infection experienced by critically ill patients. ICU-acquired pneumonia is largely associated with the use of mechanical ventilation and presents specific challenges in both diagnosis and management.Hemorrhagic stroke is a type of stroke caused by the rupture of cerebral blood vessels, leading to brain dysfunction accompanied by neurological deficits. According to the American Heart Association (AHA), hemorrhagic stroke is the most dangerous form of stroke because it can result in severe brain damage and even death. Patients with hemorrhagic stroke are admitted to the ICU, where they require continuous monitoring and prompt intervention to prevent physiological decompensation. Similarly to hemorrhagic stroke, chronic kidney disease (CKD) also accounted for the same percentage of diagnoses among ICU patients. CKD is a complex condition caused by multiple contributing factors, which may vary significantly depending on individual characteristics. Although hypertension, diabetes, and metabolic disorders are widely recognized as traditional primary causes of CKD, recent data have shown an increase in cases where patients develop this condition without any prior history of symptoms or comorbid illnesses [35,36].

The distribution of drug utilization is presented in **Table 3** and **Figure 2**. The most frequently used drug was norepinephrine at 26%, followed by furosemide at 15% and nicardipine at 11%. Other commonly administered drugs included epinephrine (8%), meprovent (7%), and vitamin K (7%). Drugs with lower utilization frequencies included dobutamine (5%), dexamethasone (4%), aminophylline, amiodarone, ISDN, and sodium phenytoin at 3% each, as well as diazepam, digoxin, lidocaine, and calcium gluconate at 1% each.

From the data in **Table 3**, it can be seen that the most frequently used drug is norepinephrine at 26%. Norepinephrine is the first-line vasopressor used for septic shock. It is administered to achieve the target mean arterial pressure (MAP), which is the primary determinant of systemic filling pressure and venous return. Achieving a sufficient MAP can increase tissue blood flow and contribute to the maintenance of tissue perfusion. A MAP below the normal threshold is typically associated with reduced organ perfusion. However, targeting a high MAP with vasopressor

administration may be associated with an increased risk of atrial fibrillation; thus, a MAP goal of 65 mmHg is more widely recommended during early resuscitation in patients with septic shock requiring vasopressors.

**Table 3.** Distribution Based on Drug Names and Dosage Administration

| Drug Classification | Drug Names | Dosage | Amount | Percentage |
|---|---|---|---|---|
| Cardiovascular Drugs | Norepineprine Inj | 0,02-0,25 mcg/kg/menit | 19 | 26% |
| | Furosemid Inj | 1-3 ampoule/24j | 11 | 15% |
| | | 0,5-0,25 cc/j | | |
| | Nicardipin Inj | 1-5 mg/j | 8 | 11% |
| | | 1-2 mcg/kgbb | | |
| | Epinefrin Inj | 0,05-0,1 mcg/kg/menit | 6 | 8% |
| | | 1 ampoule | | |
| | Dobutamin | 2,5-5 mcg/kg/menit | 4 | 5% |
| | Amiodarone | 150-300 mg | 2 | 3% |
| | ISDN | 5 mg | 2 | 3% |
| | Digoxin | 0,125 mg | 1 | 1% |
| | Lidocain Inj | 1-1.5 mg/kg | 1 | 1% |
| Respiratory Drugs | Meprovent Nebu | 1 ampul/6j-8j | 5 | 7% |
| | Aminofillin Inj | 1 ampoule | 2 | 3% |
| Neurological Drugs | Na Phenitoin Inj | 1 ampoule | 2 | 3% |
| | Diazepam Inj | 1 ampoule | 1 | 1% |
| Others | Vit K Inj | 1 ampoule | 5 | 7% |
| | Dexametason Inj | 1-2 ampoule | 3 | 4% |
| | Ca Gluconas Inj | 1 ampoule | 1 | 1% |
| | | **Total** | **73** | **100%** |

Norepinephrine acts as an adrenergic receptor agonist by increasing peripheral resistance and blood pressure through peripheral vasoconstriction. It functions as a peripheral vasoconstrictor (α-adrenergic action), a cardiac inotropic stimulator, and a coronary artery vasodilator (β-adrenergic action). Norepinephrine primarily acts on α1- and α2-adrenergic receptors to induce vasoconstriction. It is distributed locally, mainly within sympathetic nerve tissues, and is able to cross the placental barrier; however, it does not cross the blood–brain barrier [37,38].

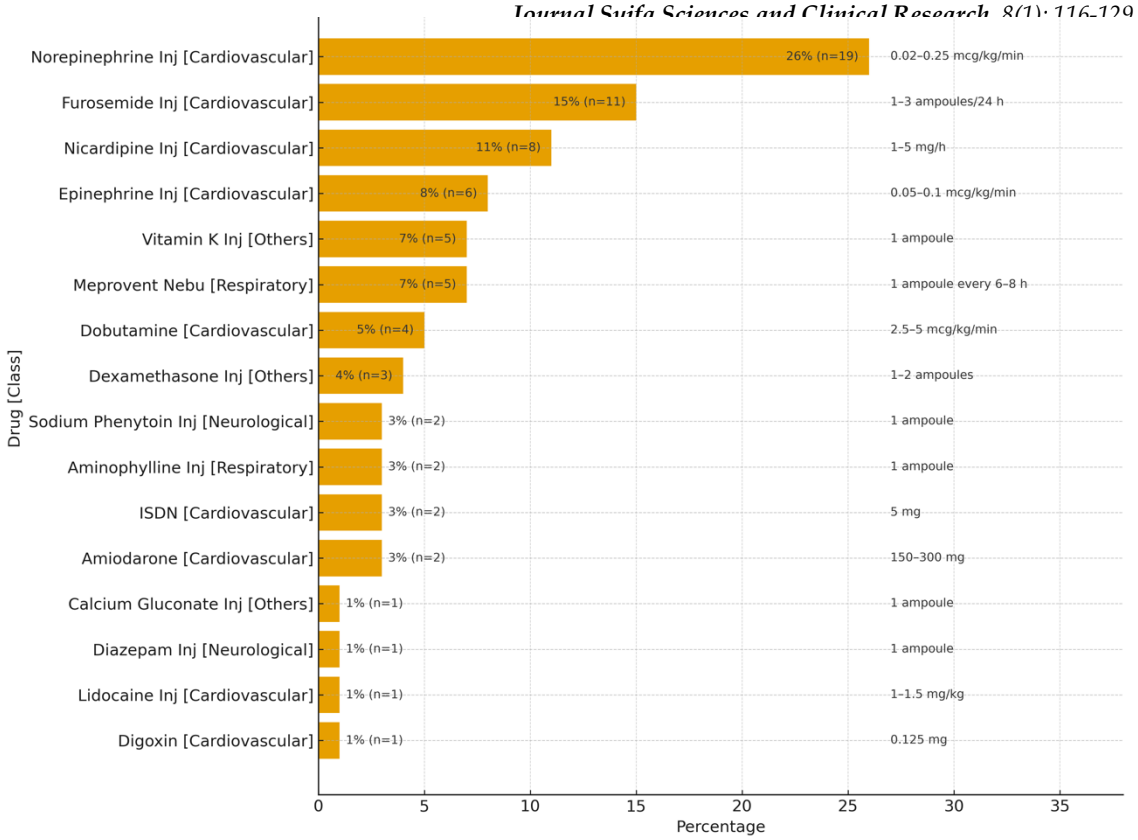


**Figure 2.** Graph Distribution Based on Drug Names and Dosage Administration

The results of this study are consistent who reported that norepinephrine was the most frequently used emergency drug in the ICU of Ulin Regional Public Hospital Banjarmasin, with a utilization percentage of 73.33%. Norepinephrine is the first-line vasopressor for all types of shock accompanied by severe hypotension, including cardiogenic shock, shock of unknown etiology, and vasodilatory/septic shock. Norepinephrine is administered at a dose of 0.01 to 3 µg/kg/min, and in all cases the dose must be titrated according to the patient's response. Patients with refractory shock may require 8 to 30 µg/min of norepinephrine. In certain cases, very high doses of norepinephrine (up to 68 mg or 17 ampoules) may be required if the patient remains hypotensive. Norepinephrine has a rapid onset of action with a duration of effect lasting 1–2 minutes after the infusion is discontinued [39,40].

The results showed that cardiovascular drugs dominated the utilization profile, with 54 drugs or approximately 74% of the total samples. Respiratory drugs ranked second with 7 drugs (10%), followed by nervous system drugs with 3 drugs (4%). The remaining 9 drugs (12%) were categorized as others, which included medications outside the major classifications but still required for the management of critically ill patients (**Table 4**).

**Table 4.** Distribution Based on Drug Classification

| Drug Classification | Amount | Percentage |
|---|---|---|
| Cardiovascular Drugs | 54 | 74% |
| Respiratory Drugs | 7 | 10% |
| Neurological Drugs | 3 | 4% |
| Others | 9 | 12% |
| **Total** | **73** | **100%** |

Cardiovascular drugs dominated the overall medications administered to ICU patients at Dr. M. M. Dunda Limboto Hospital during the period of October–December 2024. The cardiovascular system consists of the heart, blood vessels, and lymphatic vessels, and is responsible for transporting oxygen, nutrients, and other essential substances throughout the body, as well as removing metabolic waste products. Disorders of the cardiovascular system can lead to a wide range of diseases, including coronary heart disease, hypertension, heart failure, and stroke. Several studies have explained that non-modifiable risk factors for cardiovascular diseases include heredity, age, and gender, while modifiable risk factors include smoking, diabetes, hypertension, dyslipidemia, and stress. Cardiovascular drugs are compounds used to prevent or treat diseases of the cardiovascular system (the heart and blood vessels). These medications are classified based on their pharmacological effects into several major categories, such as cardiotonics, antiarrhythmics, antihypertensives, antianginals, drugs for atherosclerosis, and anticoagulants. In general, cardiovascular diseases refer to conditions that involve narrowing or blockage of the blood vessels, which may result in heart attacks, chest pain (angina), or stroke [41,42].

Based on the results of the study, most drugs were administered intravenously via syringe pump, totaling 43 drugs (59%). The IV bolus route ranked second with 22 drugs (30%). Furthermore, the inhalation/nebulization route was used for 5 drugs (7%), and the remaining drugs (4%) were administered through other routes, including sublingual and nasogastric tube (NGT), with a total of 3 drugs (**Table 5**).

**Table 5.** Distribution Based on Route of Drug Administration

| Route of Drug | Amount | Percentage |
|---|---|---|
| IV (*syringe pump*) | 43 | 59% |
| IV bolus | 22 | 30% |
| Inhalation/nebulization | 5 | 7% |
| Others | 3 | 4% |
| **Total** | **73** | **100%** |

The administration of emergency drugs in ICU patients was mostly carried out intravenously via syringe pump, accounting for 43 drugs (59%). Intravenous (IV) therapy is one of the methods used to administer medications to ICU patients by injecting the drug through an infusion line directly into the patient's bloodstream, allowing the medication to act more rapidly. Based on the intravenous administration method, several types can be identified, including continuous or drip infusion and intravenous bolus administration.

Some drugs are also administered intravenously using a syringe pump to ensure more controlled delivery. A syringe pump is a medical device used to regulate the amount of fluid entering the bloodstream through a vein. This device is particularly used for medications that require highly precise delivery rates, small volumes over an extended period, or stable drug concentrations. Specifically, the syringe pump focuses on controlling the volume of fluid administered, measured accurately in milliliters per hour (mL/hour), allowing the rate of drug delivery to be precisely adjusted according to the patient's therapeutic needs [43,44].

Despite providing a baseline description of emergency medication utilisation in the ICU of Dr. M. M. Dunda Hospital, this study has several limitations that should be considered when interpreting the findings. First, the analysis was conducted in a single centre with a relatively small sample (n = 25) and a short observation period (October–December 2024), which may limit generalisability and may not fully capture seasonal or annual variation in ICU case-mix and drug use. Second, because the study relied on retrospective medical-record documentation, the accuracy of utilisation frequencies depends on completeness and consistency of charting, and some variables (e.g., exact dosing details, infusion duration, and indication per drug exposure) may be subject to missingness or misclassification. Third, diagnostic frequencies were summarised as recorded diagnosis entries rather than patient-level prevalence because individual patients could have multiple concurrent diagnoses; therefore, percentages should not be interpreted as the proportion of patients with a given diagnosis. Finally, this descriptive design did not evaluate medication appropriateness, adherence to clinical guidelines, adverse drug events, or clinical outcomes; future studies with larger datasets and prospective designs are recommended to assess rational drug use and its impact on patient safety and outcomes.

## 4. Conclusion

This retrospective descriptive study provides a baseline profile of emergency medication utilisation among ICU patients at Dr. M. M. Dunda Hospital, Limboto, during October–December 2024. Among 25 patients, ICU utilisation was dominated by middle-aged and older adults, and the recorded diagnosis profile was led by acute respiratory failure. A total of 73 emergency-medication exposure events were documented, with norepinephrine emerging as the most frequently used individual drug and cardiovascular agents constituting the largest therapeutic class. Intravenous administration predominated, particularly via syringe pump delivery, reflecting the operational need for continuous titration of high-alert therapies in critically ill patients. Overall, these findings can inform hospital-level procurement and stock prioritisation, support standardisation of infusion practices (including syringe-pump readiness and concentration protocols), and strengthen medication-use governance for emergency drugs in the ICU.

**Acknowledgements:**
The author sincerely to the Department of Pharmacy, Faculty of Sports and Health, Gorontalo State University, for institutional support, research permissions, and facility access. Any remaining errors are the author's responsibility.

**Conflicts of Interest:**
The author declares that there are no conflicts of interest associated with this work.

## References


[1] J. Lee, E. Lee, Y. Yeo, Y. Oh, S.-S. Hong, and J. Lee, "Pharmacological interventions on surgical intensive care units initiated by pharmacists," *Journal of Acute Care Surgery*, vol. 11, pp. 1–5, 2021. [Online]. Available: https://doi.org/10.17479/jacs.2021.1.1

[2] S. Kanji, E. MacLean, F. J. Rashid, M. Pittman, M. Trinacty, D. Allan, *et al.*, "Chemotherapy in the intensive care unit: An evaluation of context and outcomes," *Canadian Journal of Hospital Pharmacy*, vol. 73, pp. 279–287, 2020. [Online]. Available: https://doi.org/10.4212/cjhp.v73i4.3027

[3] H. Hariyanto, C. Q. Yahya, and R. C. A. Aritonang, "Severe COVID-19 in the intensive care unit: A case series," *Journal of Medical Case Reports*, vol. 15, pp. 1–6, 2021. [Online]. Available: https://doi.org/10.1186/s13256-021-02799-1

[4] H. Lee, S. Choi, E. J. Jang, J. Lee, D. Kim, S. Yoo, *et al.*, "Effect of sedatives on in-hospital and long-term mortality of critically ill patients requiring extended mechanical ventilation for >48 hours," *Journal of Korean Medical Science*, vol. 36, e221, 2021. [Online]. Available: https://doi.org/10.3346/jkms.2021.36.e221

[5] A. Mansour, L. Al-Bizri, J. El-Maamary, R. Hamade, E. Saliba, D. Khammash, *et al.*, "National study on the adequacy of antidotes stocking in Lebanese hospitals providing emergency care," *BMC Pharmacology and Toxicology*, 2016. [Online]. Available: https://doi.org/10.1186/s40360-016-0092-7

[6] D. Teshome, M. Hunie, T. Desse, E. Fenta, M. Gelaw, and A. Gashaw, "Availability of emergency drugs and essential equipment in intensive care units in hospitals of Ethiopia: A multicenter cross-sectional study," *Open Access Emergency Medicine*, vol. 12, pp. 435–440, 2020. [Online]. Available: https://doi.org/10.2147/OAEM.S285695

[7] U. P. M. Fernando, M. P. Dharmawardhane, N. Subramaniam, S. Nimalan, K. U. I. S. Gunathilake, and B. M. Munasinghe, "Acute respiratory distress syndrome following anaphylactic shock—'A deadly duel'—case report and literature review," *Open Journal of Anesthesiology*, 2021. [Online]. Available: https://doi.org/10.4236/ojanes.2021.112004

[8] C. R. Anuradha and R. Jeyalalitha, "Drug utilisation study in intensive cardiac care unit of a tertiary care hospital," *University Journal of Medicine and Medical Specialities*, vol. 4, no. 2, pp. 1–4, 2018. [Online]. Available: https://paper.researchbib.com/view/paper/157830

[9] M. S. Banday, M. Manzoor, M. A. Shah, and Z. Ali, "Antimicrobial drug utilization pattern in a tertiary level intensive care unit in Northern India: Antimicrobial stewardship programme need of the hour," *Asian Journal of Medical Sciences*, vol. 14, pp. 218–223, 2023. [Online]. Available: https://doi.org/10.3126/ajms.v14i2.49602

[10] C. Lapere, J. A. Roelofse, and A. von Backstrom, "Continuous education in sedation: Anaphylaxis management during procedural sedation," *South African Dental Journal*, vol. 71, no. 8, pp. 368–369, 2016. [Online]. Available: https://scielo.org.za/pdf/sadj/v71n8/09.pdf

[11] H. Black, T. Hall, C. Hrymak, D. Funk, F. Siddiqui, J. Sokal, *et al.*, "A prospective observational study comparing outcomes before and after the introduction of an intubation protocol during the COVID-19 pandemic," *Canadian Journal of Emergency Medicine*, vol. 25, pp. 123–133, 2023. [Online]. Available: https://doi.org/10.1007/s43678-022-00422-w

[12] R. Oakley, H. Trinh, T. Yau, S. Khorshid, D. Lonsdale, and T. Odetunde, *et al.*,

"Improving adherence to and effectiveness of a vancomycin continuous infusion protocol: A pilot quality improvement project," *International Journal of Pharmacy Practice*, vol. 30, suppl. 2, pp. ii37–ii38, 2022. [Online]. Available: https://doi.org/10.1093/ijpp/riac089.043

[13] W. R. Truong and J. Yamaki, "The hospital antimicrobial use process: From beginning to end," *Open Forum Infectious Diseases*, 2018. [Online]. Available: https://doi.org/10.1093/ofid/ofy098

[14] B. Suraj, S. C. Somashekara, and B. Sandeep, "Drug utilization pattern in an intensive care unit of a teaching hospital in South India," *International Journal of Basic & Clinical Pharmacology*, vol. 8, no. 7, pp. 1527–1531, 2019. [Online]. Available: https://imsear.searo.who.int/bitstream/123456789/200235/1/ijbcp2019v8n7p1527.pd

[15] D. F. Obeid and A. H. Karara, "Drug utilization and potential drug–drug interactions within an intensive care unit at a university tertiary care hospital in Egypt," *Pharmacy*, vol. 10, no. 4, Art. no. 96, 2022. [Online]. Available: https://doi.org/10.3390/pharmacy10040096

[16] A. Sikora, X. Chen, and B. Murray, "Cluster analysis driven by unsupervised latent feature learning of intensive care unit medications to identify novel pharmaco-phenotypes of critically ill patients," *Scientific Reports*, 2023. [Online]. Available: https://doi.org/10.1038/s41598-023-42657-2

[17] R. Nadeem, Z. A. Obeida, S. Kamat, and A. N. Elsousi, "Quality and quantity of sample size is crucial in clinical studies to exclude association: antimicrobial exposure and the risk of delirium in critically ill patients," *Critical Care*, vol. 23, Art. no. 147, 2019. [Online]. Available: https://doi.org/10.1186/s13054-019-2381-1

[18] R. Carneiro, D. F. Chaves, L. Araújo, D. B. Moura, and D. S. César, "Methodological description of clinical research data collection through electronic medical records in a center participating in an international multicenter study," *einstein (São Paulo)*, 2019. [Online]. Available: https://journal.einstein.br/

[19] Y. Wang, J. N. Stroh, G. Hripcsak, C. C. L. Wang, T. D. Bennett, J. Wrobel, *et al.*, "A methodology of phenotyping ICU patients from EHR data: high-fidelity, personalized, and interpretable phenotypes estimation," *Journal of Biomedical Informatics*, vol. 148, Art. no. 104547, 2023. [Online]. Available: https://doi.org/10.1016/j.jbi.2023.104547

[20] K. Pandey and I. A. Khan, "Drug prescribing patterns in patients visiting the emergency medicine department at a tertiary care teaching hospital: A prospective study," *International Journal of Basic & Clinical Pharmacology*, vol. 5, pp. 163–168, 2016. [Online]. Available: https://www.ijbcp.com/index.php/ijbcp/article/view/189

[21] M. Kim, S. H. Mitchell, K. A. Bennett, P. R. Sutton, C. A. Crawford, S. J. Kaplan, *et al.*, "Older adults and high-risk medication administration in the emergency department," *Drug, Healthcare and Patient Safety*, 2017. [Online]. Available: https://doi.org/10.2147/DHPS.S143341

[22] N. Mazhar, "Frequency of risk factors of coronary heart diseases in patients with acute coronary syndrome and its comparison in male and female," *Archives of Clinical and Biomedical Research*, vol. 7, no. 2, pp. 167–170, 2023. [Online]. Available: https://doi.org/10.26502/acbr.50170330

[23] M. Bajracharya and S. Gangalal, "Comparative study of risk factors among the male and female patients with acute myocardial infarction admitted in CCU of

Sahid Gangalal National Heart Centre," *Nepalese Heart Journal*, vol. 6, no. 1, pp. 4–7, 2009. [Online]. Available: https://www.nhjournal.info/pdf/vol6no1/18446.pdf

[24] G. Saad, M. Khamis, and S. M. Alanazi, "Exploring sex disparities in cardiovascular disease risk factors using principal component analysis and latent class analysis techniques," *BMC Medical Informatics and Decision Making*, 2023. [Online]. Available: https://doi.org/10.1186/s12911-023-02179-3

[25] E. Zettersten, G. Jäderling, M. Bell, and E. Larsson, "The impact of patient sex on intensive care unit admission: A blinded randomized survey," *Scientific Reports*, 2019. [Online]. Available: https://doi.org/10.1038/s41598-019-50836-3

[26] G. Poulakou, S. Lagou, S. Papadatos, I. Anagnostopoulos, and G. Dimopoulos, "Infections in elderly intensive care unit patients," *Journal of Emergency and Critical Care Medicine*, 2019. [Online]. Available: https://doi.org/10.21037/jeccm.2019.09.01

[27] S. Inoue, M. Saito, and J. Kotani, "Immunosenescence in neurocritical care," *Journal of Intensive Care*, 2018. [Online]. Available: https://doi.org/10.1186/s40560-018-0333-5

[28] S. A. Tiruneh, Z. T. Tesema, and M. M. Azanaw, "The effect of age on the incidence of COVID-19 complications: A systematic review and meta-analysis," *Systematic Reviews*, vol. 10, Art. no. 80, 2021. [Online]. Available: https://doi.org/10.1186/s13643-021-01636-2

[29] A. D. Impiumi, "Outcome of the elderly patient in intensive care: A cohort study," 2015. [Online]. Available: https://doi.org/10.1186/2197-425X-3-S1-A531

[30] E. Rezoagli, B. A. McNicholas, F. Madotto, T. Pham, G. Bellani, "Presence of comorbidities alters management and worsens outcome of patients with acute respiratory distress syndrome: Insights from the LUNG SAFE study," *Annals of Intensive Care*, 2022. [Online]. Available: https://doi.org/10.1186/s13613-022-01015-7

[31] L. Maharjan, A. Shah, U. Bajracharya, and G. Shrestha, "Organ dysfunctions among deaths in critically ill patients," *Journal of Nepal Health Research Council*, vol. 15, no. 3, pp. 222–227, 2017. [Online]. Available: https://doi.org/10.3126/jnhrc.v15i3.18844

[32] G. Rawal, S. Yadav, and R. Kumar, "Acute respiratory distress syndrome: An update and review," *Journal of Translational Internal Medicine*, 2018. [Online]. Available: https://doi.org/10.1515/jtim-2016-0012

[33] P. Yingchoncharoen, "Severe acute respiratory distress syndrome secondary to concomitant influenza A and rhinovirus infection complicated by methicillin-resistant *Staphylococcus aureus* pneumonia in an early pregnancy patient with vaping-induced lung injury," *Journal of Community Hospital Internal Medicine Perspectives*, vol. 13, 2023. [Online]. Available: https://doi.org/10.55729/2000-9666.1213

[34] D. Mokra, "Acute Lung Injury—From Pathophysiology to Treatment," *Physiological Research*, vol. 69, Suppl. 3, pp. S353–S366, 2020. [Online]. Available: https://doi.org/10.33549/physiolres.934602

[35] H. Y. Volodymyrivna, "Modern principles of diagnosis and intensive therapy of spontaneous intracerebral hemorrhage," in *Scientific Practice: Modern and Classical Research Methods* (ΛΌΓΟΣ), Proc. IV Int. Sci. Pract. Conf., Boston, USA, May 26, 2023. [Online]. Available: https://doi.org/10.36074/logos-26.05.2023.095

[36] S. J. An, T. J. Kim, and B. Yoon, "Epidemiology, risk factors, and clinical features

of intracerebral hemorrhage: An update," 2017. **[Online]. Available:** *(stable DOI/link not identifiable from the citation string.)*

[37] X. Wang, M. Mao, S. Liu, S. Xu, and J. Yang, "A comparative study of bolus norepinephrine, phenylephrine, and ephedrine for the treatment of maternal hypotension in parturients with preeclampsia during cesarean delivery under spinal anesthesia," 2019. [Online]. Available: https://doi.org/10.12659/MSM.914143

[38] W. J. Cho, S. Y. Cho, and A. Lee, "Systemic hemodynamic effects of norepinephrine versus phenylephrine in intermittent bolus doses during spinal anesthesia for cesarean delivery," *Anesthesia and Pain Medicine*, vol. 15, no. 1, pp. 53–60, 2020. [Online]. Available: https://doi.org/10.17085/apm.2020.15.1.53

[39] P. M. Wieruszewski and A. K. Khanna, "Vasopressor choice and timing in vasodilatory shock," *Critical Care*, vol. 26, p. 76, 2022. [Online]. Available: https://doi.org/10.1186/s13054-022-03911-7

[40] O. Hamzaoui and R. Shi, "Early norepinephrine use in septic shock," *Journal of Thoracic Disease*, vol. 12, pp. 72–77, 2020. [Online]. Available: https://doi.org/10.21037/jtd.2019.12.50

[41] T. K. Oh and I. Song, "Cardiovascular medication and long-term outcome among intensive care unit survivors: A retrospective study," *Annals of Palliative Medicine*, vol. 10, pp. 5108–5118, 2021. [Online]. Available: https://doi.org/10.21037/apm-20-1786

[42] N. Anand, "Cardiovascular Diseases and Drug Therapy -A Review," *Research & Reviews: Journal of Pharmaceutics and Nanotechnology*, vol. 4, Special Issue: Reviews on Pharmaceutics and Nanotechnology, pp. 95–101, Sep. 2016. [Online]. Available: https://www.rroij.com/open-access/cardiovascular-diseases-and-drug-therapy-a-review-.pdf

[43] S. Manrique-Rodríguez, I. Heras-Hidalgo, M. S. Pernia-López, A. Herranz-Alonso, *et al.*, "Standardization and Chemical Characterization of Intravenous Therapy in Adult Patients: A Step Further in Medication Safety," *Drugs in R&D*, vol. 21, pp. 39–64, 2021. [Online]. Available: https://doi.org/10.1007/s40268-020-00329-w

[44] A. Blandford, P. C. Dykes, B. D. Franklin, P. Furniss, G. H. Galal, K. O. Schnock, *et al.*, "Intravenous infusion administration: A comparative study of practices and errors between the United States and England and their implications for patient safety," *Drug Safety*, 2019. [Online]. Available: https://doi.org/10.1007/s40264-019-00841-2