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RESEARCH ARTICLE

PREVALENCE AND RISK FACTORS ASSOCIATED WITH MULTI-DRUG RESISTANT ORGANISMS IN ADULT INTENSIVE CARE UNIT OF KFSH, TABUK, SAUDI ARABIA, 2023

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Abstract

Purpose: To assess the prevalence and risk factors associated with multi-drug resistant organisms in adult intensive care unit of KFSH-Tabuk during the year 2023.

Methods: This study was a retrospective, descriptive, cross-sectional institutional-based study including 88 cases of ICU patients with positive microbiology cultures for MDROs between the 1st of January 2023 to 31st of Dec 2023 in King Fahad Specialist Hospital, Tabuk, Saudi Arabia.

Results: The prevalence of MDRO among ICU patients was found to be 31.4%. Males (64.8%) were more than females (35.2%). The most common age group was found to be 66-80 years (29.5%), followed by more than 80 years (22.7%). The majority of patients (64.8%) has chronic diseases, and the most common chronic disease was hypertension (63.2%), followed by diabetes mellitus (56.1%). (93.2%) of patients had external medical support equipment. Of them, the majority (52.3%) had three external medical support equipment, followed by two (20.5%), and the most common external medical support equipment was found to be foley catheter (F.C) (81.7%), followed by central venous line (CVL) (64.6%), then endotracheal tubes (ETT) (50%). (56.8%) of patients had community-onset (CO) MDRO, while (42%) had healthcare facility-onset (HO) MDRO. Carbapenem-resistant Enterobacterales (CRE) MDR (33%) was the most common type of MDRO, followed by Acinetobacter MDR (28.4%). The majority of the identified organisms (87.5%) were gram-negative bacteria. The most common type of organism was Klebsiella pneumonia (37.5%), followed by Acinetobacter baumannii (29.5%), then Escherichia coli (10.2%). Sputum sample (42%) was the most common type of taking the sample. The majority of patients (87.5%) had only one type of organism, while (9.1%) had two types of organisms.

Conclusion: This study can conclude that the prevalence of multi-drug resistant organisms in adult intensive care unit of KFSH-Tabuk during 2023 is not that high. However, risk factors should be taken into consideration in order to prevent them, and thus, decrease the incidence of multi-drug resistant organisms and decrease the mortality.

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Introduction:-**Background:**

Multidrug-resistance organisms (MDROs) are defined as microorganisms, mainly bacteria, that are resistant to one or more classes of antimicrobial agents [1]. These involve methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococci* species (VRE), carbapenems-producing *Enterobacteriaceae*, Gram-negative bacteria that produce extended-spectrum beta-lactamases (ESBLs), MDR *Klebsiella* or *Pseudomonas*, MDR *Acinetobacter* and cephalosporin-resistance *Klebsiella* [2].

The fast developing multidrug-resistant organisms (MDROs) linked to infections with inadequate and scarce availability of better therapeutic choices are among the prioritized global health worries. Based on drug resistance patterns, multidrug-resistant organisms are categorized into multidrug-resistant (MDR), extensively drug-resistant (XDR) and pan drug-resistant (PDR) pathogenic bacteria. Multidrug-resistant organisms are non-vulnerable to at least one agent in three or more antimicrobial categories, XDR bacteria are non-susceptible to at least one agent in all but two or fewer antimicrobial categories, and PDR bacteria are non-susceptible to all agents in all antimicrobial categories. [3]

Multidrug-resistance organisms resistances restrict treatment choices for patients, making infection stronger against preventing further harm [2]. The presentation of multidrug-resistance organisms by onset time could be community-onset according to the specimen collection time which is ≤ 3 days after admission to the facility and healthcare facility onset if the specimens were collected > 3 days after admission to the facility [4].

Multidrug-resistance organisms (MDROs) have become a crucial international public health issue, causing more morbidity and mortality [5]. Multidrug-resistant organisms (MDROs) have appeared as one of the chief public health concerns of the 21st century. [6] Worldwide, antimicrobial resistance kills more than 700,000 individuals per year, as the World Health Organization (WHO) estimates that by the year 2050, the annual mortality will reach 10 million people due to antimicrobial resistance and that MDROs are becoming a greater threat universally. [7, 8]

In hospital settings, where patients are often ill or immunocompromised and therefore, more susceptible to infections, multidrug-resistance organisms pose a special challenge. Moreover, hospitals are breeding grounds for bacteria as patients are close to each other. Also, medical procedures create openings for the entry of bacteria into the body [9]. Patients who are admitted to the intensive care unit (ICU) are at the highest risk of getting infected with multidrug-resistant organisms (MDROs). This is due to the invasive procedures that are done, the use of immunosuppressive agents, and the number of medications that are administered, including antibiotics. In addition, the underlying diseases of these patients also play a role in their susceptibility to infections [10]. Hence, the ICU is an environment where there is a high risk of intensifying MDRO prevalence if infection control measures are not firmly achieved [11]. Consequently, ICUs have become a central point of focus for the control and prevention of MDRO colonization and infection within hospitals [12].

Multi-drug-resistant organism infection is usually complicated and hard to treat, and it is easy to lead to an outbreak of nosocomial infection. Multi-drug-resistant organism nosocomial infection not only extends the length of hospitalization for patients, moreover, it also increases the hospitalization costs of patients. These are causing a huge economic burden to patients, and more serious nosocomial infection in the ICU that impacts the success rate of critically ill patients and increases the mortality rate of ICU patients. Hence, the management of multi-drug-resistant organism infections has increasingly become a significant part of hospital infection control. [13]

There is a gap in the literature concerning MDROs in Tabuk City in Saudi Arabia and more specifically when related to MDROs in intensive care units. In this context, it is believed that this study will help fill the gap by determining the prevalence and risk factors of MDROs among adult ICU patients in the King Fahad Specialist Hospital Tabuk City.

Therefore, the aim of this study was to assess the Prevalence and risk factors associated with Multi-Drug Resistant Organisms in Adult Intensive Care Unit of KFSH-Tabuk During 2023

Review of the literature:-

Nosocomial infections are a chief international health concern encountered today. This worldwide health issue has been worsened in the past years due to the rise in multidrug-resistant (MDR) pathogens, with more than 2.8 million antibiotic-resistant infections assessed to happen every year, resulting in 35,000 deaths. The World Health Organization (WHO) and many other organizations and researchers approve that the spread of MDR is a crucial

concern that necessitates a coordinated global action plan to address. [14]

Many articles done by individual institutions in Saudi Arabia have reported rates of antimicrobial resistance using automated methods. Nevertheless, not many national surveillance studies have been carried out to date, which is the aim of this study.

In Saudi Arabia, there are some studies on the epidemiology of MDROs have been conducted in some regions; for example, one study carried out in the ICU of KFHH in Al-Hofuf City estimated the prevalence and risk factors of MDROs, showed that 68.2% out of 496 notification of HAI cases were MDROs with a high prevalence of risk factors including pre-existing medical conditions, invasive procedures, and the long duration of hospital stays, are more prominent in intensive care unit ICU [15].

Another study was conducted in Saudi Arabia by Saeed S. Banawas et al. in the year 2023 on the same topic that included 1125 bacterial isolates from 1039 patients; among them, gram-positive bacteria were significantly more abundant than gram-negative bacteria. The most prevalent bacteria were *Staphylococcus epidermidis* and *Klebsiella pneumoniae*. Notably, gram-negative bacteria were mainly isolated from adult patients, and 20.63% of the gram-positive isolates were from pediatric patients, which was significantly higher than the corresponding percentages in elders and adults. The gram-positive isolates were mainly resistant to cephalothin, oxacillin, amoxicillin-clavulanate, and erythromycin and susceptible to penicillin, gentamicin, ciprofloxacin, and vancomycin. Additionally, the gram-negative isolates were mainly resistant to ampicillin, cephalothin, and amoxicillin-clavulanate and susceptible to amikacin, ertapenem, aztreonam, colistin, and trimethoprim-sulfamethoxazole. [16]

In China, a study was done by Hu Jiang et al. in the year 2023 to analyze the current situation and risk factors of multi-drug-resistant organism (MDRO) infection in Neuro-intensive care unit (ICU) patients. A total of 297 patients were included, 131 patients infected with MDRO. The infection rate was 44.11%. The results of binary Logistics regression showed that tracheal intubation, artery blood pressure monitoring, fever, antibiotics, pneumonia were independent risk factors for MDRO infection in Neuro-ICU ($P < 0.05$), $AUC = 0.887$. [14]

Meanwhile, in Malaysia, a study was carried out by Khalid Ahmad Al-Sunaidar et al. in the year 2022 on the same topic. Out of 228 patients, the isolated MDRO was 97 (42.5%), of which 78% were Gram-negative bacteria. The mortality rate among those with MDRO was 85 (37.3%). The hospital acquired infection (HAI) was a significant predictor for ICU-LOS in univariate linear regression ($R^2 = 0.034$, $p = 0.005$). In MVA linear regression, both *Enterococcus faecalis* infection and *Acinetobacter baumannii* (AC)-MDRO were predictors for ICU-LOS with ($R^2 = 0.478$, $p < 0.05$). In the univariate cox regression, only the infection with AC-MDRO was a risk factor for ICU-mortality with [HR = 1.802 (95% CI: 1.2–2.706; $p = 0.005$)]. [17]

Lastly, a study was conducted in Morocco by Adel El mekes et al. in the year 2018 to determine clinical risk factors, epidemiology and the causative agents of multi-drug resistant bacteria in the ICU of the University Hospital in Marrakesh-Morocco. Among the 479 admitted patients, 305 bacteria were isolated and identified as *Acinetobacter baumannii* (31%), *Enterobacteriaceae* species (30%), and *Staphylococcus* (24%), *P. aeruginosa* (10%) and other bacterial strains (5%). The rate of MDR bacteria acquisition was 41% (124/305) with domination of *A. baumannii* resistant to imipenem (70%) and followed by Extended Spectrum β -lactamases producing *Enterobacteriaceae*, *P. aeruginosa* resistant to Ceftazidime, and Methicillin-resistant *S. aureus* (18%, 7%, and 5% respectively). The distribution of the common nosocomial infections was dominated by pneumonia, bacteremia, and catheter-related blood stream infections (39%, 29%, and 17%) respectively. Multivariate analysis identified lack of patient isolation precautions (OR: 7.500), use of quadri or triple therapy (OR: 5.596; OR: 5.175), and mechanical ventilation (OR: 4.926), as the most significant clinical and epidemiological factors associated with acquisition of MDR bacteria. The attributable mortality, in this ICU, of patients with MDR bacteria, is about 12%. [18]

Problem statement:

MDROs have become one of the most serious threats, especially in the hospital's ICU. In 2019, an estimated 4.95 million deaths were associated with MDR infections globally, of which 1.27 million were directly due to drug resistance [19]. According to a systematic review of the prevalence of multidrug-resistant organisms in the Arabian Peninsula. Saudi Arabia reported the highest number of MDR strains compared to other countries. Additionally, the country had the highest mortality rate with 365 patients dying due to MDROs [20].

Justification:

This study is meant to fill in the gap of research in the understanding about the prevalence and risk factors associated with Multi-Drug Resistant Organisms in adult intensive care unit, in Saudi Arabia, as of the best of our knowledge, there have been no epidemiological studies conducted in Tabuk City regarding prevalence and risk factors of multidrug-resistant organisms in an intensive care unit setting. Furthermore, one major challenge in tackling MDR is understanding its prevalence and risk factors.

Research question:

What are the prevalence and risk factors associated with multi-drug resistant organisms in the adult intensive care unit of KFSH-Tabuk City, Saudi Arabia, 2023

Objectives:-

The objective of this study was to assess the prevalence and risk factors associated with multi-drug resistant organisms in adult intensive care unit of KFSH-Tabuk during the year 2023.

Methodology:-

Study Design:

The study was conducted as a retrospective, descriptive cross-sectional institutional-based study.

Study Area:

The study was conducted in King Fahad Specialist Hospital (KFSH), Tabuk, Saudi Arabia. This hospital is the largest referral hospital in the Tabuk region, with a 500-bed capacity [15]. Tabuk Region sits in the extreme Northwest of Saudi Arabia. The area of the Tabuk Region is 139,000 square kilometers or about 6.2% of the total area of the Kingdom [16].

Study Population:

ICU patients of KFSH, Tabuk, Saudi Arabia.

Inclusive Criteria:

All Saudi and non-Saudi citizen, more than 18 years old patients who were admitted to the ICU of KFSH with positive microbiology cultures for MDROs between the 1st of January 2023 to 31st of Dec 2023.

Exclusive Criteria:

Pediatric patients (less than 18 years), patients from outpatients, patients with only positive fungal and positive viruses' cultures were excluded from the study.

Sample size:

Total coverage of all adult patients who were admitted to the adult ICU of KFSH with positive microbial cultures for MDROs between the 1st of January 2023 to 31st of Dec 2023.

88 ICU patients were included in this study.

Data collection tools:

The data was collected from medical records and laboratory records by manual observation of records.

1. Data like: age, gender, nationality, type of MDRO, classification of identified MDRO, type of organism, identified microorganisms (bacteria, type of sample, number of organisms per patient) were collected by manual observation of laboratory records.
2. Other Data of clinical characteristics like: comorbidities, medical history, use of external medical support, equipment, number of devices were taken from the patient's medical records.

Data Analysis:

After obtaining consent to carry out the study, the data were collected and computerized using Microsoft Excel, to form a database using all the items. Data was then encoded and analyzed using Statistical Package for Social Sciences (SPSS 27). Data was displayed and presented in the form of tables and charts. Comparison between groups were made by logistic regression test.

Ethical consideration:

The Tabuk region's Medical Research Ethics Committee approved this study.

Disclosure statement :

None of the authors disclosed any potential conflicts of interest.

Funding :

This study was not supported by any sponsor or funder.

Results& Discussion:-

Results:-

The prevalence of MDRO among ICU patients was found to be 31.4%. Males (64.8%) were more than females (35.2%). The most common age group was found to be 66-80 years (29.5%), followed by more than 80 years (22.7%). The majority of patients (80.7%) were Saudi, while (19.3%) were non-Saudi. The majority of patients (64.8%) has chronic diseases, while (35.2%) do not. The most common chronic disease was hypertension (63.2%), followed by diabetes mellitus (56.1%). (93.2%) of patients had external medical support equipment. Of them, the majority (52.3%) had three external medical support equipment, followed by two (20.5%), and the most common external medical support equipment was found to be foley catheter (F.C) (81.7%), followed by central venous line (CVL) (64.6%), then endotracheal tubes (ETT) (50%). (56.8%) of patients had community-onset (CO) MDRO, while (42%) had healthcare facility-onset (HO) MDRO, and (1.1%) had both community and healthcare facility-onset MDRO. Carbapenem-resistant Enterobacterales (CRE) MDR (33%) was the most common type of MDRO, followed by Acinetobacter MDR (28.4%), then Extended Spectrum Beta-Lactamase (ESBL) MDR (20.5%). The majority of the identified organisms (87.5%) were gram-negative bacteria, while (9.1%) were gram-positive bacteria, and (3.4%) were both. The most common type of organism was Klebsiella pneumonia (37.5%), followed by Acinetobacter baumannii (29.5%), then Escherichia coli (10.2%). Sputum sample (42%) was the most common type of taking the sample, followed by both blood and urine sample (21.6%, each). The majority of patients (87.5%) had only one type of organism, while (9.1%) had two types of organisms, and (3.4%) had three types of organisms.

Table (1):-Showing the presence of MDRO among ICU patients.

Table 1		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	88	31.4	31.4	31.4
	No	192	68.6	68.6	100.0
Total		280	100.0	100.0	

The prevalence of MDRO among ICU patients was found to be 31.4%.

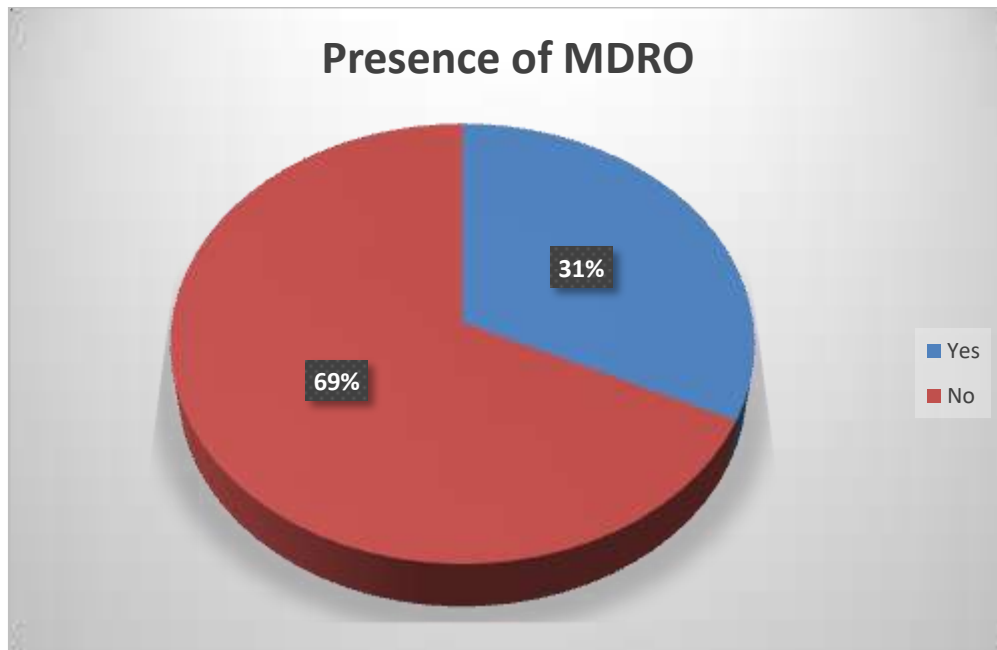


Table (1):-Showing the presence of MDRO among ICU patients.

Table (2):-Showing gender distribution among patients.

Table 2		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	57	64.8	64.8	64.8
	Female	31	35.2	35.2	100.0
Total		88	100.0	100.0	

Males (64.8%) were more than females (35.2%).

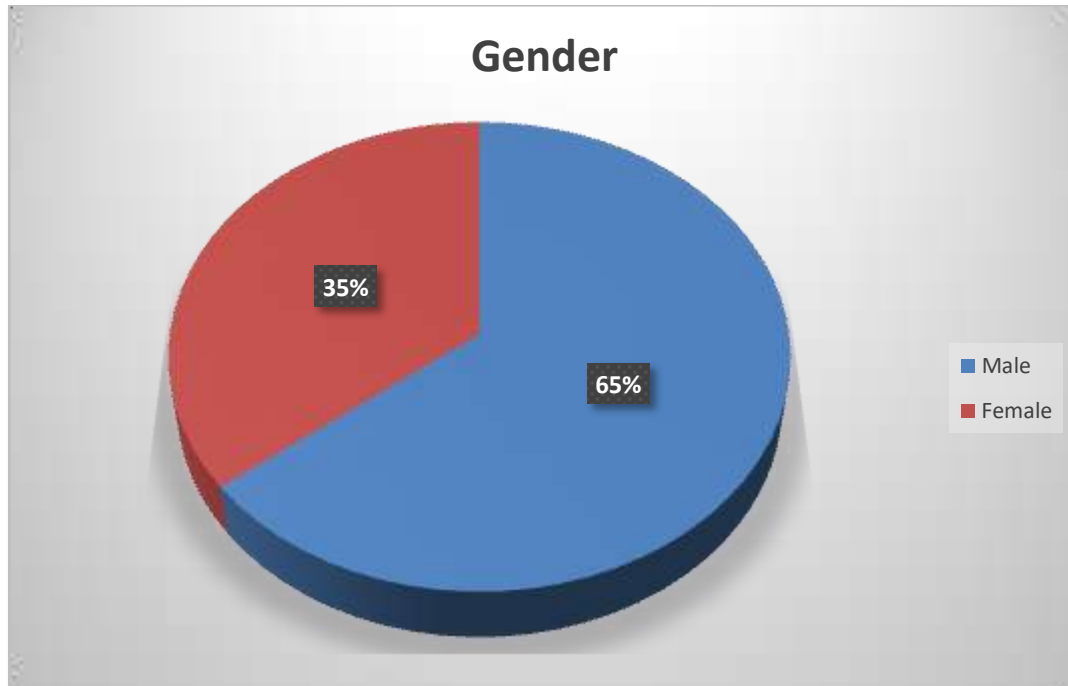
**Figure (2):-**Showing gender distribution of patients.**Table (3):-**Showing age distribution of patients.

Table 3		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 20 years	1	1.1	1.1	1.1
	20-35 years	10	11.4	11.4	12.5
	36-50 years	18	20.5	20.5	33.0
	51-65 years	13	14.8	14.8	47.8
	66-80 years	26	29.5	29.5	77.3
	More than 80 years	20	22.7	22.7	100.0
Total		88	100.0	100.0	

The most common age group was found to be 66-80 years (29.5%), followed by more than 80 years (22.7%).

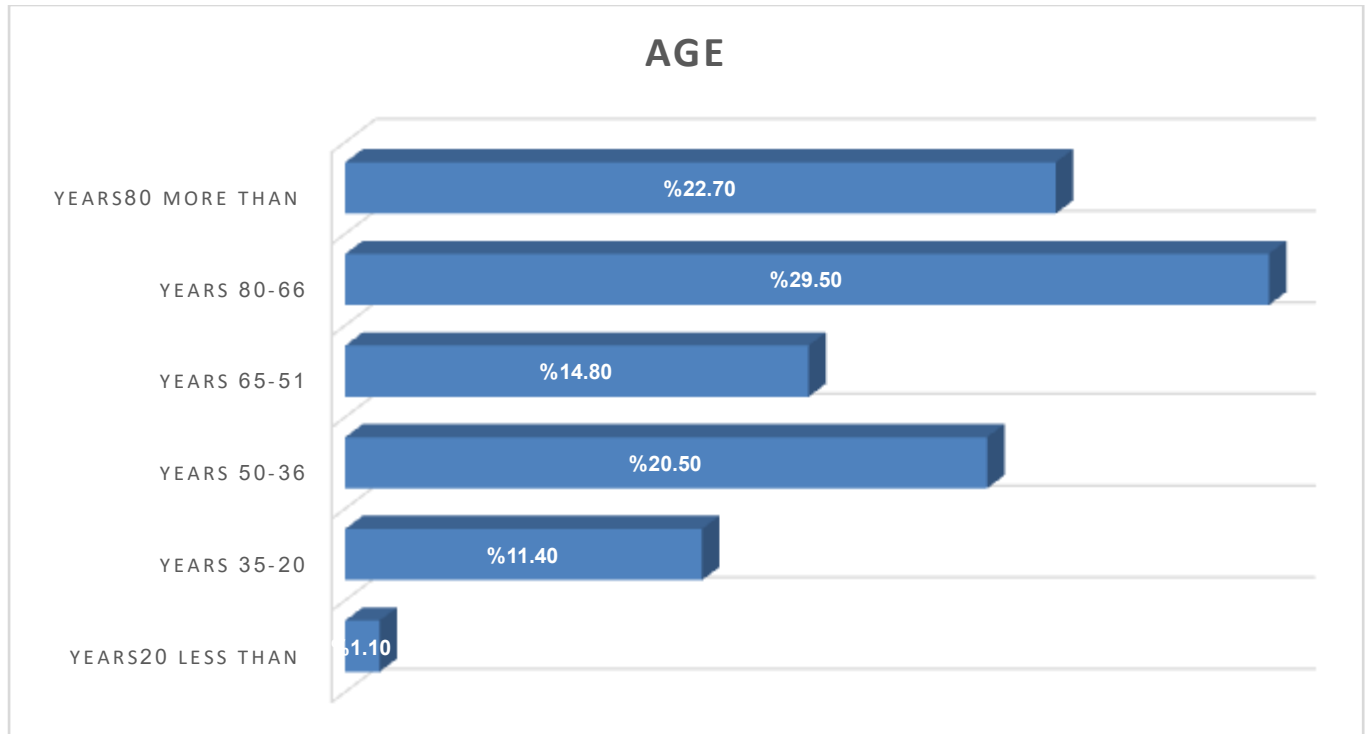


Figure (3):-Showing age distribution of patients.

Table (4):-Showing nationality of patients.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Saudi	71	80.7	80.7	80.7
	Non-Saudi	17	19.3	19.3	100.0
Total		88	100.0	100.0	

The majority of patients (80.7%) were Saudi, while (19.3%) were non-Saudi.

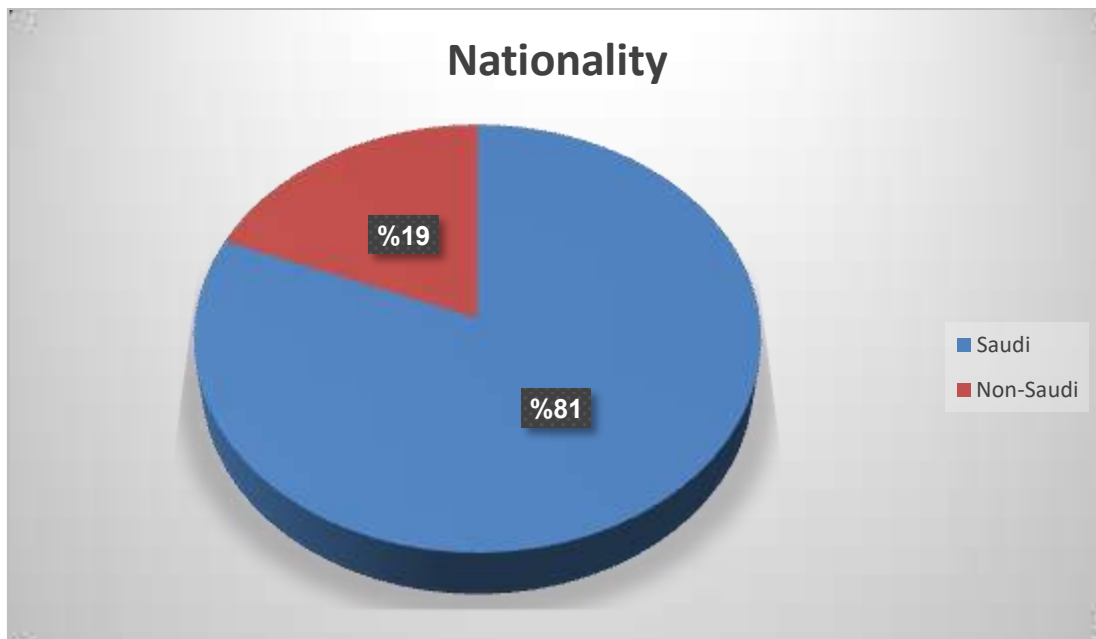


Figure (4):-Showing nationality of patients.

Table (5):-Showing presence of chronic disease of patients.

Table 5		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	57	64.8	64.8	64.8
	No	31	35.2	35.2	100.0
Total		88	100.0	100.0	

The majority of patients (64.8%) has chronic diseases, while (35.2%) do not.

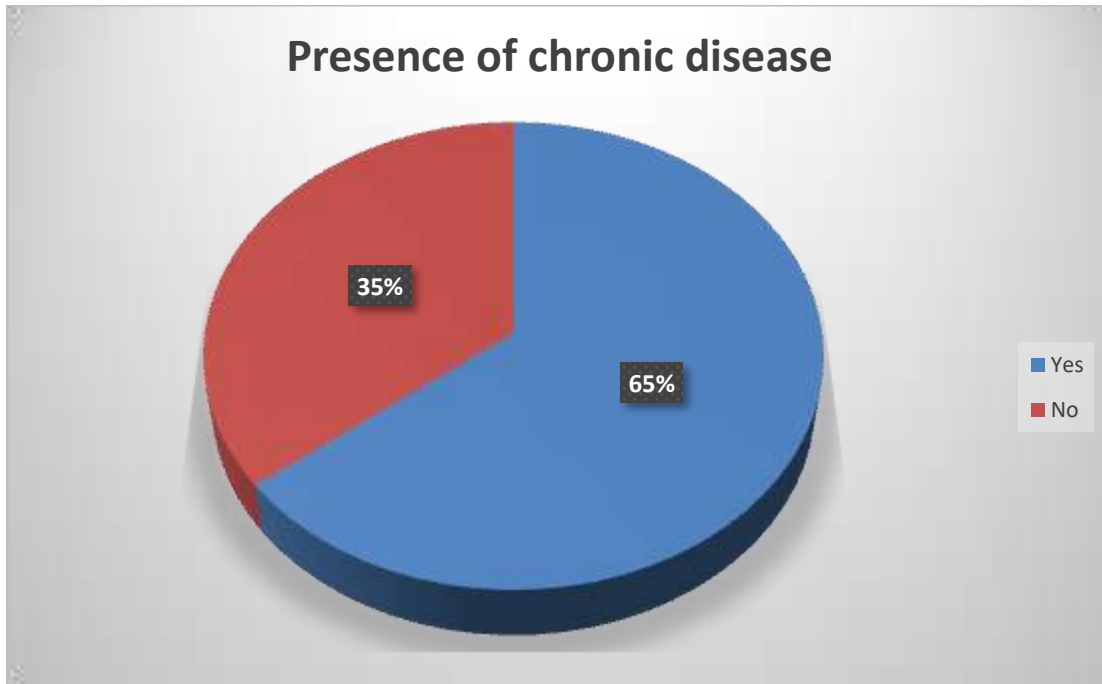


Figure (5):-Showing presence of chronic disease of patients.

Table (6):-Showing chronic diseases of patients.

	Frequency	Percent
Valid	Hypertension	36
	Diabetes mellitus	32
	Atrial fibrillation (AF)	12
	Chronic kidney disease (CKD)	7
	Ischemic heart disease (IHD)	12
	Cerebrovascular accident (CVA)	9
	Other	14
Total		57

The most common chronic disease was hypertension (63.2%), followed by diabetes mellitus (56.1%).

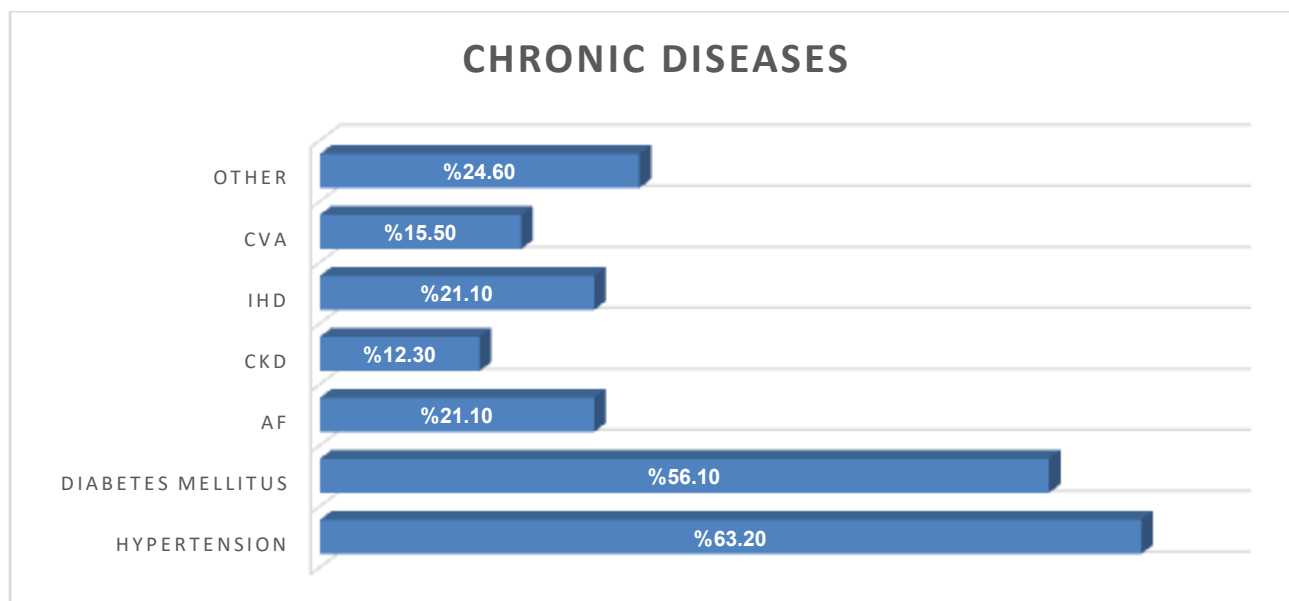


Figure (6):-Showing chronic diseases of patients.

Table (7):-Showing characteristics of MDRO among patients.

Variables	Category	Count	Percentage
Number of external medical support equipment	Zero	6	6.8%
	One	15	17%
	Two	18	20.5%
	Three	46	52.3%
	Four	3	3.4%
Type of external medical support equipment (n=82)	Endotracheal tubes (ETT)	41	50%
	Foley catheter (F.C)	67	81.7%
	Central venous line (CVL)	53	64.6%
	Tracheal tube (T.T)	19	23.2%
	Urinary catheter	13	15.9%
	Ventilator	7	8.5%
Classification of MDRO by onset	Community-onset (CO)	50	56.8%
	Healthcare facility-onset (HO)	37	42%
	Both community and healthcare facility-onset	1	1.1%
Type of MDRO	Carbapenem-resistant Enterobacterales (CRE) MDR	29	33%
	Acinetobacter MDR	25	28.4%
	Extended Spectrum Beta-Lactamase (ESBL) MDR	18	20.5%
	Methicillin-resistant Staphylococcus aureus (MRSA) MDR	11	12.5%
	Klebsiella MDR	2	2.3%
	Pseudomonas aeruginosa MDR	6	6.8%
Classification of identified MDRO	Gram-positive bacteria only	8	9.1%
	Gram-negative bacteria only	77	87.5%
	Both gram-positive and negative bacteria	3	3.4%
Type of organism	Acinetobacter baumannii	26	29.5%
	Escherichia coli	9	10.2%
	Klebsiella pneumonia	33	37.5%
	Proteus mirabilis	5	5.7%
	Pseudomonas aeruginosa	7	8%

	Staphylococcus aureus	7	8%
	Staphylococcus epidermidis	3	3.4%
	Other	5	5.7%
Type of sample	Blood sample	19	21.6%
	Sputum sample	37	42%
	Urine sample	19	21.6%
	Wound sample	18	20.5%
	Body fluid	2	2.3%
Number of organisms per patient	One	77	87.5%
	Two	8	9.1%
	Three	3	3.4%
Total		88	100%

According to Table 7, (93.2%) of patients had external medical support equipment. Of them, the majority (52.3%) had three external medical support equipment, followed by two (20.5%), and the most common external medical support equipment was found to be foley catheter (F.C) (81.7%), followed by central venous line (CVL) (64.6%), then endotracheal tubes (ETT) (50%). (56.8%) of patients had community-onset (CO) MDRO, while (42%) had healthcare facility-onset (HO) MDRO, and (1.1%) had both community and healthcare facility-onset MDRO. Carbapenem-resistant Enterobacterales (CRE) MDR (33%) was the most common type of MDRO, followed by Acinetobacter MDR (28.4%), then Extended Spectrum Beta-Lactamase (ESBL) MDR (20.5%). The majority of the identified organisms (87.5%) were gram-negative bacteria, while (9.1%) were gram-positive bacteria, and (3.4%) were both. The most common type of organism was Klebsiella pneumonia (37.5%), followed by Acinetobacter baumannii (29.5%), then Escherichia coli (10.2%). Sputum sample (42%) was the most common type of taking the sample, followed by both blood and urine sample (21.6%, each). The majority of patients (87.5%) had only one type of organism, while (9.1%) had two types of organisms, and (3.4%) had three types of organisms.

Discussion:-

This study was conducted in order to assess the prevalence and risk factors associated with multi-drug resistant organisms in adult intensive care unit of KFSH-Tabuk during the year 2023.

Various and different published studies were done about the same topic as the present article.

Regarding the study that was carried out in Saudi Arabia in the ICU of KFHH in Al-Hofuf City to estimate the prevalence and risk factors of MDROs, the findings of the study showed a higher percentage of prevalence than the one found in the current study, in which 68.2% out of 496 notification of HAI cases were MDROs with a high prevalence of risk factors including pre-existing medical conditions, invasive procedures, and the long duration of hospital stays, are more prominent in intensive care unit ICU, while the current study revealed a prevalence of MDRO of 31.4% in ICU patients. However, we should keep in mind the differences in the sample size of the studies, in which the current study had a smaller sample size giving more chances for bias. Also, the majority of patients of the current study (64.8%) has chronic diseases, while (35.2%) do not. The most common chronic disease was hypertension (63.2%), followed by diabetes mellitus (56.1%). (93.2%) of patients had external medical support equipment. Of them, the majority (52.3%) had three external medical support equipment, followed by two (20.5%), and the most common external medical support equipment was found to be foley catheter (F.C) (81.7%), followed by central venous line (CVL) (64.6%), then endotracheal tubes (ETT) (50%). (56.8%) of patients had community-onset (CO) MDRO, while (42%) had healthcare facility-onset (HO) MDRO, and (1.1%) had both community and healthcare facility-onset MDRO[15].

When comparing the results of the study that was conducted in Saudi Arabia by Saeed S. Banawas et al. in the year 2023 on the same topic that included 1125 bacterial isolates from 1039 patients; among them, gram-positive bacteria were significantly more abundant than gram-negative bacteria, which is dissimilar to the findings of the current study, in which the majority of the identified organisms (87.5%) were gram-negative bacteria, while (9.1%) were gram-positive bacteria. In addition to that, the previously done study revealed that the most prevalent bacteria were Staphylococcus epidermidis and Klebsiella pneumoniae. Similarly, Klebsiella pneumonia (37.5%), and Acinetobacter baumannii (29.5%) were the most common organisms in the current study. The gram-positive isolates were mainly resistant to cephalothin, oxacillin, amoxicillin-clavulanate, and erythromycin and susceptible to

penicillin, gentamicin, ciprofloxacin, and vancomycin. Additionally, the gram-negative isolates were mainly resistant to ampicillin, cephalothin, and amoxicillin-clavulanate and susceptible to amikacin, ertapenem, aztreonam, colistin, and trimethoprim-sulfamethoxazole. Meanwhile, Carbapenem-resistant Enterobacterales (CRE) MDR (33%) and Acinetobacter MDR (28.4%) were the most common in the current study. [16]

The findings of the study that was done in China by Hu Jiang et al. in the year 2023 that included a total of 297 patients, revealed that 131 patients were infected with MDRO, with an infection rate of 44.11%, which is almost similar to the infection rate found in the current study (31.4%). Additionally, the results of binary Logistics regression of the previously done study showed that tracheal intubation, artery blood pressure monitoring, fever, antibiotics, pneumonia were independent risk factors for MDRO infection in Neuro-ICU ($P < 0.05$), AUC = 0.887. [14]

Regarding the study that was carried out in Malaysia by Khalid Ahmad Al-Sunaidar et al. in the year 2022 on the same topic, out of 228 patients, the isolated MDRO was 97 (42.5%), of which 78% were Gram-negative bacteria. These findings align with the ones found in the current study, strengthening the evidence. Also, the previously done study revealed that the mortality rate among those with MDRO was 85 (37.3%). The hospital acquired infection (HAI) was a significant predictor for ICU-LOS in univariate linear regression ($R^2 = 0.034$, $p = 0.005$). In MVA linear regression, both Enterococcus faecalis infection and Acinetobacter baumannii (AC)-MDRO were predictors for ICU-LOS with ($R^2 = 0.478$, $p < 0.05$). Meanwhile, in the current study, (87.5%) of organisms were gram-negative bacteria, while (9.1%) were gram-positive bacteria, and (3.4%) were both [17]

Lastly, Adel El mekes et al. conducted a study in Morocco in the year 2018 to determine clinical risk factors, epidemiology and the causative agents of multi-drug resistant bacteria in the ICU of the University Hospital in Marrakesh-Morocco. Among the 479 admitted patients, 305 bacteria were isolated and identified as Acinetobacter baumannii (31%), Enterobacterales species (30%), and Staphylococcus (24%), P. aeruginosa (10%) and other bacterial strains (5%). However, in the current study, the most common type of organism was Klebsiella pneumonia (37.5%), followed by Acinetobacter baumannii (29.5%). The rate of MDR bacteria acquisition was 41% (124/305) in the previously done study, with domination of A. baumannii resistant to imipenem (70%) and followed by Extended Spectrum β -lactamases producing Enterobacterales, P. aeruginosa resistant to Ceftazidime, and Methicillin-resistant S. aureus (18%, 7%, and 5% respectively). While Carbapenem-resistant Enterobacterales (CRE) MDR (33%), and Acinetobacter MDR (28.4%) were the most common in the current study. The distribution of the common nosocomial infections was dominated by pneumonia, bacteremia, and catheter-related blood stream infections (39%, 29%, and 17%) respectively, meanwhile, in the current study, the most common external medical support equipment was found to be foley catheter (F.C) (81.7%), followed by central venous line (CVL) (64.4%), then endotracheal tubes (ETT) (50%). [18]

As a summary, it was noticed that the results of the majority of the previously done studies align with the ones found in the current study in regard to the prevalence and risk factors associated with multi-drug resistant organisms in adult intensive care unit, supporting the evidence and diminishing the gap found in the literature review. However, differences were found in other studies regarding the prevalence, which could be due to the sample size, and also the differences in geographic features of different regions.

Conclusion & Recommendations:-

Conclusion:-

This study can conclude that the prevalence of multi-drug resistant organisms in adult intensive care unit of KFSH-Tabuk during 2023 is not that high. However, risk factors should be taken into consideration in order to prevent them, and thus, decrease the incidence of multi-drug resistant organisms and decrease the mortality.

Recommendations:-

1. Effective measures on multi-drug resistant organisms-related factors should be taken among the health policies.
2. Healthcare providers should work on increasing the awareness of the public about the risks of over-the-counter antibiotics administration.
3. Proper counseling should be provided to already diagnosed patients, explaining the risk factors to them and the possible outcomes.

4. More studies regarding this topic should be conducted in order to support the evidence and decrease the incidence of the disease and the mortality rate.

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