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Assess Validity and Reliability of Intra-Transportation Preparedness Scale for Critically Ill Patients

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Abstract:
Background*: Critically ill patients are needed for several diagnostic and therapeutic management combined with transport from the ICU and other settings.* ***Aim****: This study aimed to assess new developed intra-transportation preparedness scale validity and reliability.* ***Subject and method****: Design: A descriptive design was applied. Setting(s): The study was undertaken at the Alexandria main university hospital ICUs. Subjects: The participants were critically ill patients (n = 150), and nurses (n = 150). Tools of data collection: Two tools were used to collect data. Tool I is intra-transportation nurses' questionnaires. The questionnaires consist of 23 items using a 5-point Likert items, according to item priorities. Tool II: Assessment of patient preparedness for transport. It consists of three parts to determine the risk of transfer. Data collection was done throughout 4 phases.* ***Results****: Internal consistency was done, and accepted (0.977). Test-retest reliability for the newly developed scale was conducted and accepted at a level of r=0.889 and p <0.001. The analysis of the sensitivity and specificity of the developed score using the ROC Curve was performed. It showed good sensitivity and high specificity with an AUC of 0.999 (p<0.001), with a sensitivity of 98%, and a specificity of 97.5%, with 95% C. I 0.997 – 1.000.* ***Conclusions****: The intra-transportation preparedness scale is a good reliable and valid prediction risk for critically patient transportation.* ***Recommendation****: The intra-transportation preparedness scale is recommended forguidance nurses to transport critical ill patients with different severity of illness and decrease adverse events of transporting.*

Key Word*: Adverse effects, Intra-hospital transportation, Safety, Scale, ReliabilityValidity.*

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I. Introduction

Critical nurses need to acquire and improve their own technical and tactical skills, using adequate human resources with appropriate equipment to improve the quality of intra-hospital transport for ICU patients who continuous needs assessment and care during a stay at their bedside or intra-transportation (Akrami, Sargazi, Safabakhsh & pishkar mofrad, 2019; Alizadeh Sharafi, Ghahramanian, Sheikhalipour, Ghafourifard & Ghasempour, 2021). Transporting critically ill patients need a great deal of attention and careful planning to ensure their safety. The primary purpose of critical care nurses is to collaborate with a multidisciplinary team and to urge them to maintain patient safety (Nasser, 2016).

Critically ill patients may be connected to a variety of invasive devices, including an endotracheal tube, arterial line, chest drainage system tube, urine catheter, and mechanical ventilators. As a result, intra-transport adverse events might endanger the patient's safety and worsen the patient's health (Gimenez et al., 2017). Intrahospital transports are associated with an increased incidence of lethal complications and the mortality rate. The most prevalent side effects were airway obstruction, hypoxia, vascular line dislodgement, decrease in the patient's hemodynamic stability, and equipment failure. Complications occurred often during intra-hospital transport, according to reports. The occurrences should be tracked to help in the continuing improvement of patient safety (Alamanou & Brokalaki, 2014; Nasser, 2016; Bergman, Pettersson, Chaboyer, Carlström & Ringdal, 2017; Gimenez et al., 2017; Williams, Karuppiah, Greentree & Darvall, 2020). Transfer-related complications occur within 2.5 to 75% of patients during transportation. These complications during transfer are uncontrollable outside the unit such as cardiac or pulmonary arrest, airway obstruction, aspiration, and change in respiratory rate (Akrami et al., 2019).

Several qualified organizations, including the Australasian College for Emergency Medicine, the Society of Critical Care Medicine (SCCM), the European Society of Intensive Care Medicine (ESICM), the American Association of Respiratory Care, and the Study Group for Safety in Anesthesia and Intensive Care, had published guidelines for the performance of intrahospital transports, Furthermore, hospitals based their intrahospital transportation rules on these principles. However, not all hospitals follow these criteria owing to a

lack of finances or properly qualified employees (Alamanou & Brokalaki, 2014). During the evacuation of critically sick patients, multidisciplinary ICU personnel that are well-trained and competent are required. This team should have at least two health care personnel, one of whom should be a nurse and the other should be a physician with experience in airway management (Blakeman & Branson, 2013). In everyday ICU clinical practice, nurses are the principal members of the intrahospital transport team. They should have adequate knowledge and skills to detect latent serious risks that occur during the transport of patients (Alamanou & Brokalaki, 2014).

The choice to transfer patients with severe conditions should be based on the possible benefits evaluated against the risk of bad events occurring during the procedure (Nasser, 2016). Previous studies found that educational programs for medical and nursing staff on transferring critically ill patients are not enough and effective and these directives have been relatively restricted (Akrami et al., 2019). Throughout the transportation process, hazards and unfavorable effects produce increased tiredness and tension, as well as detrimental impacts on nurses' cognitive function, poor judgement, and effective execution of standardized protocols. Establish guidelines to make changes in clinical practice by educating employees and employing appropriate equipment, and constant monitoring via the use of a checklist to guarantee safety and high quality of care to avoid transfer issues (Akrami et al., 2019). Using transfer guidelines and intrahospital transfer checklists had significantly decreased the incidence of adverse events during transporting patients within the hospital (Choi et al., 2012; Hagiwara et al., 2016). Habibzadeh, Aliha, Mehran and Imanipour (2017) also reported that using interactive training can have a positive impact on the performance of nurses who are responsible for transporting patients as well as minimize adverse events and improve patients' safety.

Up to our knowledge, there is no national and international intra-transportation scale developed to determine the risk of transfer patient outside the ICU, there is just transfer checklist had been used to ensure that patients safety before, during, and after transport. National Institute for Health and Care Excellence [NICE] (2018) had advocated the use of standardized care systems involving checklists when transferring critically ill patients inside or outside the hospitals. To have a standardized intra-transportation, several transfer guidelines and recommendations discuss how to improve the patients' safety throughout the transport process. The pre-transfer phase was the main focus of the transport checklist and recommendations (Fanara, Manzon, Barbot, Desmettre & Capellier, 2010; Silva & Amante, 2015; Akrami et al., 2019; Intensive Care Society, 2019; Geldenhuys, Wise & Rodseth, 2020). Brunsveld-Reinders, Arbous, Kuiper and de Jonge (2015) published a checklist containing all three phases (pre- during- and post-transfer) of the transfer process. The checklist assesses risk for transport based on the selected criteria and determines if the patient had a low, moderate, or high for transfer. Critical care nurses promote patient safety before, during, and after transportation and the use of a checklist may assist with this. Preparation for patients' transportation in the ICU is essential to maintain the patients' safety (Williams et al., 2020). Therefore, the current study aims to assess the validity and reliability of the developed scale to predict the risk for transport.

SIGNIFICANCE OF THE STUDY:

Intrahospital transport is related to a high incidence of adverse events, and transport time and the use of sedatives and vasoactive drugs were related to these events among critically ill patients (Veiga et al., 2019). Despite numerous reports on the occurrence of adverse events connected to in-hospital transport of critically ill patients, there is little evidence of a link between the utilization of checklists and the occurrence of adverse events (Nonami et al., 2022). The presence of standardized tools to assess the risk of transportation is a critical issue for patients' safety. Critically nurses play a vital role throughout the transportation process which consists of three phases before: during and after transport. Now is the time to consider scale for assessing preparedness for intra-transportation. So, critical nurses can determine the parameters needed to assess and the equipment's demanded to prepare before transportation.

II. Material And Methods

This descriptive study was carried out on patients of general intensive care units (units I, II, III) of the Alexandria main university hospital Egyptfrom February to December 2021. A total 150 adult subjects (both male and females) of aged ≥ 18, years were for in this study

Aim of the study:

This study aims to assess validity and reliability of developed intra-transportation preparedness scale for transport critical ill patients.

Study question:

Is the developed intra-transportation preparedness scale valid and reliable to predict the risk for transport critically ill patients

Study design: A descriptive research design was applied.

Study location: This study was conducted in the three general intensive care units (units I, II, III) of the Alexandria main university hospital Egypt.
Study Duration: February 2021 to December 2021.
Study subjects:
A convenience sample of 150 critically ill adultshad been selected using a power analysisand 150 critical care nurses who worked in the previous selected units and approved to include in the study. All patients being transported to radiology for imaging, or an interventional procedure were eligible for inclusion. Patients who planned transportation to the operating theatre were excluded from the study. The minimum sample size based on power analysis [Epi-Info program was used to estimate sample size using population size over 6, months 240, expected frequency 50%, acceptable error 5%, confidential coefficient 95%, the sample size was 148 patients].
Tools for data collection: Two tools were used to collect data.
Tool I:***intra-transportation nurses questionnaires***: The researcher developed it after reviewing the literature review (Hales, Terblanche, Fowler & Sibbald, 2008; Day, 2010; Fanara et al., 2010; Australian and New Zealand College of Anaesthetists [ANZCA], 2015; Brunsveld-Reinders et al., 2015; Comeau, Armendariz-Batiste & Woodby, 2015; Silva & Amante, 2015; Association of Critical Care Transport, 2016; Nasser, 2016; AlbertaHealthServies, 2018; National Institute for Health and Care Excellence [NICE], 2018; Humber, 2019; Intensive Care Society, 2019; Williams et al., 2020; Alizadeh Sharafi et al., 2021; Dabija, Aine & Forsberg, 2021) to determine all the dimensions and items need to assess before the intra-transportation. The questionnaires consist of 23 items indicating the importance of each item using a 5-point Likert items, where 1 indicated "least priority" and 5 indicated "highest priority". The possible range of scores was between 23 and 115. The higher scores indicated the highest priorities need to assess before transportation. All items on the scale were observation items. The data analysis was used to determine the highest priority items that need to assess before the transportation process.
Tool II: Assessment of patient preparedness for transport. It consists of three parts. **Part I** contained demographic and clinical patient data, such as age, sex, current diagnosis, history, National Early Warning Score scores, and APACHE II score. **Part II** was adopted from Intensive Care Society, (2019) to use a pretransfer risk assessment form checklist. It is comprised of three dimensions to determine the risk of transfer; if it is low, medium, and high risk. **Part III** included the new developed intra-transportation preparedness scale. The researcher developed this scale to assess the risk of intra-transport for critically ill patients. It consisted of 23 items used to assess patient condition (age, body mass index, stability of C-spine injury, level of consciousness, Richmoid agitation sedition scale, systolic blood pressure, pulse, ECG dysrhythmia, degree of chest pain, temperature, respiratory rate, saturation of oxygen, friction inspired oxygen, PEEP, attached emergency drug, need for fluid therapy, gastrointestinal loss, risk for fall, attached invasive devices, need of oxygen cylinder, availability of needed portable MV, Availability of needed portable pulse oximeter, need needed portable syringe pump or infusion pump. The total score was 60, cut off point used to determine risk of transfer, less than 1 mean no risk, score of 2 to 34 mean mild risk, score 35 to 59 mean high risk, and 60 score mean dangerous to risk (Appendix).

Procedure methodology:

An official letter was from the faculty of nursing at Damanhour university to conduct the study. Official approval was obtained from the hospital administration to conduct the study in the previously mentioned units.

The researcher reviews national and international literature to gain more knowledge about the area of the study during this phase. This also aided in developing the research instruments.
Data were collected between February to December 2021. Four phases were sequentially applied to develop the score was done:
Phase one included scale item development. After a review of the available literature on intrahospital transportation guidelines and checklists, to identify the potential dimensions and items of the developed score.
Validity:
Phase two: To establish content validity, ICU Expert opinions were taken using a questionnaire developed by the researcher to assess the developed score content validity. After a clarification of the study aim, acceptance to share in the questionnaires mean that participants were willing to involve in the study. The participants (n = 150) were ICU nurses from the selected a university hospital. All participants were assured that their data would remain confidential. Besides, it was explained to nurses that participating in the study was fully voluntary and that they were allowed to leave the research whenever they wished. Questionnaires consisted of 23 items of parameters that were needed before transportation. A Likert scale was used and ranged from 5 scores meaning highest priorities to 1 score meaning least priorities. A total score for these items was computed, which ranged from 23 to 120. Online electronic google forms were used to disturb the questionnaire. Electronic invitations

(via electronic emails and WhatsApp) were sent to 150 nurses in the previously included settings to take part in the study. Acceptance of the invitation means that nurses were willing to involve in the study. In addition, internal consistency was done for 23 items of the Intra-transportation nurses' questionnaires which were measured using Cronbach alpha coefficients to be 0.977 under the accepted level.

Phase three included an***intra-transportation preparedness scale development***. The researcher developed the scale after reviewing the literature and analyzing the data of the questionnaires. It contained 23 items including age, BMI, cardiovascular, central nervous system, respiratory, and GIT assessment parameters. The risk for falls was assessed using Morse Fall Scale (Schwendimann, De Geest & Milisen, 2006). Emergency medications, need for IV fluid therapy, number of invasive devices, and needed portable equipment were such as infusion pump, cardiac monitor, and mechanical ventilator were included in the developed scale. The highest score for each item indicated that the patient is at a high risk to be transported, while the lowest score indicated that there is no risk to transporting a patient. The score is divided into the equal interval and the severity of items, such as blood pressure, pulse, and respiratory rate adopted from the NEWS Score (Doyle, 2018). The total highest score (60) means that the patient is a dangerous risk for intra-transport. Ascore less than 1 referred to the patient had no risk to transport. The score ranged from 2 to 34 means the patient had a mild risk for transport, and >35 to 59 means a high risk to transport. Reliability Cronbach's alpha was used to assess internal consistency reliability. Internal consistency was done for 23 items of the newly developed scale" intra-transportation preparedness scale" was measured using a Cronbach alpha coefficient and it was 0.925 which accepted.

Pilot study: Phase four includedintra-transportation preparedness scale evaluation. The researcher adopted a pretransfer risk assessment checklist from the Intensive Care Society (2019) to determine the readiness of the critically ill patients for transport and compare it with the developed scale. A pilot test was done on 15 critically ill patients to assess the applicability of the transportation preparedness scale. All patients being transported to radiology for imaging, or an interventional procedure were eligible for inclusion. Patients who need transported assess for their severity condition to transport using NEWs score, APACH II score, pretransfer risk assessment checklist and new developed intra-transportation preparedness scale simultaneously.

Ethical considerations

Ethical approval was obtained to collect data from the hospital administrative after explaining the aim of the study. The confidentiality and privacy of data were ensured. The nurses had the right to withdraw from the study without giving any reason. Patients' data was protected and ensured privacy.

Statistical analysis:

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. Qualitative data were described using numbers and percentages. Quantitative data were described using range, mean, and standard deviation. The significance of the obtained results was judged at the 5% level. Pearson coefficient was used to correlate between two normally distributed quantitative variables. Q Cochran's test was used for the non-parametric test for binary response variables and Post Hoc Test (Dunn's) for pairwise comparisons. Receiver operating characteristic curve (ROC) generated by plotting sensitivity (TP) on the Y axis versus 1-specificity (FP) on the X axis at different cut-off values.

III. Result

Table 1 presented the frequency distribution of ICUs nurses' questionnaires on the transportation scale items. More than half of the nurses reported that assessment of cervical spinal injury (63.3%), systolic blood pressure (50%), respiratory rate (67.3%), Fio2 (80%), Fall (66.7%), presence of invasive devices (70%), oxygen therapy (72%), and mechanical ventilator (67.3%) had the highest priorities to be assessed before transportation.

Table 1: Frequency distribution of ICUs nurses' questionnaire on the transportation scale items.

Items	1Least priorities		2		3		4		5 Highest priorities		Mean ± SD.
	No.	%	No.	%	No.	%	No.	%	No.	%	
Age	32	21.3	30	20.0	47	31.3	10	6.7	31	20.7	2.85 ± 1.39
Body mass index	27	18.0	59	39.3	30	20.0	5	3.3	29	19.3	2.67 ± 1.35
Spinal cervical injury	1	0.7	1	0.7	18	12.0	35	23.3	95	63.3	4.51 ± 0.74
GCS	0	0.0	0	0.0	1	0.7	98	65.3	51	34.0	4.33 ± 0.49
RASS	0	0.0	8	5.3	43	28.7	77	51.3	22	14.7	3.75 ± 0.77
Systolic Blood pressure	0	0.0	0	0.0	10	6.7	65	43.3	75	50.0	4.43 ± 0.62
Pulse	0	0.0	18	12.0	57	38.0	57	38.0	18	12.0	3.50 ± 0.86
ECG change	0	0.0	5	3.3	65	43.3	31	20.7	49	32.7	3.83 ± 0.93
Chest pain	4	2.7	16	10.7	56	37.3	53	35.3	21	14.0	3.47 ± 0.95
Temperature	1	0.7	8	5.3	18	12.0	70	46.7	53	35.3	3.33 ± 0.78
Respiratory rate	1	0.7	1	0.7	9	6.0	38	25.3	101	67.3	4.58 ± 0.70
Fio2	0	0.0	0	0.0	5	3.3	25	16.7	120	80.0	4.65 ± 0.50
SpO2	4	2.7	6	4.0	15	10.0	22	14.7	103	68.7	3.37 ± 1.18

PEEP	10	6.7	36	24.0	50	33.3	3	2.0	51	34.0	3.03 ± 1.26
Medication	8	5.3	49	32.7	43	28.7	28	18.7	22	14.7	3.05 ± 1.15
Fluids	2	1.3	30	20.0	54	36.0	53	35.3	11	7.3	3.27 ± 0.91
Fall	0	0.0	0	0.0	2	1.3	48	32.0	100	66.7	4.65 ± 0.50
GIT Bleeding	0	0.0	24	16.0	61	40.7	38	25.3	27	18.0	3.45 ± 0.97
Invasive devices	0	0.0	4	2.7	3	2.0	37	24.7	106	70.7	4.63 ± 0.66
Oxygen therapy	0	0.0	23	15.3	13	8.7	6	4.0	108	72.0	4.06 ± 0.73
MV	0	0.0	2	1.3	1	0.7	46	30.7	101	67.3	3.31 ± 0.50
Pulse oximeter	0	0.0	0	0.0	37	24.7	40	26.7	73	48.7	4.24 ± 0.82
Syringe pump	3	2.0	32	21.3	46	30.7	47	31.3	22	14.7	3.35 ± 1.04

Table 2 showed that most of the studied patients (n=150, 27.3%) aged from 60-69 and n=150, 53.3% male. Respiratory diseases were the chief cause of the studied patient's admission with a history of cardiac and respiratory diseases. More than a quartile of them (n=150, 38.7%) had Apache scores ranging from 15-19; and n=150, 52% of them had NEWS scores ranging from 5-to 6. Approximately, n=150, 54% had a mild risk for intra-transportation using the pretransfer risk assessment form, and n=150, 64% of them had a 2-34 score using the newly developed score "Intra-transportation Preparedness Scale".

Table (2): Distribution frequency of Patient's demographic and clinical data (n = 150).

Patient demographic and clinical data	No.	%	
Age			
20-29	21	14.0	Min. – Max.
30-39	24	16.0	20.0 – 75.0
40-49	19	12.7	Mean ± SD
50-59	25	16.7	51.51 ± 15.93
60-69	61	40.6	
Sex			
Male	80	53.3	
Female	70	46.7	
Diagnosis			
Cardiac	55	36.7	
Respiratory	78	52.0	
Neurological	17	10.6	
History			
Cardiac	98	65.3	
Respiratory	97	64.7	
Neurological	32	21.3	
GIT	20	13.3	
Renal	9	6.0	
Apache score			
5-9	10	6.7	Min. – Max.
10-14	7	4.7	4.0 – 55.0
15-19	58	38.7	Mean ± SD
20-24	6	4.0	25.82 ± 12.26
25-29	10	6.7	
30-34	8	5.3	
≥35	51	34.0	
NEWS score			
0-4	22	14.7	
5-6	78	52.0	
≥7	50	33.3	
The risk of the transfer form			
Low	20	13.3	
Mild	81	54.0	
High	49	32.7	
The newly developed score			Min. – Max.
0	6	4.0	0.0 – 50.0
2-34	96	64.0	Mean ± SD
35-59	48	32.0	24.25 ± 10.88
60	0	0	

Figure 1 presented that the area under the ROC curve denotes the diagnostic performance of the test. More than half of the ROC area gives an acceptable performance and an area of about 100% is the best performance for the test. The ROC curve also allows a comparison of performance between the newly developed scale with the two tests (Apache score, and NEWs score).

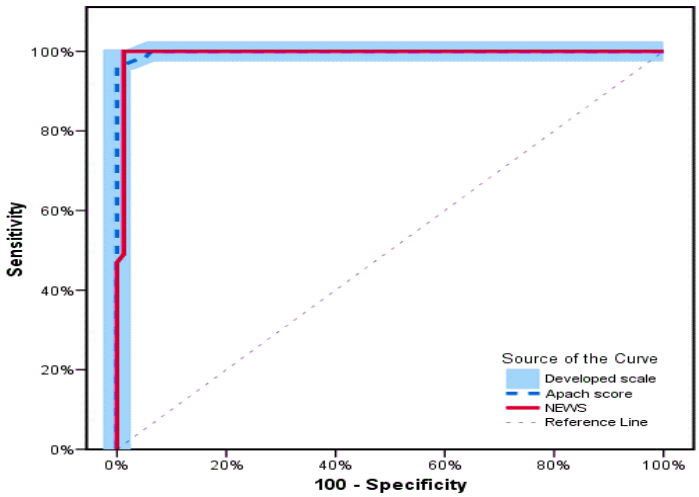

Figure (1): ROC curve for the Developed score, Apache score, and News to predict the risk of transfer.

Table 3 illustrated the analysis of the sensitivity and specificity of the developed score" Intra-transportation Preparedness Scale" using the ROC curve was done with the pretransfer assessment form Score checklist, Apache score, and News score. The intra-transportation Preparedness Scale showed a good sensitivity and high specificity for assessing preparedness for transport for critical patients with an AUC of 0.999 ($p<0.001$) and a predictive value (sensitivity 98% and specificity 97.5%) with 95% C. I 0.997 – 1.000. Apache II score and News score showed good sensitivity and specificity in congruence with the intra-transportation preparedness scale. The cut point of the developed scale was >32 to determine the elevated risk for transport for critical patients. The scale divided the risk into no mild, high, and dangerous for intra-transportation in the equal interval

Table (3): Validity (AUC, sensitivity, and specificity) for the Developed scale, Apache score, and News to predict the risk of transfer.

	AUC	p	95% C. I	Cutoff	Sensitivity	Specificity
Developed scale	0.999	<0.001*	0.997 – 1.000	>32	98.0%	97.5%
Apache II score	0.998	<0.001*	0.996 – 1.000	>32	98.0%	95.1%
News Score	0.994	<0.001*	0.981 – 1.000	>8	79.6%	98.8%

AUC: Area under a curve,p-value: Probability value, CI: Confidence intervals, *: Statistically significant at $p \leq 0.05$.

Table 4 presented test-retest reliability for a newly developed scale was conducted after ensuring content validity on 23 of the scale using the Pearson coefficient test at the level of significant $p \leq 0.05$. Test-retest reliability result was accepted ($r=0.889$; $p <0.001$).

Table (4): Test-retest reliability of the new developed intra-transportation preparedness scale:

Items	r	p
New developed intra-transportation preparedness scale	0.889*	<0.001*

r: Pearson coefficient*: Statistically significant at $p \leq 0.05$

Table 5 showed that there was a significant a strong positive correlation between both the pretransfer assessment form checklist ($r= 0.977$, $p<0.001$) and intra-transportation preparedness developed scale ($r= 0.982$, $p<0.001$) concerning the Apache II score. There was also a significant strong positive correlation between both the pretransfer assessment form checklist ($r= 0.809$, $p<0.001$) and the intra-transportation preparedness developed scale ($r= 0.814$, $p<0.001$) about the NEWs score.

Table (5): Correlation between intra-transportation preparedness scale and pretransfer assessment form (n = 150).

	Pretransfer assessment form		Newly developed scale	
	r	p	r	p
Apache II score	0.977*	<0.001*	0.982*	<0.001*
News score	0.809*	<0.001*	0.814*	<0.001*

r: Pearson coefficient *: Statistically significant at $p \leq 0.05$

IV. Discussion

Patients are required for numerous diagnostic and therapeutic management procedures, as well as transportation between the ICU and other settings. The fundamentals of inter and intrahospital transportation were the same, although intrahospital transport is the more prevalent. Nonami et al. (2022) reported that The rate of adverse events associated with critically sick patients being transported in-hospital ranges from 37.4 to 79.9%. Transportation recommendations and guidelines are used to reduce the risk of transportation-related adverse events. Brunsveld-Reinders et al. (2015) employed a checklist that covered the three stages of the hospital transport: before, during, and after Some checklists, on the other hand, focused on the pre-transport phase, which included checking the patient's condition and equipment before transfer. Several research have demonstrated that using checklists reduces the number of adverse events incidences (Choi et al., 2012; Beigmohammadi et al., 2016; Akrami et al., 2019; Geldenhuys et al., 2020; Williams et al., 2020). Up to date, there is a limitation in using standardized tools such as scales or checklists to determine the risk for transportation for critically ill patients (Jia, Wang, Gao, Liu & Yu, 2016; Veiga et al., 2019; Hu, Shi, You & Li, 2021; Nonami et al., 2022).

After assessing the benefits and risks, the decision to transfer a critically sick patient is taken. In practise, strategies to reduce adverse occurrences during transportation should be explored (Jia et al., 2016). Gimenez et al. (2017) Veiga et al. (2019) reported that Patient-related variables that enhance adverse events during transportation include high disease severity ratings, ventilation with positive end-expiratory pressure (PEEP) > 5 mmHg, drowsiness, antihypertensive medications, and body weight. Jia et al. (2016) reported that monitoring changes in the patient's vital signs transport were automatically recorded every 5 min, which increased the number of adverse events collected.

ICUs were created to offer a safe environment for critically ill patients, staffed by highly trained physicians and nurses who employ the latest advanced medical equipment and medicines (Valentin, 2016). Checklists can improve the safety and quality of care provided to patients in the healthcare system, while it also lowering ICU expenses (Silva & Amante, 2015). The item of the developed scale mainly assessed the preparedness and risk to transport critical patients based on the items on the checklist (Silva & Amante, 2015; Williams et al., 2020). The scale's components are based on a review of the literature and a survey of critical nurses on the criteria that must be assessed and prepared before transferring patients. The surveys' content validity was tested and found to be acceptable. The most severe condition in each category received the highest score, while the least severe received the lowest, which was consistent with ICU rating systems. The NEWS score, airway patency, FiO2 level, requirement for inotrope or vasopressor support, temperature, and degree of consciousness are all evaluated on the pretransfer evaluation form checklist. The pretransfer assessment form was one of the components on the produced score. Self-reported surveys were used to establish content validity, and all the included nurses agreed on all the topics.

The severity of the patient's disease, the availability of equipment, and the environment all play a role in patient monitoring during transportation. The lack of guidelines and standards in the transportation profession is largely due to this huge discrepancy (Branson & Rodriquez, 2020). Association of Critical Care Transport (2016) recommended the need for critical care transport will continue to increase. The goal of this study was to create a transportation readiness scale and evaluate its validity, reliability, sensitivity, and specificity. When compared to the pretransfer assessment form checklist, Apache II score, and News score, the generated scale had a high AUC area.

Early warning scoring tools are used to detect the deterioration in patient conditions based on physiological parameters from patient observations recording. The observations included in this scoring system are temperature, pulse, blood pressure, respiratory rate, oxygen saturation, consciousness' level, and urine output (National Institute For Health And Care Excellence [NICE], 2020). Apache II score is used to measure the severity of illness based on 12 basic physiologic parameters, including body temperature, central arterial pressure, heart rate, respiratory rate, PaO2, arterial pH, serum sodium, serum potassium, creatinine, haematocrit, WBCs, and consciousness' level, age and previous health illness (Jeong, 2018).

The ROC curve is an important tool for evaluating diagnostic tests. The area under the ROC curve measures the difference between these two distributions (AUC). A good classification rule is represented by a ROC curve in the top left triangle of the square. A curve's quality increases as it approaches the top left corner. A curve that follows the left and top boundaries of the square indicates complete separation (Jaskowiak, Costa & Campello, 2022). In this study, the newly constructed transportation scale was compared to the NEWs score, Apache score, and transfer evaluation checklist. The newly created scale had a high discrimination ROC area, which was satisfactory performance.

In a binary classifier, Receiver Operating Characteristic (ROC) curves are a common approach to displaying the exchange between sensitivity and specificity (Bartlett, 2014). Sensitivity of the developed scale means the probability of the scale will be positive when the risk is present. While, specificity means the probability of the developed scale to be negative when the risk is not present (Zhou, Obuchowski & McClish,

2016). The newly designed scale is an excellent predictor of transportation risk. The transportation preparation scale had strong sensitivity and specificity, and it was able to identify the genuine high-risk categories for transportation. The transportation preparation scale's capacity to predict transportation risk (predictive validity) has therefore been examined. The devised scale was extremely reliable and valid. This scale may be used by nurses in the acute situation based on hemodynamic data, physical examination, equipment availability, and machine. The choice to transfer or not transport the patient should be made based on the score. This is the only research to date to attempt to construct a scale for predicting transportation risk.

LIMITATIONS:

The nurses in the acute setting can be overloaded with other duties and it can take time to fill the scale.

V. CONCLUSION

Intra-transportation preparedness scale is valid and reliable and could be used by professional and technical nurses. In addition, a transportation preparedness scale is highly sensitive and specific to predicting patients' risk for transportation in relation to NEWs score, APACH II score and pretransfer risk assessment checklist.

VI. RECOMMENDATION

Based on the findings, the following recommendations were suggested:

Developing periodical in-service educational programs for ICUs nurses and emergency nurses' staff to the importance of using standardized tools such as checklists and scales for intra-transportation patients to ensure their safety.

ICU staff should be trained to provide adequate and effective nursing care during intra-transportation for ICUs patients.

Establishing standard guidelines for transportation to maintain and provide good quality health services.

The study should be replicated in various ICUs and emergency settings, particularly private hospitals, and clinics.

A simple brochure with updated knowledge and practices about newly developed intra-transportation scales should be available in the ICU unit.

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CONFLICT OF INTEREST

None.

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Appendix : CRITICALLY ILL PATIENTS FOR TRANSPORTATION PREPAREDNESS Scale			**Preset score**
Item	**Description**	**Point**	
Age	**≥65**	**1**	
	<65	**0**	
BMI	**Obese class III (≥ 40)**	**3**	
	30-39.9	**2**	
	25-29.9	**1**	
	18.5-24.9	**0**	
CNS			
C-spine injury	**Unstable unconfirmed C-spine injury**	**3**	
	Unstable confirmed C-spine injury	**2**	
	Stable C-spine injury		
	Clear	**0**	
GCS	**3-8**	**3**	
	9-4	**2**	
	12-10	**1**	
	13-15	**0**	
RASS	**≥-3 or ≥+3**	**3**	
	-2 or +2	**2**	
	-1 or +1	**1**	
	0	**0**	
CVS			
Systolic Bl. PR	**≤90 or ≥180**	**3**	
	91-100 or 140-179	**2**	

	101-110 or 130-139	**1**	
	120-129	**0**	
Pulse	**≤40 or ≥131**	**3**	
	110-130	**2**	
	41-50 or 91-110	**1**	
	51-90	**0**	
ECG change	**Life threatens dysrhythmia (VF-VT)**	**3**	
	Unstable but non-life-threatening dysrhythmia (Atrial flutter – Atrial fibrillation)	**2**	
	Stable dysrhythmia	**1**	
	Stable ECG rhythm	**0**	
Chest pain	**New onset or unrelieved chest pain**	**3**	
	Uncontrol chest pain	**2**	
	Control chest pain	**1**	
	No chest pain	**0**	
Temp	**≤35**	**3**	
	≥39.1	**2**	
	38-39.1 or 35.1-36	**1**	
	36.1-38	**0**	
V&Q			
Respiratory rate	**≤8 or ≥25**	**3**	
	21-24	**2**	
	9-11	**1**	
	12-20	**0**	
SpO2	**≤91**	**3**	
	92-93	**2**	
	94-95	**1**	
	≥96	**0**	
Oxygen therapy FIO2	**Fio2 > 60%**	**3**	
	Fio2 > 50%	**2**	
	YES Fio2 ≤ 50%	**1**	
	(NO) Air	**0**	
PEEP	**PEEP >10 mmHg**	**3**	
	PEEP >5 mmHg	**2**	
	PEEP ≤5 mmHg	**1**	
	Non-MV	**0**	
Emergency Medications	**On vasopressor high dose**	**3**	
	On vasopressor intermittent dose	**2**	
	On vasopressor low dose	**1**	
	No	**0**	
Need for Fluid therapy	**More than two IV therapies**	**3**	
	Two IV therapies	**2**	
	One attached IV therapy	**1**	
	No IV therapy needed	**0**	
GIT system	**Active (vomiting or bleeding)**	**1**	
	Controlled (vomiting or bleeding)	**0**	
Fall Risk Score	**High risk**	**3**	
	Moderate risk	**2**	
	Low risk	**1**	
	No risk	**0**	
Invasive devices	**≥4**	**3**	
	≥3 invasive devices	**2**	
	1-2 invasive devices	**1**	
	NO	**0**	
Equipment			
Oxygen cylinder	**Available and full tank / not indicated**	**0**	
	Not Available or not full tank	**1**	
Availability of needed portable MV	**Yes / not indicated**	**0**	
	No	**1**	
Availability of needed portable pulse oximeter	**Yes/ not indicated**	**0**	
	No	**1**	
Need needed portable syringe pump or infusion pump	**Yes/ not indicated**	**0**	
	No	**1**	
The total score	**Zero means no risk**		
	A score of 1-34 means mild risk		
	A score of 35 – 59 meansa high risk		
	A score of 60 meansa dangerous risk		
The developed scale for hospital intra-transportation			