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Risk Factors Associated with Occurrence of Cellulitis in Critically Ill Patients with Fulminant Hepatic Failure

Shimmaa Mohamed Elsayed[1], Hanaa Atef Elbana[2]

[1]*Lecturer, Critical care, and emergency nursing department, Faculty of Nursing, Damanhour University, Egypt.*

[2]*Lecturer, Critical care, and emergency nursing department, Faculty of Nursing, Tanta University, Egypt.*

Abstract: Background: Cellulitis is one of the common infections causing limb swelling that should be distinguished from the other skin inflammation. One of the most common infectious diseases that are associated with liver cirrhosis and lead to high morbidity, mortality, and hospital readmissions for quick diagnosis and effective treatment. Design: A descriptive study design was used. Setting(s): This study was conducted in the medical intensive care units at Tanta hospitals. **Setting:** A convenience sample of eighty newly admitted patients diagnosed with an acute liver failure were included. Instruments: Cellulitis risk factors structured questionnaire was used. **Results:** Risk factors for cellulitis were chronic venous insufficiency (76.3%), peripheral vascular disease (61.3%), obesity (87.5%), previous cellulitis (76.3%), heart failure (47.5%), sepsis (16.3%), immune suppression (3.8%), blood sugar>180mg/dl (96.25%), age 65 yrs. (21.3%), bacteraemia (47.5%), vasopressor medications (36.3%), grade VI edema (96.25%), using elastic stoking (17.5%), fluid balance >1000 ml (25.0%) and limited range of motion (61.3%).Conclusions: Risk factors associated with occurrence of cellulitis in patients with fulminant hepatic failure are chronic venous insufficiency, peripheral vascular disease, previous cellulitis, heart failure, sepsis, immune suppression, blood sugar>180mg/dl, age 65 yrs., using elastic stoking, fluid balance >1000 ml, and limited range of motion. **Recommendations:** Early identification for high-risk groups for cellulitis on acute live failure patients and early prevention can reduce risk for recurrent attack. Skin and foot care protocols should be educated and used for caring those patients.

Keywords: *Acute liver failure; Cellulitis; Critical ill patients; Risk factors*

Introduction

One of the most prevalent infectious causes of limb edema is cellulitis. Cellulitis can be a series of recurring episodes or a single isolated incident. It is frequently misinterpreted as chronic venous insufficiency or recurrent thrombophlebitis. It is important to identify lymphangitis from cellulitis. Lymphangitis is clinically represented by red streaks and may be distinguished from cellulitis by the shape of the afflicted lymphatic vessels, while cellulitis is characterized by localized, anatomically nonspecific swelling and redness of the limb (Janice Hinkle & Cheever, 2018).

Cellulitis is one of the most often reported dermatological illnesses in the ICU and skin and soft tissue infection. About 7% of infections in patients admitted to the ICU with sepsis are skin and soft tissue infections (Cranendonk et al., 2017).

The dermis and subcutaneous tissues are affected by the inflammatory skin disorder known as cellulitis, which has an infectious etiology. It is a widespread medical illness that can range in severity from moderate to life-threatening. The usual skin barriers breaking down and creating an access site for bacteria to penetrate and release their toxins into the subcutaneous tissues is the primary pathophysiology of cellulitis. The most common pathogen responsible for cellulitis is either streptococcus species or staphylococcus aureus (Janice Hinkle & Cheever, 2018). Cellulitis can affect any area of the body but most commonly affects the lower extremities (Nassaji et al., 2016). Based on the lesion morphologic features, cellulitis can be diagnosed including erythema, swelling, warmth, pain, and fever in severe conditions. The main cause of cellulitis is infection by streptococci which cause skin and soft-tissue infection (Tianyi et al., 2018). Oral antibiotic therapy can be used to treat patients with mild cellulitis, where the intravenous antibiotics should be used in the severe conditions (Janice Hinkle & Cheever, 2018).

Several studies discussed the risk factors of cellulitis. Meanwhile, the common risks were superficial or deep venous insufficiency, edema, trauma, previous surgery, skin disorders, diabetes mellitus, prior malignancy, body mass index (BMI), smoking, alcoholism and ethnicity (Björndóttir et al., 2005; Teerachaisakul et al., 2013; Hamza et al., 2014; Nassaji et al., 2016; Njim et al., 2017; Tianyi et al., 2018). One infectious condition that affects 10.5–12.5% of people with liver cirrhosis is cellulitis. High rates of morbidity and death may necessitate repeated hospital stays for prompt diagnosis and effective care. Recurrent admission could lead to a socioeconomic burden that include long hospital stays and expensive expenses. The short-term prognosis, recurrence rate, frequency of hospitalizations, and in-hospital mortality have all been markedly improved by the early administration of appropriate prophylactic antibiotics (Hamza et al., 2014).

Critical care nurses (CCNs) have a great role in assessing and managing cellulitis as the nurse is the first medical person who deals with patients' body. CCNs depend on various ways to assess the cellulitis status, such as clinical examination and measurement of peripheral vascular condition, complete blood count, blood culture, and sensitivity test to guide therapy (Beldon, 2011). The most prevalent bacterial cellulitis in individuals with liver cirrhosis include pneumonia, UTI, and spontaneous bacterial peritonitis. One of the gram-negative bacteria, Escherichia coli is the main cause of bacterial cellulitis. Bacterial infections are considered to a very high amount in instances of liver cirrhosis, although their etiology has not been established to a sufficient level (Preveden, 2015).

Purpose of the study:

To determine risk factors associated with the occurrence of cellulitis in critically ill patients with fulminant hepatic failure.

Research questions:

What are the risk factors which are associated with the occurrence of cellulitis in critically ill patients with fulminant hepatic failure?

Material and Method

Study design

A descriptive research design was applied.

Research settings

The study was conducted at medical intensive Care Unit at Tanta Main University Hospital, the emergency, and the medical ICUs at Tanta International Educational Hospital.

Sampling:

A convenience sample of newly admitted adults diagnosed with acute liver failure were selected throughout seven consecutive days. The minimum number of the sample was 80 using G*Power software 3.1.9.6 program based on the following parameters: f: is the effect size; Alpha= 0.05; βeta=0.05; Power= 1- β = 0.95. Adults diagnosed with acute liver failure who had just been hospitalized and were between the ages of 18 and 60 and had no cellulitis symptoms or signs were included in the inclusion criteria. Patients with deep vein thrombosis, skin infections, and peripheral vascular insufficiency are excluded.

$$f = \frac{\sigma_\mu}{\sigma}$$

$$\sigma_\mu^2 = \frac{\sum_{i=1}^{k} n_j (\mu_i - \mu)^2}{N}$$

Instruments of data collection:

One instrument was included in this study.

Data collection instrument: "Cellulitis Risk Factors Structured Assessment Questionnaire"

This instrument was developed by the researcher after reviewing related literature (Koulaouzidis et al., 2007; Phoenix et al., 2012; Njim et al., 2017; Aiello et al., 2017; Cranendonk et al., 2017; Anwar et al., 2018; Tianyi et al., 2018;Cutfield et al., 2019; Ibrahim et al., 2019) to assess the critically ill hepatic patients' risk for the development of cellulites. It included four parts:

- **Part I: "Patients' Demographic profile":** This part included patients' characteristics such as age and sex. The ICU stay duration, APACHE II and SOFA scoring system, chief complaint on admission, health history, end-stage liver disease (MELD) assessment for the severity of end stage liver failure, and etiology of cirrhosis.
- **Part II: "Patients' clinical data":** This part included hemodynamic parameters (temperature, heart rate, and mean arterial pressure), physical examination such as capillary refill, edema, skin colour, condition and temperature, risks factors associated with cellulitis such as chronic venous insufficiency, peripheral vascular disease, obesity, previous cellulitis, injury in the lower extremities, heart failure, sepsis, immune suppression, diabetes, age of 65 years, clinically relevant bacteraemia, use of vasopressors, prolonged swelling and edema of extremities, using of elastic stoking, fluids balance, limited ROM, abscess, necrotizing fasciitis, and a skin sore or rash).
  - Dundee classification of cellulitis severity was adopted from Cutfield et al. (2019) which was used for the assessment of cellulitis severity. Score one referred to the least severity of cellulitis and score four referred to the highest severity of cellulitis. It is classified from one (least severity) to four (highest severity.
- **Part III: "Patients' laboratory investigation":** This part included laboratory investigation such as haemoglobin, leucocytes, serum creatinine, albumin, sodium, serum bilirubin, blood culture, INR, platelet count, and liver function.

Validity and Reliability

Five specialists (two professors in critical care nursing and three assistant professors in medical surgical nursing) were asked to determine the content validity. No modifications were done.

Reliability

Cronbach coefficient alpha test was used to determine the reliability of the instrument (a=0.78)

Pilot Study

Eight patients (10% of the sample) participated in a pilot study to evaluate the instruments' usability, clarity and time required to answer the questions. The required adjustments were made. Pilot study sample was not included in the studied sample

Procedure:

An official letter was submitted from the Dean of the Faculty of Nursing to the director of the selected hospital. It included the purpose of the study and methods of data collection. Then, a permission to perform the study was obtained from the administrative authorities

All newly admitted patients to the previously mentioned units who approved to participate in the study were enrolled in this study and assessed for the seven consecutive days. The characteristics of patients were assessed using part I of the instrument throughout seven consecutive days. Hemodynamic parameters, physical examination, and risks factors associated with cellulitis were assessed using part II (instrument one) throughout the seven consecutive days. Severity of cellulitis was assessed using Dundee classification of cellulitis severity throughout seven days. Cellulitis manifestations assessment was done which included the signs and symptoms of cellulitis throughout the seventh day.

Ethical considerations:

Approval of Research Ethics Committee in the Faculty of Nursing, Damanhour University was obtained before data collection (code no 61.a). An informed written consent was obtained from patients after explaining the purpose of the study potential benefits, risks, and discomforts from participation and the right to refuse to participate in the study were emphasized to subjects.

Patients were assured about the maintenance of the anonymity, privacy, and confidentiality of the collected data during and after the implementation of the study. The patients were told that they had the right to withdraw from the study at any time.

Statistical analysis

Data was analysed and tabulated using IBM SPSS software package version 22.0. (Armonk, NY: IBM Corp). Numbers and percentages were used to label qualitative data. Range, mean, standard deviation, median was used to define quantitative data and 5% was used as a determination of the significance level of the obtained results.

Results:

Table 1displays Frequency distribution of patients having different grades of cellulitis in days 1,2,3. On the first and second days of the study, around 55% of patients had grade II, and on the third day of observation, 55% of them had grade IV.

Table 2 shows frequency distribution of patients according to their characteristics clinical data and grade of cellulitis. Mean age of selected patients was 52.25± 5.68, and 52.5% of them were females. 85% of the patients in the study had a history of breathing problems, and 76.3% also had histories of heart disease, cellulitis, and chronic venous insufficiency. Hepatitis C virus (51.3%) was the most frequent cause

of liver cirrhosis in the individuals under study. No statistically significant difference was found between characteristics of patients having different clinical data and different grades of cellulitis at 5% level of statistical significance (except for gender)

Table 3 showed the frequency distribution of patients according to risks associated with cellulitis and their grades of severity of cellulitis on the third day. About 61% of patients in the study experienced cellulitis in the past and chronic venous insufficiency. On the third day, there was a statistically significant difference (p=0.032) between the Dundee classification of cellulitis severity, chronic venous insufficiency, and prior history of cellulitis. On the third day, the severity of cellulitis was much more in the oldest patients (65 years old and older (p=0.05)). About 61.3% of them had limited range of motion exercises, and there was a statistically significant difference with increasing Dundee categorization of severity (p=0.05).

Table 4 shows mean and standard deviation of clinical parameters for patients having different grades of cellulitis. The mean of heart rate of the studied patients was 89.24±20.79, respiratory rate was 23.12±0.51, mean arterial pressure was 92.68±19.80, and temperature was 37.89±0.11. There was a very highly statistically significant difference between the increased severity of cellulitis and hemodynamic parameters including respiratory rate, mean arterial pressure, and temperature (p=0.002, <0.001, and <0.001, respectively). About 62.5% of them had delayed capillary refill and there was a very highly statistically significant difference between the increased severity of cellulitis and delayed capillary refill (p=0.004). The mean score of edema grade for patients who were classified grade 1 cellulitis was 2.73±0.45, while patients who were classified as grade 4 cellulitis was 4.00±0.0. There was a very highly statistically significant difference between the grade of edema and the increased severity of cellulitis (p=0.001). The studied patients had a haemoglobin mean with value of 9.50±0.37 mg/dl, WBCs of 15.18±0.95, and albumin of 3.17±0.43. There was a very highly statistically significant difference between the increased WBCs count and increased severity of cellulitis (p= 0.01). The current study illustrated that 62.5% of them had a positive skin culture and 37.5% of them had a negative skin culture. There was a statistically significant difference between skin culture and the increased severity of cellulitis (p=0.05).

Table 5 illustrates the frequency distribution of patients according to the findings of their physical examination and the grade of cellulitis. Most of patients (42.5%) had pale skin, while 7.5% experienced itchy skin. Besides, 35% of the studied patients had moist skin, and 65% had dry skin. 45% of patients reported warm skin temperatures. Around 77.5% of the studied patients had pain during touch complain. There were very highly statistically significant differences between patients having different skin conditions, different skin temperature, pain with touch in different locations and their different grades of cellulitis (p=0.005).

Results:

Table (1): Frequency distribution of patients having different grades of cellulitis in days 1,2,3 (n = 80).

Dundee classification of cellulitis severity	Day 1 (n=80)		Day2 (n=80)		Day 3 (n=80)	
	No.	%	No.	%	No.	%
Grade I (less sever)	4	5.0	4	5.0	2	2.5
Grade II	44	55.0	44	55.0	18	22.5
Grade III	16	20.0	16	20.0	16	20.0
Grade IV (most sever)	16	20.0	16	20.0	44	55.0

Table (2): Frequency distribution of patients according to their characteristics, clinical data and grade of cellulitis (n = 80).

Characteristics and clinical data	Total Patients (n=80)		Dundee classification of cellulitis severity on the third day of observation								Test of Sig.	P
			Grade 1 (n=2)		Grade 2 (n=18)		Grade 3 (n=16)		Grade 4 (n=44)			
	No.	%	No.	%	No.	%	No.	%	No.	%		
Sex												
Male	38	47.5	1	50.0	12	66.7	10	62.5	15	34.1	χ^2= 7.418*	^{MC}p= 0.043*
Female	42	52.5	1	50.0	6	33.3	6	37.5	29	65.9		
Age	52.25 ± 5.68		47.50 ± 0.71		53.50 ± 3.81		51.94 ± 5.97		52.07 ± 6.27		H= 3.150	P= 0.369
Duration of stay in intensive care unit	10.43 ± 2.75		10.0 ± 0.0		9.84 ± 2.74		10.0 ± 2.19		12.28 ± 2.67		F= 3.934*	P= 0.012*
APACHE II scoring system	41.19 ± 7.81		37.50 ± 3.54		41.17 ± 5.98		41.56 ± 10.25		41.23 ± 7.76		H= 3.953	p= 0.267
Health history											χ^2	^{MC}p
Respiratory	68	85.0	2	100	18	100	14	87.5	34	77.3	5.527	0.106
Cardiovascular	61	76.3	2	100	13	72.2	13	81.3	33	75.0	8.176*	0.032*
Previous cellulitis	61	76.3	2	100	17	94.4	14	87.5	28	63.6	8.176*	0.032*
GIT	14	17.5	0	0.0	1	5.6	5	31.3	8	18.2	3.903	0.227
Renal	36	45.0	1	50.0	9	50.0	8	50.0	18	40.9	0.974	0.857
Diabetes	22	27.5	1	50.0	4	22.2	2	12.5	15	34.1	3.722	0.269
Chronic venous insufficiency	61	76.3	2	100	17	94.4	14	87.5	28	63.6	8.176*	0.032*
MELD score	24.05 ± 4.83		23.50 ± 0.71		25.44 ± 2.75		24.69 ± 3.82		23.27 ± 5.76		H= 1.622	P= 0.654
Etiology of cirrhosis												
HCV	41	51.3	1	50.0	12	66.7	10	62.5	18	40.9	χ^2= 4.562	^{MC}p= 0.187
NSAD	39	48.8	1	50.0	6	33.3	6	37.5	26	59.1		

Table (3): Frequency distrbution of patients according to risks associated with cellulitis and their grades of severity of cellulitis on the third day

Factors associated with cellulitis	Total Patients (n=80)		Dundee classification of cellulitis severity on the third day								χ^2	^{MC}p
			Grade 1 (n=2)		Grade 2 (n=18)		Grade 3 (n=16)		Grade 4 (n=44)			
	No.	%	No.	%	No.	%	No.	%	No.	%		
Risk factors												
Chronic venous insufficiency	**61**	**76.3**	2	100	17	94.4	14	87.5	28	63.6	8.176*	0.032*
Peripheral vascular disease	49	61.3	1	50.0	7	38.9	13	81.3	28	63.6	6.784	0.056*
Obesity	**70**	**87.5**	1	50.0	16	88.9	15	93.8	38	86.4	3.094	0.391
Previous cellulitis	**61**	**76.3**	2	100	17	94.4	14	87.5	28	63.6	8.176*	0.032*
Heart failure	38	47.5	2	100.0	7	38.9	9	56.3	20	45.5	2.941	0.413
Sepsis	13	16.3	1	50.0	3	16.7	4	25.0	5	11.4	3.875	0.238
Immune suppression	3	3.8	0	0.0	1	5.6	0	0.0	2	4.5	1.841	1.000
Random blood sugar >180mg/dl	**77**	**96.25**	2	100	11	61.11	20	62.5	44	100	9.652	0.057*
Age 65 years	17	21.3	0	0.0	2	11.1	5	31.3	10	22.7	6.320	0.05*
Clinically relevant bacteremia	38	47.5	2	100.0	7	38.9	9	56.3	20	45.5	2.941	0.413
On vasopressors medication	29	36.3	0	0.0	8	44.4	4	25.0	17	38.6	2.241	0.554
Grade VI edema	**77**	**96.25**	2	100	11	61.11	20	62.5	44	100	9.652	0.057*
Using elastic stoking	14	17.5	0	0.0	6	33.3	0	.0	8	18.2	6.790	0.073
Fluid balance > 1000 ml	20	25.0	0	0.0	5	27.8	4	25.0	11	25.0	0.523	1.000
Limited ROM	**49**	**61.3**	1	50.0	7	38.9	13	81.3	28	63.6	6.784	0.05*

$\chi 2$: Chi square test, MC: Monte Carlo,
P: p value for comparing between the studied groups,
*: Statistically significant at $p \leq 0.05$.

Table (4): Mean and standard deviation of clinical parameters for patients having different grades of cellulitis

Clinical parameters	Total Patients (n=80)		Dundee classification of cellulitis severity on the third day								Test of Sig.	P
			Grade 1 (n=2)		Grade 2 (n=18)		Grade 3 (n=16)		Grade 4 (n=44)			
Heart rate	89.24±20.79		76.50±12.02		89.67±22.77		94.56±22.98		87.70±19.52		F= 0.674	p= 0.571
Respiratory rate	23.12 ± .51		24.0 ± 0.0		26.33 ± 0.49		25.13 ± 0.34		30.05 ± 0.57		H= 24.022	p= 0.002*
Mean arterial pressure	92.68±19.80		96.00 ± 0.0		97.81±17.35		107.63±9.28		85.00±20.41		H= 23.380*	p= <0.001*
Temperature	37.89 ± 0.11		37.80 ± 0.0		36.93 ± 0.08		37.89 ± 0.11		38.87 ± 0.11		H= 23.380*	p= <0.001*
Capillary refill	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**		
Delayed	50	62.5	2	100.0	12	66.7	10	62.5	26	59.1	χ^2= 11.200	MCp= 0.004*
Normal	30	37.5	0	0.0	6	33.3	6	37.5	18	40.9		
Edema grade	3.78 ± 0.42		2.73 ± 0.45		2.78 ± 0.43		3.01 ± 0.34		4.00 ± 0.0		10.048	0.001*
Braden scale for pressure sore	13.45 ± 1.17		14.0 ± 0.0		13.56 ± 1.20		13.63 ± 1.15		13.32 ± 1.20		1.277	0.735
Hemoglobin	9.50 ± 0.37		9.0 ± 0.0		9.51 ± 0.39		9.58 ± 0.36		9.48 ± 0.36		4.149	0.246
White blood count	15.18 ± 0.95		16.0 ± 0.0		15.67 ± 0.49		15.13 ± 0.56		14.95 ± 1.12		11.405*	0.010*
Creatinine	1.38 ± 0.07		1.30 ± 0.0		1.39 ± 0.03		1.36 ± 0.10		1.38 ± 0.07		10.212	0.017*
Albumin	3.17 ± 0.43		3.0 ± 0.0		3.03 ± 0.05		3.21 ± 0.54		2.22 ± 0.47		1.723	0.0632
Sodium	142.45 ± 3.92		140.0 ± 0.0		142.11 ± 3.58		144.0 ± 3.39		142.14 ± 4.22		2.501	0.475
Bilirubin	1.17 ± 0.08		1.10 ± 0.0		1.17 ± 0.07		1.19 ± 0.08		1.17 ± 0.09		3.476	0.324
Aspartate aminotransferase	43.62 ± 4.24		42.0 ± 0.0		44.44 ± 1.38		43.50 ± 5.51		43.41 ± 4.61		4.829	0.185
Alanine aminotransferase	60.47 ± 5.67		62.0 ± 0.0		61.22 ± 1.66		58.75 ± 8.62		60.73 ± 5.53		1.488	0.685
	No.	**%**	**No.**	**%**	**No.**	**%**	**No**	**%**	**No.**	**%**		
Positive skin culture	50	62.5	2	100.0	14	77.8	12	75.0	35	79.5	6.339	0.05*
Negative skin culture	30	37.5	0	0.0	4	22.2	4	25.0	5	11.3		

SD: Standard deviation,
H: H for Kruskal Wallis test, pairwise comparison bet. Each four groups,
p: p value for comparing between the studied groups,
*: Statistically significant at $p \leq 0.05$.

Table (5): Frequency distribution of patients according to the findings of their physical examination and the grade of cellulitis.

Physical examination	Total Patients (n=80)		Dundee classification of cellulitis severity on the third day								χ^2	^{MC}p
			Grade 1 (n=2)		Grade 2 (n=18)		Grade 3 (n=16)		Grade 4 (n=44)			
	No.	%	No.	%	No.	%	No.	%	No.	%		
Skin color												
Pale	34	42.5	2	100.0	10	55.6	6	37.5	16	36.4	4.374	0.203
Cyanosis	22	27.5	2	100.0	6	33.3	0	.0	14	31.8	12.464*	0.003**
Redness	30	37.5	0	0.0	4	22.2	10	62.5	16	36.4	6.615	0.063
Swollen	20	25.0	0	0.0	2	11.1	6	37.5	12	27.3	3.587	0.286
Ached	6	7.5	2	100.0	2	11.1	0	0.0	2	4.5	12.009*	0.004**
Yellowish	10	12.5	0	0.0	0	0.0	0	0.0	10	22.7	8.362*	0.027*
Skin condition												
Dry	52	65.0	2	100.0	8	44.4	10	62.5	32	72.7	11.122	0.005**
Wet	28	35.0	0	0.0	10	55.6	6	37.5	12	27.3		
Skin temperature												
Hot	36	45.0	2	100.0	10	55.6	8	50.0	16	36.4	9.145	0.001**
Cold	18	37.5	0	0.0	8	44.4	4	25.0	18	40.9		
Warm (warm to touch)	14	17.5	0	0.0	0	0.0	4	25.0	10	22.7		
Pain with touch												
Yes	62	77.5	2	100.0	16	88.9	16	100.0	28	63.6	11.219*	0.005**
No	18	22.5	0	0.0	2	11.1	0	0.0	16	36.4		
Location												
Bilateral	62	77.5	2	100.0	16	88.9	16	100.0	28	63.6	11.219*	0.005**
Unilateral	18	22.5	0	0.0	2	11.1	0	0.0	16	36.4		

χ^2: Chi square test, MC: Monte Carlo,
p: p value for comparing between the studied groups,
*: Statistically significant at $p \leq 0.05$. ** $p \leq 0.01$

Discussion

In the current study, risk variables for cellulitis among critically sick patients with fulminant hepatic failure were assessed. The Dundee classification was utilized in the current study. For individuals with a diagnosis of cellulitis, it was used to determine the severity of the illness and the best course of therapy based on clinical results (Cutfield et al., 2019). It was found that most of studied patients were classified as grade II on the first observation day. The severity of cellulitis increased on the third observation day. According to Cranendonk et al. (2017), 7% of patients admitted to ICUs had skin and soft tissue infections. The most common skin and soft tissue infections in the ICU are cellulitis and necrotizing fasciitis. In hospitalized patients, necrotizing fasciitis skin problems were more frequently reported than cellulitis, with an incidence rate of less than 2.5%.

Several studies including Cutfield et al (2019), Ortiz-Lazo et al (2019), and Blake et al (2020) discussed the rates of cellulitis in different settings. Blake et al. (2020) indicated that early diagnosis of cellulitis in older patients is critical because they had a higher risk of hospital-associated complications and a higher risk of recurring cellulitis following a hospital readmission. Li et al. (2018) reported that those patients who were early diagnosed with pseudo cellulitis had a shorter hospitalization period. Therefore, more than half were less likely to receive unnecessary antibiotics. Consequently, they had fewer treatment complications.

The risk variables linked to increased cellulitis severity among the patients in the current research were age (65) , male gender, cardiovascular history, prior cellulitis, and chronic venous insufficiency. These factors are thought to worsen the severity of cellulitis in older people. Considerable edema grade rise, restricted range of motion, change in hemodynamic parameters like tachycardia, increase in mean arterial pressure and body temperature, increase in white blood count, and the presence of a positive skin culture were among the modifiable risk factors. According to skin inspection, most patients exhibited unusually coloured skin, dry skin, hot skin, and an increase in discomfort when touched.

A standardized skin care clinical trials, systematic reviews, and evidence-based need to be summarized for applying safe evidence based and skin care for nurses and other healthcare workers (Kottner & Surber, 2016). Therefore, nurses needed to differentiate between cellulitis and pseudo-cellulitis and their associated risk factors for patients in ICUs.

The current findings were in line with Blake et al. (2020) who reported that the chief risk factor was previous history of cellulitis, with other prominent factors such as obesity, venous deficiency, and diabetes. Each addition 10 years of age are associated with increased incidence of cellulitis up to 43%.

Patients with acute liver failure brought on by an abrupt hepatic insult may or may not be able to pinpoint the chronic liver disease as the underlying cause. Numerous factors, such as coagulopathy, jaundice, aberrant energy metabolism, protein synthesis, fat metabolism, and glycaemic control, contributed to the pathogenesis of acute liver failure. Hepatotoxicity is primarily caused by the build-up of toxic metabolites, which are also responsible for immunological processes and toxic metabolites (Dong et al., 2020).

Kumar et al. (2020) stated that after hospitalization, age is considered as an independent risk factor for increased length of stay for cellulitis, alongside with some other factors including duration of symptoms, tachycardia, hypotension, increased white blood count, decreased albumin, increased serum creatinine, presence of bacteraemia, increased body mass index, and hyperglycaemia. Njim et al (2017) divided the risk factors for cellulitis into global and regional components. As general risk factors, peripheral vascular disease, diabetes mellitus, a history of cellulitis, immunosuppression, higher risk of septic shock, and obesity are present. Local risk factors include untreated wounds, toe-web intertrigo, and leg ulcers.

Poor glycemic control was associated in this study with the development of cellulitis. The study also suggests that exposure to oral prednisolone increases the risk of cellulitis, pneumonia, and upper respiratory infection (Zacay et al., 2021). Boettler et al. (2022)

reported that Cellulitis was one of the causes of skin related hospitalization. Nurses also need to observe IV site and any evidence of infiltration because of the risk of extravasation and resultant cellulitis, or necrosis should be reported (Janice Hinkle & Cheever, 2018).

Therefore, nurses need to identify the risk factors that increase risk for recurrent cellulitis on acute liver failure patients. Ong et al. (2022) noted that early prevention should be the main objective in the therapy of cellulitis since recurrence of cellulitis after successful treatments is prevalent. Obesity, venous illness, and persistent edema are risk factors that increase the chance of recurrence. To reduce the likelihood of cellulitis occurring again, these risk factors should be controlled.

Limitations:

The main limitation of the result is sample size was sample and generalized the results over population.

Conclusion and recommendation:

Cellulitis risk factors in critically sick patients with fulminant hepatic failure are age 65, male gender, cardiovascular history, prior cellulitis, and chronic venous insufficiency are among the risk variables that cannot be changed and are thought to worsen the severity of cellulitis in older people, restricted range of motion, change in hemodynamic parameters like tachycardia, increase in mean arterial pressure and body temperature, increase in white blood count, and the presence of a positive skin culture were among the modifiable risk factors. According to skin inspection, most patients exhibited unusually coloured skin, dry skin, hot skin, and an increase in discomfort when touched.

Recommendations:

To prevent cellulitis among patients with acute liver failure, nurses must examine the skin and look for dryness, crackles, or fissures. It is important to keep the skin moist, therefore apply a cold then warm compress to the afflicted region. High-risk populations should receive routine skin and foot care. Patients with acute liver failure who have fulminant hepatic failure should maintain glycemic control.

Further research is required to inform nurses and other members of the medical staff about the risk factors and the importance of early detection of cellulitis. The afflicted region should be elevated above the level of the heart. Nurses must keep an eye on any sensory or circulatory deficiency, such as tingling or numbness or a delay in capillary refill. Random blood sugar levels should be kept within the normal range. For hospitalized patients, especially those with acute liver failure, skin and foot care guidelines should be thoroughly taught and strictly followed

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