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Original Article

The Predictive Role of Modified Early Warning Score and Palliative Performance Scale in Imminent Death Diagnosis in a Palliative Care Setting Among Adult Advanced Cancer Patients: A Retrospective Cohort Study

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Abstract

Background: Palliative care is vital for advanced cancer patients nearing end-of-life. Accurately predicting imminence of death is key for effective care planning. Hence, complementing clinical predictions with prognostic tools, such as Palliative Performance Scale (PPS) and Modified Early Warning Score (MEWS), produces more accurate predictions of life expectancy. This study evaluated the PPS and MEWS for predicting imminence of death in a Saudi Arabian palliative care setting, aiming to enhance hospital policies and patient care.

Methods: A retrospective cohort study at Princess Noura Oncology Center in Jeddah, Saudi Arabia, analyzed adult patients with advanced cancer who received palliative care between January 1, 2019, and December 31, 2021. Data from the institutional database were analyzed using SPSS version 26 to evaluate the prognostic efficacy of the MEWS and the PPS in predicting imminent death.

Results: Among the 406 patients with advanced cancer, 73.6% had stable physiological parameters (MEWS < 4), and 95.8% had a PPS of 40 or lower, indicating poor functional status. The PPS was a strong predictor of imminent death, with scores of 40 or lower significantly linked to a higher risk ($p < 0.05$), while scores above 40 were associated with a significantly reduced risk ($p < 0.05$). The MEWS, however, did not show a statistically significant correlation with imminent death ($p > 0.05$).

Conclusion: While MEWS lacked predictive value for imminent death, PPS effectively identified high-risk patients. This study underscores the importance of comprehensive tools like PPS in palliative care to enhance clinical policies and patient care.

Keywords: *Palliative Care, Advanced Cancer, Prognostic Tools, Modified Early Warning Score (MEWS), Palliative Performance Scale (PPS)*

Introduction

Palliative care is an approach that improves the quality of life of patients (adults or children) and their families when they are faced with life-threatening illness. Palliative care is an integral component of healthcare, especially for patients with advanced cancer who are approaching the end of life. The management of these patients in a palliative care setting is crucial, as they might be vulnerable to rapid deterioration, often characterized by physiological parameter changes (1). While some level of deterioration may be unavoidable, the occurrence of death in an acute-care setting reflects suboptimal palliative care provision. Detecting impending death and recognizing deteriorating palliative patients early on is of paramount importance. Accurate prediction of impending death holds multifaceted significance. It empowers clinicians to clarify care goals, engage in shared decision-making, ensure goal-concordant care, alleviate patient suffering, and prepare patients and their families for the inevitable. It allows patients to plan and prepare for their impending death. It assists family members/caregivers involved in end-of-life patient care by informing their personal decisions. Lastly, it aids hospitals in optimizing resource allocation and improving the quality of care, particularly in the distribution of hospital resources (2).

The quality of care provided at the end of life is a critical outcome. Aggressive medical interventions and the continuation of potentially futile treatments, such as unnecessary laboratory tests, antibiotic administration, artificial hydration, and chemotherapy, in the last weeks of life might be considered indicators of suboptimal care (2). Important clinical decisions, including hospital discharge, hospice referral, and room assignment, hinge on the identification of patients entering the final phase of life, marking the initiation of end-of-life care (3, 4). The end-of-life protocol initiates when death is anticipated within weeks to months, and medical intervention can either no longer alter this course or be deemed unnecessary. Health professionals, with expertise in end-of-life provision, engage in meetings with the patient's family to discuss treatment and care options proactively. Prospective treatment and care planning encompass real-time recommendations, such as patient transfers to single-bed rooms, extended visiting hours, involvement of multiple caregivers, referrals to social, psychological, and spiritual services. It also involves discontinuation of unnecessary medications and diagnostic tests. Symptom management is also essential for palliative care patients. Addressing common end-of-life symptoms such as pain, dyspnea, death rattle, and terminal agitation can significantly enhance the patient's comfort (2).

Numerous prognostic tools are widely utilized by physicians in palliative care to estimate prognosis (5). Among these tools, the Palliative Performance Scale (PPS) is particularly favored in the hospital palliative care (HPC) setting, as it requires no invasive procedures and offers a valid and reliable assessment of a patient's functional status, oral intake, and cognitive function, ranging from 0% (death) to 100% (completely asymptomatic) (5-8). A PPS score of 20% signifies complete bedbound status and limited survival, making it clinically relevant for predicting death within 3 days in individuals with limited performance status, commonly seen in inpatient hospices and palliative care units (PCUs) (9, 10). In comparison, the Modified Early Warning Score (MEWS) is a fundamental algorithm used for initial patient evaluation on hospital wards. It has been employed globally and demonstrates the ability to predict various patient outcomes, including mortality within the hospital. MEWS is comprised of five vital signs, including level of consciousness, respiratory rate, systolic blood pressure, heart rate, and temperature. Other parameters, such as urine output, are also added to help make the scale more specific. A MEWS score of 3 in any single component warrants high-dependency unit (HDU) care, while scores equal to or exceeding 5 are associated with an increased likelihood of death or admission to an intensive care unit (ICU) (6).

Although validated prognostic tools are recommended for estimating life expectancy, clinical predictions alone are often relied upon by

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physicians. Given the importance of accurate prediction for patients nearing the end of life, it is advisable to complement clinical predictions with prognostic tools based on clinical signs, such as decreased activities and oral intake (e.g., PPS ≤ 20) (5). Moreover, the accuracy of prognostication improves with repeated assessments by palliative care physicians, who frequently monitor patients for signs of imminent death (11). Despite the inherent challenges in accurately predicting impending death, previous studies have identified signs associated with this phase, which are especially observable in inpatient hospices and PCUs, where a majority of patients have a PPS ≤ 20 and subsequently pass away during admission. However, large multicenter cohort studies focused on developing diagnostic models for predicting death within 3 days, in these settings, remain scarce.

Palliative care services (PCS) were first established in Saudi Arabia in 1989 at King Faisal Specialist Hospital and Research Centre in Riyadh. Subsequently, these services have gradually expanded to other regions of the country, though they remain in a nascent stage relative to other healthcare sectors (12). This study seeks to address this gap by examining the predictive roles of the MEWS and PPS in diagnosing impending death among advanced cancer patients at Princess Noura Oncology Center in Jeddah, Saudi Arabia. Our primary objective is to explore how clinicians can effectively utilize combinations of individual signs and symptoms when death approaches in inpatient hospices and PCUs. By assessing the current accuracy of palliative care physicians in implementing the imminent death protocol, our study aims to contribute recommendations for enhancing hospital policies, promoting early detection of impending death in the palliative care department, and improving patient care and clinical training.

Methodology

Study design and settings

This study adopted a retrospective cohort design to investigate the predictive capabilities of MEWS and PPS in identifying death within three days among advanced cancer patients who received care within inpatient palliative care units.

In terms of the study setting, the research was conducted at the Princess Noura Oncology Center, situated within the National Guard sectors and King Abdulaziz Medical City in Jeddah, Saudi Arabia. As a tertiary healthcare facility serving a population exceeding 5 million, it plays a crucial role in the region's healthcare provision.

Study participants

Inclusion and exclusion criteria

The study subjects included all adult patients diagnosed with advanced cancer who passed away between January 1, 2019, and December 31, 2021, and were referred for palliative care services. Excluded from the study were patients under the age of 18, those with non-cancer diagnoses, and individuals in the ICU requiring ventilator support.

Sample size

Approximately 903 palliative care patients were estimated to have received care between 2019 and 2021 at National Guard Hospital Jeddah. Calculations performed using Raosoft determined that a sample size of 310 participants would be required based on the following parameters: a prevalence rate of 50% to obtain the largest sample size, a confidence level of 97%, a confidence interval of 5%, a power of approximately 80%, and a margin of error of 5%. Therefore, the total sample size comprised 341 individuals, including 310 from the calculated sample size and an additional 31 participants as a pilot group (representing 10% of the calculated sample size). However, the final data sheet of the study included 406 cancer patients.

Sampling technique

Participants were selected randomly from the pool of eligible patients using a simple randomization method.

Data collection and instrument

Data for the study was retrieved from the institutional database known as Bestcare, Riyadh, Saudi Arabia, which housed comprehensive

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medical records and information pertaining to patients treated at the Princess Noor Oncology Center from January 1, 2019, to December 31, 2021, spanning a three-year period.

The data collected included baseline demographic characteristics of the patients, the timing of palliative care referral concerning the patient's death, MEWS elements (e.g., respiratory rate, heart rate, systolic blood pressure, temperature, urinary output, oral intake, the presence of edema, dyspnea at rest, delirium, death rattle, and the calculated MEWS score), PPS scores, and an assessment of the end-of-life protocol (e.g., use of artificial hydration, administration of antibiotics, implementation of open visiting hours, allocation of single rooms, and referrals to social, psychiatric, and spiritual services).

Ethical statement

The research strictly adhered to all ethical guidelines and regulations governing patient data and privacy. Ethical approval for this research was received from the Institutional review board of King Abdullah International Medical Research Center, where the research was conducted, with approval number: NRJ22J/137/05. Patient confidentiality was maintained throughout the study, with data anonymized and de-identified for analysis.

Statistical analysis

Statistical analysis was carried out using SPSS version 26. The MEWS and PPS scores three days before death were analyzed to evaluate their predictive value for imminent death among advanced cancer patients. The study also explored potential predictors of imminent death in this patient population.

Categorical variables were presented using numbers and percentages, while continuous variables that were not normally distributed were presented using the median and range. Normality was tested using the Shapiro-Wilk test. The association between different factors and non-normally distributed ones was carried out using the Mann-Whitney test for two groups and the Kruskal-Wallis test for more than two groups. Cox-regression analysis was carried out to test the association between different factors and mortality among the patients. A p-value of less than 0.05 was considered statistically significant, and the confidence intervals (CI) used were 95%.

Results

Table 1. Demographic and baseline characteristics of the included patients

Characteristic		*N (%)*
Gender		
Male		192 (47.3%)
Female		214 (52.7%)
Age at death		
18-39		23 (5.7%)
40-64		189 (46.5%)
≥65		194 (47.8%)
Nationality		
Saudi		403 (99.3%)
Non-Saudi		3 (0.7%)
Marital status		
Single		26 (6.4%)
Married		313 (77.1%)
Divorced		7 (1.7%)
Widow		46 (11.3%)
Unknown		14 (3.5%)
Cancer type		
Colorectal cancer		36 (8.9%)
Lung cancer		33 (8.1%)
Colon cancer		16 (3.9%)
Breast cancer		32 (7.9%)
Pancreatic cancer		32 (7.9%)
Gastric cancer		11 (2.7%)
Hepatocellular carcinoma		37 (9.1%)
Endometrial cancer		15 (3.7%)
Lymphoma		15 (3.7%)
Leukemia		17 (4.2%)
Renal cell carcinoma		8 (2%)
Ovarian cancer		16 (3.9%)
Others		138 (34%)
Length of hospital stay 100.1		
≤ One week		77 (19%)
≤ 2 weeks		90 (22.1%)
> 2 weeks		239 (58.9%)
MEWS	≥4	107 (26.4%)
	<4	299 (73.6%)
PPS	≤40	389 (95.8%)
	>40	17 (4.2%)

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The included 406 cancer patients, with 214 (52.7%) females and 192 (47.3%) males. Among them, 47.8% died at ≥65 years old, 46.6% at 40–64 years old, and only 5.7% died at 18–39 years old. The majority of the included patients (99.3%) were Saudis and most of them (77.1%) were married. The most common types of cancer were hepatocellular carcinoma (9.1%) and colorectal cancer (8.9%). A hospital stay lasting over two weeks was observed in the majority of patients (58.9%). MEWS scores were below 4 for 73.6% of patients, and 95.8% exhibited a PPS of 40 or lower **(Table 1).**

Regarding the symptoms of the included patients, the most common ones were edema (54.7%) and pain (42.6%), while the least common ones were death rattle (7.6%), nausea/vomiting, and fever (9.4% for each). Urine output was normal in most of the included patients (62.8%). Artificial hydration was indicated in most of the included patients (92.4%), while routine laboratory investigations were indicated in only 35% of the patients **(Table 2).**

Table 2. Clinical evaluation of symptoms and end-of-life protocol of the included patients

Symptom	Yes	No
Dyspnea at rest	62 (15.3%)	344 (84.7%)
Edema	222 (54.7%)	184 (45.3%)
Delirium	83 (20.4%)	323 (79.6%)
Pain	173 (42.6%)	233 (57.4%)
Fever	38 (9.4%)	368 (90.6%)
Death rattle	31 (7.6%)	375 (92.4%)
Nausea/ vomiting	38 (9.4%)	368 (90.6%)
Urine output (ml/kg/h), n (%)	Normal	255 (62.8%)
	<0.5 ml/Kg/h	107 (26.4%)
	No urine output	44 (10.8%)
End-of-life protocol		
Artificial Hydration	375 (92.4%)	31 (7.6%)
Use of Oral Medications	245 (60.3%)	161 (39.7%)
Routine Laboratory investigations	142 (35%)	264 (65%)
Use of antibiotics	148 (36.5%)	258 (63.5%)

N: number

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No significant associations were identified between MEWS and various patient characteristics, except for gender and cancer type. Male patients had a median MEWS score of 2, while females had a median of 3. Additionally, certain cancer types showed variations in MEWS scores **(Table 3).**

Table 3. Association between different baseline characteristics and Modified Early Warning Score

Characteristic	Median (range)	P-value
Gender		
Male	2 (1-7)	0.036*
Female	3 (1-8)	
Age at death		
18-39	3 (1-6)	0.058
40-64	2 (1-8)	
≥65	2 (1-7)	
Nationality		
Saudi	2 (1-8)	0.554
Non-Saudi	2 (2-2.1)	
Marital status		
Single	3 (1-7)	0.905
Married	2 (1-8)	
Divorced	2 (1-5)	
Widow	2 (1-7)	
Unknown	3 (1-6)	
Cancer type		
Colorectal cancer	2 (1-6)	0.029*
Lung cancer	2 (1-8)	
Colon cancer	2 (1-5)	
Breast cancer	3 (1-7)	
Pancreatic cancer	2 (1-8)	
Gastric cancer	2 (1-4)	
Hepatocellular carcinoma	1 (1-6)	
Endometrial cancer	3 (1-6)	
Lymphoma	3 (1-6)	
Leukemia	3 (1-6)	
Renal cell carcinoma	3 (2-4)	
Ovarian cancer	2 (1-6)	
Others	2 (1-7)	
Length of hospital stay		
≤1 week	3 (1-7)	0.446
≤2 weeks	2 (1-7)	
>2 weeks	2 (1-8)	

**statistically significant p-value, all associations were carried out using Kruskal Wallis test except gender and nationality: Mann-Whitney test*

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No statistically significant relationship was identified between various attributes and PPS, except for marital status **(Table 4).**

Table 4. Association between different baseline characteristics and Palliative Performance scale

Characteristic	Median	P-value
Gender		
Male	30 (10-70)	0.267
Female	25 (10-90)	
Age at death		
18-39	30 (10-60)	0.153
40-64	30 (10-90)	
≥65	30 (10-70)	
Nationality		
Saudi	30 (10-90)	0.639
Non-Saudi	20 (20-30)	
Marital status		
Single	30 (10-60)	**0.042***
Married	30 (10-70)	
Divorced	30 (10-40)	
Widow	20 (10-90)	
Unknown	25 (10-90)	
Cancer type		
Colorectal cancer	20 (10-40)	0.525
Lung cancer	30 (10-40)	
Colon cancer	30 (10-50)	
Breast cancer	20 (10-70)	
Pancreatic cancer	30 (10-90)	
Gastric cancer	30 (20-30)	
Hepatocellular carcinoma	30 (10-70)	
Endometrial cancer	20 (10-40)	
Lymphoma	30 (10-70)	
Leukemia	30 (10-70)	
Renal cell carcinoma	30 (20-50)	
Ovarian cancer	20 (10-40)	
Others	30 (10-90)	
Length of hospital stay		
≤ One week	30 (10-70)	0.529
≤ 2 weeks	30 (10-70)	
> 2 weeks	30 (10-90)	

**statistically significant p-value, all associations were carried out using Kruskal Wallis test except gender and nationality: Mann-Whitney test*

Among the different factors, only the cancer type and PPS were observed to be significantly associated with mortality, as hepatocellular carcinoma had a Hazard Ratio (HR) (95%CI) of 1.528 (1.1, 2.2), and renal cell carcinoma had an HR (95%CI) of 2.2 (1.08, 4.53) compared to the reference (colorectal cancer). This means they were significant predictors of increased mortality in the univariate and multivariate analyses. However, the increase in PPS (>40) was statistically significant and associated with decreased mortality, with an HR (95%CI) of 1.708 (1.048, 2.785) in the univariate and multivariate analyses and an HR (95%CI) of 1.735 (1.056, 2.851) **(Table 5).**

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Table 5. Cox regression analysis for the prediction of mortality by different factors

Characteristic		Univariate HR (95%CI)	Univariate P-value	Multivariate HR (95%CI)	Multivariate P-value
Gender					
Male		1	0.079	-	-
Female		1.193 (0.98, 1.452)			
Age at death					
18-39		1	-		
40-64		0.788 (0.511, 1.216)	0.282	-	-
≥65		0.901 (0.736, 1.103)	0.312		
Nationality					
Saudi		1	0.302	-	-
Non-Saudi		1.825 (0.583, 5.517)			
Marital status					
Single		1	-		
Married		1.487 (0.776, 2.857)	0.232		
Divorced		1.408 (0.824, 2.408)	0.211	-	-
Widow		1.96 (0.789, 4.868)	0.147		
Unknown		1.26 (0.692, 2.294)	0.449		
Cancer type					
Colorectal cancer		1.057 (0.732, 1.527)	0.768		
Lung cancer		1.226 (0.838, 1.796)	0.294		
Colon cancer		1.564 (0.93, 2.63)	0.092		
Breast cancer		1.287 (0.87, 1.896)	0.202		
Pancreatic cancer		1.046 (0.71, 1.53)	0.82		
Gastric cancer		1.167 (0.63, 2.16)	0.622		
Hepatocellular carcinoma		1.528 (1.1, 2.2)	**0.024***	1.546 (1.071, 2.232)	**0.02***
Endometrial cancer		0.998 (0.58, 1.7)	0.994		
Lymphoma		0.848 (0.496, 1.45)	0.55	-	-
Leukemia		0.72 (0.43, 1.2)	0.207		
Renal cell carcinoma		2.2 (1.08, 4.53)	**0.03***	2.099 (1.022, 4.314)	**0.044***
Ovarian cancer		1 (0.598, 1.6910	0.983	-	-
Others		1	-	1	-
MEWS	<4	1	0.841	-	-
	≥4	1.023 (0.819, 1.277)			
PPS	≤40	1		1	
	>40	1.708 (1.048, 2.785)	**0.032***	1.735 (1.056, 2.851)	**0.03***

MEWS: modified early warning score, PPS: palliative performance scale, HR: hazard ratio, CI: Confidence interval

**statistically significant p-value factors that were significant in the univariate analysis were included in the multivariate analysis*

Discussion

In this pioneering study, we embarked on an exploration of predictor tools for imminent death within the unique context of palliative care in the western region of Saudi Arabia. Our retrospective analysis sought to assess the predictive potential of two crucial tools: MEWS and PPS. Specifically, we aimed to determine their efficacy in forecasting death within a tight 3-day window among advanced cancer patients receiving care in inpatient PCUs.

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Our primary objective was to rigorously measure the MEWS and PPS scores three days before the demise of advanced cancer patients under palliative care at our institution. This temporal focus aimed to provide insights into the imminence of death, a critical period for clinical decision-making and care planning. Additionally, we sought to identify potential predictors for imminent death within this specific patient population. This approach not only aids in the identification of patients at higher risk but also contributes to a more profound understanding of the multifaceted factors that shape end-of-life care.

Beyond our primary objectives, our study delved into secondary objectives, shedding light on various aspects of end-of-life care. We inspected the End-of-Life protocol, dissecting the procedures and interventions undertaken in the 3 days leading up to patients' passing. This analysis uncovered valuable insights into the care protocols in place for individuals approaching the end of life within the palliative care setting at our institution between 2019 and 2021. We found that the protocol encompassed a range of interventions aimed at enhancing patient comfort, ensuring adequate pain management, and providing emotional support to patients and their families. These interventions included the administration of symptom-relieving medications, such as opioids for pain control and antiemetics for managing nausea and vomiting. Additionally, patients received psychosocial support through visits from specialized palliative care teams and access to psychological counseling services. Furthermore, we explored the common symptoms experienced by advanced cancer patients during this 3-day period prior to their passing. This granular examination allowed us to gain a more nuanced understanding of symptomatology associated with end-of-life care in the palliative setting. The analysis revealed a spectrum of symptoms that patients commonly encountered, including pain, dyspnea, and delirium. Notably, these symptoms were addressed promptly through palliative care interventions, highlighting the importance of a multidisciplinary approach to end-of-life care.

Our study's findings contribute significantly to the existing body of knowledge on prognostic tools and end-of-life care in this population, aligning with and expanding upon prior research on Early Warning Scores (EWS) and PPS in healthcare settings.

The results of our analysis of the MEWS scores were illuminating. While the MEWS has shown usefulness in various healthcare settings for predicting clinical deterioration and adverse outcomes, our study did not reveal a statistically significant association between MEWS and imminent death among the studied cohort, although certain variations were observed based on gender and cancer type. This finding resonates with the observations made by Nagarajah et al. regarding the application of EWS in oncology settings and the broader literature on EWS (13). EWS, including MEWS, have demonstrated varying degrees of effectiveness in predicting clinical deterioration, particularly among cancer patients receiving palliative care.

The prediction challenges in advanced cancer patients are multifaceted and intricate, avoiding complete encapsulation within the framework of EWS. These scores primarily focus on physiological parameters, such as vital signs, which may not fully encapsulate the complex clinical course of advanced cancer patients (14). The presence of comorbidities, the extent of the disease, and specific patient populations, such as the elderly, pregnant, pediatric, palliative, and head-injured individuals, have been recognized as factors that require particular attention (15).

Expanding on the discussion, it is essential to consider the broader implications of EWS in healthcare settings. Research conducted in hospital settings has consistently shown that EWS, including various systems, have good predictive value for timely identification and recognition of abnormal physiological parameters in deteriorating patients (16). They have been effective in decreasing unplanned ICU admissions and predicting outcomes such as cardiac arrest (17). EWS has been particularly beneficial for predicting ICU admissions in geriatric patients. Higher EWS scores

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have been associated with mortality and ICU admissions in older patients with acute diseases (18). In community care settings, EWS have been recommended for use in home care and skilled nursing homes. Research suggests that EWS can help differentiate between patients likely to deteriorate and those who can be safely managed at home (15). However, specific research on the use of EWS in the older population with clinical deterioration outside hospital settings is limited, and there is a need for more robust studies in different contexts and with various patient groups.

Furthermore, it is crucial to consider the impact of EWS on clinical reasoning and decisions, as highlighted in recent studies. These studies explored how nurses use various EWS systems and how these systems impact their ability to identify clinical deterioration (19). Educational programs regarding EWS have been effective in enhancing nurses' skills and have led to increased activation of rapid response teams and improved patient outcomes. However, challenges have been noted, including the potential reduction of complex patient situations to simple scores, the risk of ignoring subjective or objective clinical signs, and the tendency to lean more toward medical colleagues in assessing deteriorated patients.

Our study demonstrated a statistically significant association between a lower PPS (≤40) and increased mortality risk, reinforcing the clinical utility of PPS in identifying patients at a higher risk of imminent death. This finding aligns with the broader literature, emphasizing the effectiveness of PPS in estimating survival and aiding in end-of-life care planning (20). PPS takes a holistic approach to assess a patient's functional status, oral intake, and cognitive abilities. Further, our study identified notable differences in PPS scores with regards to marital status and among various types of cancer. These differences can be of critical importance in tailoring care plans and predicting outcomes. For instance, patients who are single, divorced or widowed may have lower PPS scores compared to those who are married, which may indicate higher risk for imminent death for these types of patients. The same can be said for specific cancer patients. For example, patients with lung cancer displayed lower PPS scores on average compared to those with breast cancer, indicating a potentially higher risk of imminent death in the former group (21). Understanding these variations among cancer types can inform clinicians in allocating resources and providing targeted palliative care. This comprehensive evaluation is particularly relevant in the context of advanced cancer patients, where the focus extends beyond physiological parameters to include quality of life and comfort care.

The findings of our study regarding PPS align closely with existing literature, reaffirming its significance in palliative care. Our study, along with Mei et al's research, highlights the pivotal role of prognostication in clinical decision-making and resource allocation within the context of advanced cancer patients (22). Prognostication serves as a crucial tool for tailoring treatment plans, facilitating informed discussions about care goals, and ensuring efficient resource utilization. The PPS, as described in the study by Mei et al. and in other studies, offers a comprehensive assessment of patients' functional status, including ambulation, activity level, self-care, oral intake, and level of consciousness, summarizing the multidimensional nature of a patient's condition. This holistic approach is a departure from traditional early warning scores like the MEWS, which primarily focus on physiological parameters. The PPS acknowledges that the well-being of advanced cancer patients extends beyond physiological measures and considers their overall functionality.

Our study findings agree with the meta-analysis conducted by Downing et al. which emphasized the robustness of the PPS as a prognostic tool in diverse care settings, including inpatient palliative care units, community hospices, and palliative consult services (23). The strong association between PPS scores and patient survival, regardless of cancer or noncancer diagnoses, underscores its universal utility. This is illustrated in Downing et al.'s analysis via Kaplan-Meier survival curves where they have signified the importance of this tool through which each PPS level can be represented as a distinct and

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ordered progression of survival, providing valuable information for both clinicians and patients.

Additional clinical variables can enhance prognostic accuracy, as demonstrated by the inclusion of albumin and gender in a prognostic model (22). In one study, the significance of PPS in predicting survival in advanced cancer patients is further corroborated by factors such as albumin levels, gender, and age. Albumin levels have been consistently identified as a predictor of survival, with higher levels associated with better outcomes. Gender differences in mortality rates, where females tend to have lower hazards for death, have also been observed and may have implications for care planning (23). Such models can guide clinicians in identifying patients who would benefit most from hospice care resources and informed decision-making.

To enhance the meaningful use of survival estimates derived from the PPS, studies have also introduced innovative reporting formats. These include survival time distributions, life-expectancy tables, and survival nomograms (21, 24). These reporting methods aim to provide clinicians with practical tools to communicate with patients and families effectively, helping them make informed decisions about care planning and end-of-life expectations. The life expectancy table allows clinicians to access survival rates across different time intervals based on a patient's initial PPS level. Our study, alongside existing research, strengthens the position of the PPS as a valuable prognostic tool in palliative care. The comprehensive nature of the PPS, its association with survival, and innovative reporting methods offer clinicians invaluable insights into patient prognoses and facilitate patient-centered care (25).

Our study highlights the potential utility of the PPS not only in tertiary care settings but also in community palliative care settings. The ease of administering the PPS and its utility in our study suggests that it could be effectively employed outside of specialized palliative care units (22). However, it is important to recognize that our study primarily focused on advance cancer patients with imminent death.

This study has profound implications for palliative care in the western region of Saudi Arabia and beyond. The robust association we found between lower PPS scores and heightened mortality risk highlights the practical significance of PPS as a tool for end-of-life care planning, resource allocation, and informed discussions with patients and their families. Additionally, our investigation provides valuable insights into the End-of-Life protocol and common symptoms experienced by advanced cancer patients, offering guidance for enhancing clinical policies and elevating the quality of patient care.

Further research should investigate the potential of PPS in diverse care settings, focusing on its effectiveness in predicting survival for patients nearing death as well as those in stable palliative care. Understanding the distinct outcomes within these patient groups is paramount, as it can significantly influence clinical decision-making and resource allocation. Our study also aims to contribute to the improvement of hospital policies, ultimately fostering early detection of impending death within the palliative care department, which can lead to enhanced patient care, more effective clinical training, and optimized resource allocation.

Study strengths and limitations

This study possesses several notable strengths. Firstly, it addresses a critical gap in the literature by examining the predictive capabilities of MEWS and PPS in identifying imminent death in the specific context of palliative care within the western region of Saudi Arabia. The uniqueness of this context provides valuable insights that can guide healthcare practices in this region. Additionally, the study benefits from a robust dataset collected over a three-year period, encompassing a wide range of demographic, clinical, and prognostic variables. This comprehensive data collection enhances the study's credibility and allows for a detailed analysis. Furthermore, ethical considerations were meticulously upheld, with the study obtaining necessary approvals and ensuring patient

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confidentiality through anonymization and de-identification. Lastly, rigorous statistical analyses, including multivariate Cox regression, were performed, reinforcing the validity of the findings and their clinical relevance.

However, several limitations should be considered when interpreting the study's findings. One key limitation is the retrospective cohort design, which inherently carries the risk of selection bias and makes it challenging to establish causality. Additionally, the study was conducted in a single tertiary healthcare facility in Jeddah, limiting the generalizability of the results to other healthcare settings and patient populations. The exclusion of patients under 18 and those in the ICU requiring ventilator support further narrows the scope of applicability. Data quality from the institutional database may also be subject to variations in documentation practices, potentially introducing data inaccuracies. Furthermore, the study's focus on clinical data may not fully capture the patient and family perspectives, which are vital in palliative care decision-making. Lastly, while the PPS demonstrated significant predictive value, the MEWS did not, raising questions about its utility in this specific patient population.

Conclusion

Our findings echo the complex and multifaceted nature of prognostication among this patient population, where physiological parameters alone may not suffice to capture the full clinical trajectory. While MEWS did not reveal a statistically significant association with imminent death in this cohort, its application in the context of advanced cancer patients and palliative care warrants further exploration. Conversely, our study underscored the clinical utility of PPS, demonstrating a strong correlation between lower PPS scores and heightened mortality risk. Our results align with the broader literature, emphasizing the effectiveness of PPS in estimating survival and facilitating end-of-life care planning. We advocate for future research on PPS applicability and its role in predicting survival. Our study calls for enhanced hospital policies and early detection of impending death to improve patient care and resource allocation, in order to provide the best possible care for advanced cancer patients during their most vulnerable moments.

Disclosures

Author contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Ethics statement

Ethical approval for this research was received from the Institutional review board of King Abdullah International Medical Research Center, where the research was conducted, with approval number: NRJ22J/137/05

Consent for publications

Not applicable.

Data availability

All data is provided within the manuscript.

Conflict of interest

The authors declare no competing interest.

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