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Screening instruments for early identification of unmet palliative care needs: a systematic review and meta-analysis

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ABSTRACT

Background The early detection of individuals who require palliative care is essential for the timely initiation of palliative care services. This systematic review and meta-analysis aimed to (1) Identify the screening instruments used by health professionals to promote early identification of patients who may benefit from palliative care; and (2) Assess the psychometric properties and clinical performance of the instruments.

Methods A comprehensive literature search was conducted in PubMed, Embase, CINAHL, Scopus, CNKI and Wanfang from inception to May 2023. We used the COnsensus-based Standards for the Selection of Health Measurement INstruments to assess the methodological quality of the development process for the instruments. The clinical performance of the instruments was assessed by narrative summary or meta-analysis. Subgroup analyses were conducted where necessary. The quality of included studies was assessed using the Newcastle-Ottawa Scale and the Cochrane Collaboration's risk of bias assessment tool.

Results We included 31 studies that involved seven instruments. Thirteen studies reported the development and validation process of these instruments and 18 studies related to assessment of clinical performance of these instruments. The content validity of the instruments was doubtful or inadequate because of very low to moderate quality evidence. The pooled sensitivity (Se) ranged from 60.0% to 73.8%, with high heterogeneity (I2 of 88.15% to 99.36%). The pooled specificity (Sp) ranges from 70.4% to 90.2%, with high heterogeneity (I2 of 96.81% to 99.94%). The Supportive and Palliative Care Indicators Tool (SPICT) had better performance in hospitals than in general practice settings (Se=79.8% vs 45.3%, p=0.004; Sp=59.1% vs 97.0%, p=0.000).

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Early palliative care can improve the quality of life for patients with non-communicable diseases in advanced stages.
⇒ However, it is difficult to identify patients with palliative care needs early and at the right time for reasonable palliative care.

WHAT THIS STUDY ADDS

⇒ Seven screening instruments were identified, but none comprehensively assessed the patient's physical, psychological and spiritual distress, and their need for social support.
⇒ The overall methodological quality of the evidence ranged from very low to moderate.
⇒ In hospitals, Supportive and Palliative Care Indicators Tool has better clinical performance than Necesidades Paliativas (Palliative Needs) and Taiwanese version Palliative Care Screening Tool, with a pooled sensitivity of 79.8% (95% CI 72.6% to 85.5%).

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Future studies should focus on validating screening instruments against relevant criteria for referring patients to palliative care rather than solely against their ability to predict mortality.
⇒ Additional efforts are required to enhance the comprehensiveness of existing instruments by encompassing a broader spectrum of concerns, including those related to the physical, psychological, social and spiritual dimensions
⇒ The applicability of these instruments in different healthcare settings should be validated to improve their clinical performance.

Conclusion The clinical performance of existing instruments in identifying patients with palliative care needs early ranged from poor to reasonable. The SPICT is used most commonly, has better clinical performance than other instruments but performs better in hospital settings than in general practice settings.

BACKGROUND

More than 50 million people die from non-communicable diseases (eg, cancer, cardiovascular diseases, and respiratory diseases) globally each year—equivalent to 71% of all deaths.[1 2] People with life-limiting illnesses may experience a significant degree of physical, psychological and spiritual distress.[3] For them, palliative care is an approach to preventing and alleviating symptoms and improving quality of life through early identification and appropriate management of symptoms.[4 5] The need for palliative care continues to grow as a result of the ageing population and the incidence of non-communicable diseases.

Early palliative care is associated with improved symptom control, satisfaction with healthcare, quality of life and survival.[6 7] It may also reduce hospital stays, the use of aggressive treatments close to death and healthcare expenditure.[8 9] However, most people still only receive palliative care in their last few days or weeks of life. Delayed access to palliative care can contribute to negative outcomes including ineffective medical interventions, higher healthcare costs,[10] inappropriate use of treatment modalities,[11] and insufficient support for patients and their families.[12]

The early detection of individuals who require palliative care is essential for the timely initiation of palliative care services.[13] Several screening instruments have been developed to identify individuals who would benefit from palliative care so that healthcare professionals (HCPs) can tailor palliative care to the specific needs and preferences of patients.[14–19] Five reviews have been conducted to evaluate these instruments but were limited to narrative summaries of the main characteristics or psychometric properties of screening instruments. They did not conduct a meta-analysis to pool the clinical performance of the instruments.[19–23] Additionally, existing reviews only included instruments used within a single type of setting, such as primary care settings or hospital settings.[19–21 23] Therefore, it is unclear how screening instruments were used across different settings, and whether variations exist in their clinical performance across these instruments and different settings.

To address the gap, this systematic review aimed to (1) Identify existing screening instruments for early identification of individuals who are in need of palliative care, irrespective of setting of care; (2) Describe the key characteristics and psychometric properties of screening instruments, including validity and reliability; and (3) Pool and compare their clinical performance in identifying patients with palliative care needs early.

METHODS

This systematic review was registered in PROSPERO (CRD42022335942) and followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.[24]

Search methods

We conducted two rounds of literature searches. First, we performed a systematic search using four English databases (PubMed, CINAHL, Embase and Scopus) and two Chinese databases (CNKI and Wanfang), from inception to May 2023. After identifying the instruments, we used their name to search for additional relevant studies. A detailed search strategy is provided in online supplemental appendix S1.

Study selection process

All retrieved articles were imported into the software Covidence to facilitate citation management. After removing duplicates, two researchers independently screened by titles and abstracts of the included citations. Full-text reading was then performed by the same researchers against the pre-established criteria. After that, the researchers completed quality evaluation, data extraction and analysis. Discrepancies between researchers were resolved by a third author when necessary.

Inclusion/exclusion criteria

Target population

We included instruments targeting: (1) Adults aged 18 years or older; and (2) Patients with any advanced non-communicable diseases such as cancer, heart disease, dementia, organ failure and so on.

Instruments

Screening instruments were used to identify patients with palliative care needs early. We excluded screening instruments designed for a specific disease because our objective was to identify generic instruments for multiple diseases and settings. We excluded screening instruments specifically for intensive care units and emergency departments. It was because the rapid change in patient conditions in these settings makes long-term palliative care needs prediction challenging.[25] We excluded screening instruments that were primarily used in the last few days or weeks of life because these instruments are not suitable for the early identification of palliative care patients.

Outcomes

The outcomes of interest were the development, validation and clinical performance of screening instruments. For development of the instruments, we examined aims and methodology. With regards to key characteristics

and psychometric properties of screening instruments, we explored the number of items, responses format, time frame, scope of population, settings for use and content. The clinical performance indicators included sensitivity, specificity, positive likelihood ratio (LR+), negative likelihood ratio (LR–), positive predictive values (PPV), negative predictive values (NPV) and diagnostic OR (DOR).

Types of studies

We included studies published in peer-reviewed journals in either the English or Chinese language because the research team members are fluent in both languages. We excluded protocols, conference abstracts, reviews, commentaries, letters to the editor, oral presentations, case reports and studies for which full texts were not available.

We divided the included studies in two groups. Group 1 was the studies describing the development of the included instruments (development and validation studies); group 2 referred to the studies aiming at examining the clinical performance of the included instruments (clinical performance studies).

Assessment of methodological quality of included instruments

We used COnsensus-based Standards for the Selection of Health Measurement INstruments (COSMIN) to assess the methodological quality of the development of screening instruments.[26] COSMIN assesses design quality, test quality, content validity and construct validity, using a 4-point rating scale (1=very good, 2=sufficient, 3=doubtful, 4=inadequate). Results from all studies were qualitatively summarised to determine the overall relevance, comprehensiveness, understandability and content validity of the screening instrument, with each aspect rated as adequate (+), insufficient (−), inconsistent (±) or inconclusive (?).[27] Finally, the quality of the evidence was graded as 'high', 'moderate', 'low' or 'very low', using the revised Grading of Recommendations, Assessment, Development and Evaluation methodology.[27]

Risk of bias of the included studies

We assessed the risk of bias using the Newcastle-Ottawa Scale for observational studies and Cochrane Collaboration's risk of bias assessment tool for randomised clinical trials (RCTs). The Newcastle-Ottawa Scale rates bias on three dimensions: selection, comparability and outcome, resulting in low (less than 5 points), medium (6–7 points) and high (8–9 points).[28] The Cochrane Collaboration's risk of bias assessment tool assesses seven possible sources of bias, including selection bias, performance bias, detection bias, attrition bias, reporting bias and other bias, and has three responses (ie, 'High risk', 'Low risk' and 'Unclear') for each item.[29]

Data extraction

Three predefined data extraction forms were used to extract information. The first table extracted the basic features of screening instruments from development and validation studies (eg, year of development, country, language, target populations, users of the instrument, numbers of items, format of responses, psychometric properties, survival time predicted by the instruments, settings for use and contents). The second table extracted information about the clinical performance studies, including study design, instrument used, setting and number of subjects. For each clinical performance study, we also developed a third table, the 2×2 table, to calculate sensitivity, specificity, LR+, LR–, PPV, NPV and DOR. The sensitivity is the ratio of correctly identified deaths (true positive results) to the total number of actual deaths (positive results). The specificity is the ratio of correctly identified non-deaths (true negative results) to the total number of non-deaths (negative results). The DOR, the ratio of disease positive rate to the non-disease positive rate (LR+ divided by LR−), ranges from 0 to infinity, with higher values indicating better discriminatory test performance.[30] We also recorded the area under the curve for each instrument. If necessary, researchers contacted the authors for more data to calculate clinical performance. Data were extracted by one researcher and double-checked for accuracy by a second researcher.

Data synthesis and analysis

The key features of screening instruments were described in a narrative synthesis. We performed a meta-analysis to pool the sensitivity, specificity, LR+, LR− and DOR using Meta-Disc 2.0 and Stata 17.0. The threshold heterogeneity in clinical performance among studies for each instrument was determined by the Spearman correlation coefficient between the logarithm of sensitivity and 1−specificity. If $p<0.05$ of the Spearman correlation coefficients reveals heterogeneity of threshold effect, the summary receiver operating characteristics (SROC) curve was used to combine the statistics from which the specificity and sensitivity of the group of studies were obtained. The SROC curve is an integrated receiver operating characteristics curve based on the weighting of the diagnostic advantage ratio in individual diagnostic tests.[31] We used I2 measures to report non-threshold effect heterogeneity in the summary estimates of diagnostic performance ($I2<50\%$ for low, $50\%\leq I2<75\%$ for moderate, and $I2\geq75\%$ for high).[32] If significant heterogeneity existed ($I2>50\%$), the random effects model was used; otherwise, the fixed effects model was applied. Subgroup analyses were performed by the age groups of included populations or healthcare settings ($p<0.05$). Publication bias was assessed using the asymmetry regression test described by Deek's, with a symmetrical plot indicating no publication bias.[33] A

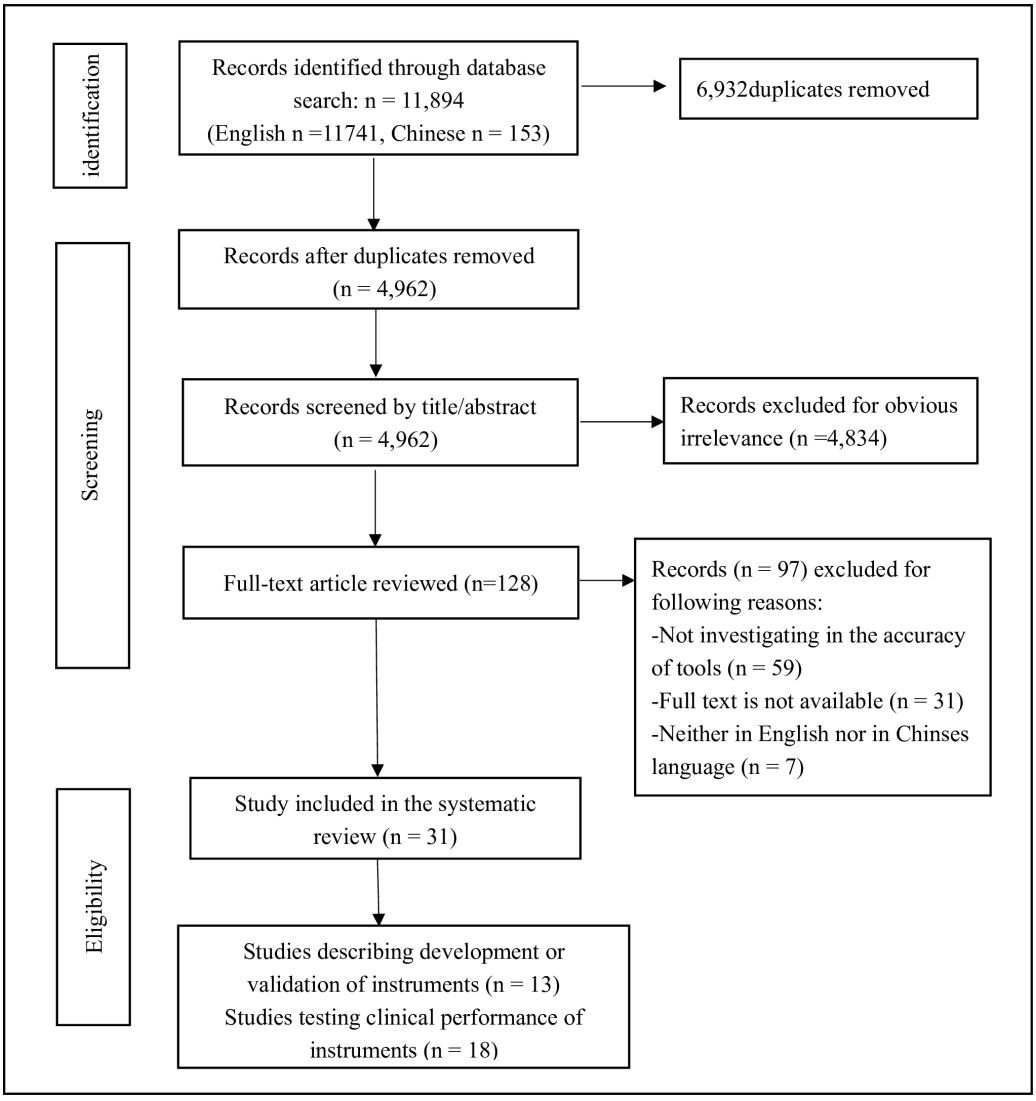

Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart of the study selection.

narrative synthesis was completed if data associated with the clinical performance of screening instruments was insufficient for meta-analysis.

RESULTS

As shown in figure 1, a total of 11 894 articles were initially retrieved, and 4962 articles remained after removing duplicates. After title and abstract screening, 128 articles remained. Following a full-text review, 31 articles were included, reporting seven screening instruments: the Gold Standards Framework Prognostic Indicator Guidance (GSF-PIG), the RADboud indicators for PAlliative Care needs (RADPAC), the Taiwanese version Palliative Care Screening Tool (TW-PCST), the Necesidades Paliativas (Palliative Needs) (NECPAL), the Supportive and Palliative Care Indicators Tool (SPICT), Rainone and AnticiPal. Out of the 31 articles, 13 reported the development and validation of these instruments,[17 18 34–44] while the other 18 articles focused on the clinical performance of the instruments.[14 15 45–60] The content validity of these seven screening instruments was doubtful or inadequate because of very low to moderate quality evidence. The quality of the clinical performance articles ranged from 6.5 to 8 (online supplemental appendix S2). There was no evidence for publication bias in the funnel plot (online supplemental appendix S3).

As indicated in table 1, the majority of the studies (17 studies, 94%) were observational. Follow-up times varied across the studies. No studies on the clinical performance of AnticiPal were retrieved.

We identified six studies that reported the clinical performance of SPICT in either hospital or primary care settings with follow-up periods of 6 months or 12 months. Among studies on SPICT, one was an RCT, and the remaining five were observational studies.[14 56–60] SPICT was used by a range of HCPs, including specialists, general practitioners, nurses and doctors.

Four observational studies evaluated the clinical performance of NECPAL in multiple settings (eg, hospital, nursing home and primary care centre)

Table 1 Characteristics of the clinical performance articles

Reference	Country	Study design	Versions of screening instruments used	Setting	Months of prognosis	Target diagnostic groups	Evaluators	Number of patients assessed	Age of patients (years) (mean±SD)	Per cent of patients identified by instruments as positive (%)
Rainone F *et al* 2007[15]	USA	A prospective observational study	Rainone	Primary care	NR	Any diagnosis	Family medicine staff	839	NR	25.9
Haga K *et al* 2012[45]	UK	A cohort study	GSF-PIG	NR	12	Chronic heart failure	NR	138	77±10.0	87.0
O'Callaghan A *et al* 2014[46]	New Zealand	A prospective cohort study	GSF-PIG	Acute hospital	12	Any diagnosis	Two palliative care experts (doctor and a nurse)	501	70.5±15.3	19.8
Raubenheimer PJ *et al* 2019[47]	South Africa	A cohort study	GSF-PIG	Hospital	12	Any diagnosis	Clinicians	822	52, IOR: 37–67	27.0
Gómez-Batiste X *et al* 2017[48]	Spain	A prospective cohort study	NECPAL	Three primary care centres, an acute bed hospital, four nursing homes and an intermediate care centre	24	Respiratory diseases	HCPs (doctors and nurses)	1059	81.4	73.7
Calsina-Berna A *et al* 2018[49]	Spain	A cohort study	NECPAL	Hospital	24	Advanced chronic disease	HCPs (doctors and nurses)	236	68.2±14.7	85.6
Gastelurrutia P *et al* 2019[50]	NR	A cohort study	NECPAL	Heart failure clinic	12	Heart failure	NR	922	69.3±12.2	24.3
Tabernero Huguet E *et al* 2021[51]	Spain	A prospective cohort study	NECPAL	Hospital respiratory unit	12	Respiratory diseases	Respiratory diseases	363	76±11.0	73.7
Wang SS *et al* 2019[52]	China Taiwan	A prospective cohort study	TW-PCST	Hospital	6	Any diagnosis	Nurses	21 596	58.8±24.5	27.0
Yen YF *et al* 2020[53]	China Taiwan	A cohort study	TW-PCST	Hospital	3	Any diagnosis	NR	47 153	61.7±19.3	25.0
Yen YF et al 2022[54]	China Taiwan	A prospective cohort study	TW-PCST	Hospital	12	Any diagnosis	Nurses	21 109	62.8±19.0	11.1
Yen YF et al 2022[55]	China Taiwan	A cohort study	TW-PCST	Hospital	6	Any diagnosis	Primary care nurses	111 483	60.9±19.1	4.5
De Bock et al 2017[57]	Belgium	A retrospective cohort study	SPICT	Hospital acute geriatric unit	12	Any diagnosis	Medical staff	435	84, IOR: 80–88	54.7
Mitchell GK *et al* 2018[56]	Australia	A randomised controlled trial	SPICT	NR	12	Any diagnosis	General practitioners	4365	79.1±6.9	33.6
van Wijmen MPS *et al* 2020[58]	The Netherlands	A prospective cohort study	SPICT-NL	General practice	12	Any diagnosis	General practitioners	3640	NR	13.7
Piers R *et al* 2021[60]	Belgium	A prospective cohort study	SPICT-FR and SPICT-NL	Hospital acute geriatric units and cardiology unit	12	Any diagnosis	Geriatrician	AGUs: 209 CUs: 249	NR	AGUs: 53.9 CUs: 40.6
Low J *et al* 2022[14]	UK	A prospective cohort study	SPICT	Hospital liver unit	12	Liver	Three expert palliative care/hepatology specialists	117	52.3±15.9	52.0
Chan AS *et al* 2022[59]	USA	A retrospective cohort study	SPICT	Community hospital	6	Advanced cancer	NR	227	66±9.7	60.0

AGUs, acute geriatric units ; CUs, cardiology units; GSF-PIG, Gold Standards Framework Prognostic Indicator Guidance; HCP, healthcare professional; IOR, interquartile range ; NECPAL, Necesidades Paliativas (Palliative Needs); NR, not reported; SPICT, Supportive and Palliative Care Indicators Tool; SPICT-FR, the French version of the Supportive and Palliative Care Indicators Tool; SPICT-NL, the Dutch version of the Supportive and Palliative Care Indicators Tool; TW-PCST, Taiwanese version Palliative Care Screening Tool.

Table 2 Main features of the identified screening instruments

	GSF-PIG	RADPAC	NECPAL	SPICT	TW-PCST	Rainone	AnticiPal
Year of development	2004	2012	2012	2011	2017	2007	2015
Country of development	UK	The Netherlands	Spain	UK	China	USA	UK
Methodology	NR	A procedure consisting of three steps: literature review, focus group, and modified and Delphi	Building on GSF-PIG and SPICT, a multidisciplinary panel of experts conducted semistructured interviews.	A literature review, peer review and prospective case investigation	NR	Multidisciplinary expert assessments	An iterative software development life-cycle approach for application creation
Application settings	All	Primary care	All	All	Hospital	General practice	General practice
Language of original version	English	Dutch	Spanish	English	Chinese	NA	NA
Languages of adapted versions	NR	NR	Portuguese, Israeli	Thai, Spanish, Italian, German, Swedish, Indonesian, Danish, Japanese, Nepali, Dutch, French, Greek, Portuguese	NR	NA	NA
Targeted diagnostic groups	All	Patients with COPD, congestive heart failure and cancer	All	All	All	All	All
Forms (traditional paper-based or electronic instruments)	Paper-based	Paper-based	Paper-based	Paper-based	Paper-based	Electronic instruments	Electronic instruments
Prognosis	NR	NR	NR	SPICT: Few minutes; SPICT-LIS: An average of 3.3 min; SPICT-ES: An average of 4 min and 45 s; SPICT-DE: An average of 7.5 min	An average of 5 min	NR	NR
Number of indicators	73 indicators in total, comprising 12 general indicators and 12 sets of specific indicators	21 indicators in total, distributed across 3 domains, with 6–8 items in each	59 indicators in total, comprising 12 general indicators and 9 sets of specific indicators	34 indicators in total, comprising 6 general indicators, 23 specific clinical indicators and 5 recommended indicators	26 indicators in total	6 indicators in total	NA
Inclusion of SQ	Yes	No	Yes	No	No	Yes	NA
Criteria for positive	The SQ response was 'No' and who presented ≥1 general indicator or ≥1 specific indicator	NR	The SQ response was 'No' and also the person presented with ≥1 other positive criterion	≥2 general indicators and ≥1 clinical indicators	The sum of the four parts scores ≥2 or 4 points	The SQ response was 'No' and/or answer affirmatively to any of items 2~5.	NR

COPD, chronic obstructive pulmonary disease; GSF-PIG, Gold Standards Framework Prognostic Indicator Guidance; NA, not applicable; NECPAL, Necesidades Paliativas (PalliativeNeeds); NR, not reported; RADPAC, RADboud indicators for PAlliative Care needs; SPICT, Supportive and Palliative Care Indicators Tool; SPICT-DE, the German version of the Supportive and Palliative Care Indicators tool ; SPICT-ES, the Spanish version of the Supportive and Palliative Care Indicators tool ; SPICT-LIS, The Supportive and Palliative Care Indicators Tool for Low-income setting; SQ, surprise question; TW-PCST, Taiwanese version Palliative Care Screening Tool.

with follow-up periods of 12 months or 24 months. NECPAL was used by either physicians or nurses.[49–51]

Four observational studies reported the clinical performance of TW-PCST.[52–55] These studies were conducted in hospitals settings, with follow-up periods ranging from 3 months to 12 months. TW-PCST was used by nurses in these studies.

Three observational studies used GSF-PIG to predict the12-month prognosis of patients in hospitals, with the evaluators being specialists and clinicians.[45–47]

A prospective observational study on Rainone was conducted in primary care settings, and patients were evaluated by family medical staff. The study did not report follow-up times.[15]

Development process of the screening instruments

Among the seven identified instruments, five were in the format of traditional paper-based screening instruments (SPICT, NECPAL, RADPAC, GSF-PIG and TW-PCST),[16–18 39 52] and two were in the format of electronic screening instruments (AncitiPal and Rainone).[15 61] Development of the traditional paper-based screening instruments involved a combination of literature review, expert consultation, focus group interviews and clinical trials. SPICT was developed in the UK through a literature review, peer expert review and prospective case finding. It is the most widely used instrument and is now available in 15 languages (eg, Italian, Thai, German, Spanish, Swedish, Danish and Indonesian).[34–38 40 42 43 62 63] The development of NECPAL was based on GSF-PIG and SPICT. NECPAL has been translated into Portuguese and Chilean.[41 44] RADPAC was developed through a process that included literature review, focus group discussions and a modified Rand Delphi approach. GSF-PIG was originally developed in English and translated into Italian in 2014.[64] We did not find detailed development information about GSF-PIG and TW-PCST. As for the electronic instruments, AncitiPal used an iterative software development life-cycle approach and analysed retrospective cases to create a computer software algorithm for the automatic identification of individuals with palliative care needs. Rainone used electronic medical records to identify the most common factors affecting inpatient mortality and built identification criteria on that basis, but detailed development information was not reported.

Characteristics of the screening instruments

The detailed characteristics of the seven screening instruments are shown in table 2. More detail information about the instruments can be found in online supplemental appendix S4. Except for RADPAC, all instruments include both general and disease-specific palliative care indicators.[15 16 18 39 52 61] All instruments are appropriate for patients with cancer, chronic obstructive pulmonary disease and congestive heart failure. All the included instruments except RADPAC

Table 3 Summary of psychometric properties of the identified screening instruments

	Development study		Content validity																	
			Relevance			Comprehensiveness			Comprehensibility			Structural validity			Internal consistency			Cross-cultural validity			Reliability			Measurement error			Criterion validity	
	MQ	QR	QR	Quality of evidences		QR	Quality of evidences		QR	Quality of evidences		QR	Quality of evidences		QR	Quality of evidences		QR	Quality of evidences		QR	Quality of evidences		QR	Quality of evidences		OR	Quality of evidences
GSF-PIG	NR		NR			NR			NR			NR			NR			NR			NR			NR		NR	
RADPAC	3	–	–	Low		–	Very low		–	Very low		NR			NR			NR			NR			NR		NR	
NECPAL	3	+	+	Low		±	Low		±	Low		NR			NR			NR			+	Moderate		NR		NR	
SPICT	3	+	±	Moderate		±	Moderate		–	Low		NR			+	Moderate		NR			+	Moderate		NR		NR	
TW-PCST	4	–	–	Very low		–	Very low		–	Very low		NR			NR			NR			NR			NR		NR	
Rainone	4	–	–	Very low		–	Very low		–	Very low		NR			NR			NR			NR			NR		NR	
AncitiPal	3	+	+	Moderate		–	low		–	low		NR			NR			NR			NR			NR		NR	

±, inconsistent; –, insufficient; +, sufficient; 1, very good, 2, sufficient, 3, doubtful, 4, inadequate; GSF-PIG, Gold Standards Framework Prognostic Indicator Guidance; MQ, measurement quality; NECPAL, Necesidades Paliativas (PalliativeNeeds); NR, not reported; QR, quality rating; RADPAC, RADboud indicators for PAlliative Care needs; SPICT, Supportive and Palliative Care Indicators Tool; TW-PCST, Taiwanese version Palliative Care Screening Tool.

are also appropriate for patients with cardiac, respiratory, neurological, liver and kidney disorders, and frailty. Three instruments (GSF-PIG, NECPAL and Rainone) include the surprise question (SQ) which asks the assessing clinician to consider likely death within a specified timeframe.[15 16 18] Four instruments (GSF-PIG, NECPAL, TW-PCST and AnticiPal) include indicators related to comorbidity.[16 18 52 61] Three instruments include psychological indicators (NECPAL, TW-PCST and Rainone).[15 18 52] GSF-PIG and NECPAL assess the occurrence of adverse events.[16 18] NECPAL considers request of palliative care service from both the patients and their families.[18] GSF-PIG is the only instrument that evaluates the financial conditions of patients.[16] SPICT provides recommendations for future care plans based on the results of assessment.[39]

Psychometric properties of the included instruments

The quality of evidence related to the development process and content validity was generally poor (table 3). Specific information regarding the quality of evidence can be found in online supplemental appendix S5. Only the articles of SPICT and NECPAL provided data on reliability or content validity of the instruments. Five studies reported the reliability of different versions of SPICT, with a range of 0.35–0.97 on the Kuder-Richardson formula 20,[37 38 42] a Kappa range of 0.66–0.98[36 38 42] and a Cronbach's alpha of 0.84.[63] The Content Validity Index (CVI) was only reported for the Italian-SPICT, which was 0.86.[36] One study reported a Kappa-adjusted CVI of 0.96 for the Israeli-NECPAL.[44] The reliability and content validity of TW-PCST, GSF-PIG, RADPAC and Rainone was not reported. According to the COSMIN methodology, no studies reported construct validity, cross-cultural validity assessment, measurement error and criterion validity of the identified instruments.

Clinical performance of the included instruments

Eighteen studies reported clinical performance for five instruments (GSF-PIG, SPICT, NECPAL, TW-PCST and Rainone). Detailed information on the clinical performance of each instrument can be found in online supplemental appendix S6. We found that different studies used different positive cut-off values (scores ≥2 or ≥ 4) for TW-PCST. In the meta-analysis, the Spearman correlation coefficient of TW-PCST was not statistically significant ($\rho=0.8$, $p=0.200>0.05$), indicating that there was no heterogeneity of threshold effect in the studies for TW-PCST.

A meta-analysis of pooled sensitivity (Se), pooled specificity (Sp), LR+, LR−, area under the receiver operating characteristics curve and DOR for each instrument revealed high heterogeneity (table 4). To identify the source of heterogeneity, we conducted a subgroup analysis of sensitivity, specificity, LR+, LR− and DOR, taking into account the setting and age of the population (table 5). The results indicated

Table 4 Details of clinical performance of the identified screening instruments

Screening instruments	Sensitivity % (95% CI) P value	Heterogeneity (I2), % (95% CI)	Specificity % (95% CI) P value	Heterogeneity (I2), % (95% CI)	LR+ (95% CI) P value	Heterogeneity (I2), % (95% CI)	LR− (95% CI) P value	Heterogeneity (I2), % (95% CI)	PPV (95% CI)	NPV (95% CI)	AUC (95% CI)	DOR (95% CI)
SPICT*	71.7 (57.5–82.6) p=0.000	94.06 (91.04 to 97.08)	78.0 (55.1–91.1) p=0.000	99.51 (99.40 to 99.62)	3.25 (1.64–6.47) p=0.000	97.66 (97.66 to 98.86)	0.36 (0.27–0.49) p=0.000	96.04 (94.27 to 97.82)	20.5 to 66.4	80.0 to 99.6	0.80 (0.76 to 0.83)	8.96 (4.67 to 17.20)
NECPAL*	73.8 (56.1–86.2) p=0.000	88.15 (83.09 to 93.02)	70.4 (47.4–86.3) p=0.000	96.81 (95.89 to 97.72)	2.50 (1.51–4.13) p=0.000	93.77 (93.77 to 96.82)	0.37 (0.26–0.52) p=0.000	77.97 (66.82 to 89.11)	21.9 to 72.2	61.9 to 96.2	0.78 (0.75 to 0.82)	6.73 (4.49 to 10.08)
TW-PCST*	60.0 (44.3–73.9) p=0.000	99.36 (99.13 to 99.58)	90.2 (82.3–94.7) p=0.000	99.94 (99.93 to 99.95)	6.10 (4.15–8.95) p=0.000	99.77 (99.77 to 99.85)	0.44 (0.32–0.61) p=0.000	98.83 (98.33 to 99.33)	22.8 to 34.1	94.9 to 98.1	0.85 (0.82 to 0.88)	13.71 (10.80 to 17.45)
GSF-PIG	63–83	NA	22–92	NA	1.06–7.73	NA	0.30–0.77	NA	33.0 to 67.7	75.0 to 93.0	NR	1.38 to 18.85
RADPAC	NR	NA	NR	NA	NR	NA	NR	NA	NR	NR	NR	NR
Rainone	94.0	NA	97.0	NA	31.33	NA	2.00	NA	36.0	99.0	NR	15.67
AnticiPal	NR	NA	NR	NA	NR	NA	NR	NA	NR	NR	NR	NR

*Pooled results in meta-analysis.

AUC, area under the receiver operating characteristics curve; DOR, diagnostic OR; GSF-PIG, Gold Standards Framework Prognostic Indicator Guidance; LR+, positive likelihood ratio; LR−, negative likelihood ratio; NA, not applicable; NECPAL, Necesidades Paliativas (Palliative Needs); NPV, negative predictive value; NR, not reported; PPV, positive predictive value; RADPAC, RADboud indicators for PAlliative Care needs; SPICT, Supportive and Palliative Care Indicators Tool; TW-PCST, Taiwanese version Palliative Care Screening Tool.

Table 5 Clinical performance of SPICT across setting and age of population

Subgroup		Sensitivity % (95% CI)	P value	Specificity % (95% CI)	P value	LR+ (95% CI)	LR− (95% CI)	DOR (95% CI)
Setting	Hospital	79.8 (72.6 to 85.5)	0.004	59.1 (52.2 to 65.1)	0.000	1.95 (1.64 to 2.32)	0.34 (0.24 to 0.48)	5.70 (3.51 to 9.28)
	Non-hospital	45.3 (30.2 to 61.4)		97.0 (95.7 to 97.9)		15.07 (8.97 to 25.34)	0.56 (0.42 to 0.76)	26.75 (12.44 to 57.41)
Age of population	Elderly patients	72.7 (55.5 to 85.0)	0.964	71.0 (44.1 to 88.4)	0.247	2.51 (1.34 to 4.69	0.38 (0.29 to 0.52)	6.52 (3.71 to 11.48)
	Non-elderly patients	72.0 (42.4 to 90.0)		90.2 (60.4 to 98.2)		7.33 (1.93 to 27.82)	0.31 (0.15 to 0.66)	23.64 (8.90 to 62.77)

DOR, diagnostic OR; LR–, negative likelihood ratio; LR+, positive likelihood ratio; SPICT, Supportive and Palliative Care Indicators Tool.

a significant difference in the sensitivity and specificity of the SPICT-setting subgroup (p=0.004 < 0.05), but significant heterogeneity was not presented for the age of the population. The clinical performance of SPICT was found to be better than other instruments (NECAPAL and TW-PCST) in hospital settings. In hospital settings, SPICT demonstrated a Se of 79.8% (95% CI 72.6% to 85.5%), a Sp of 59.1% (95% CI 52.2% to 65.1%), and a pooled DOR of 5.70 (95% CI 3.51 to 9.28). In contrast, when used in non-hospital settings, SPICT exhibited a Se of 45.3% (95% CI 30.2% to 61.4%), a Sp of 97.0% (95% CI 95.7% to 97.9%) and a pooled DOR of 26.75 (95% CI 12.44 to 57.41). However, due to the limited number of studies, we were not able to identify the source of heterogeneity for NECPAL and TW-PCST.

The clinical performances of GSF-PIG and Rainone were narratively summarised because of the small number of studies (table 4). The sensitivity of GSF-PIG ranged from 62.6% to 83%, specificity ranged from 22% to 91.9%, and DOR was between 1.38 and 18.85, which showed a wide variation in clinical performance. In the case of Rainone, an observational study reported a sensitivity of 94.0%, specificity of 97.0%, LR+of 31.33, LR− of 2.00 and DOR of 15.67.[15]

DISCUSSION

The systematic review identified and assessed psychometric properties and the clinical performance of seven screening instruments for early identification of patients with palliative care needs. The overall methodological quality of evidence related to the reliability and validity of screening instruments ranged from very low to moderate. Notably, the quality of evidence about NECPAL was rated as low, which is consistent with findings of previous reviews.[20 22] The quality of evidence regarding the content validity of SPICT was rated as 'moderate' in this review, but was rated as very low by Teike's review.[20] One possible reason for this discrepancy is that we included the validation studies of all versions of SPICT, but Teike's review only included the development study of the original version of SPICT. Additionally, we found that none of the screening instruments demonstrated high clinical performance, with a Se ranging from 60.0% (poor) to 73.8% (moderate).

This review found that none of the included instruments assessed all of the physical, psychological, social and spiritual domains of care. Palliative care is described as a holistic approach to care which addresses the needs of the whole individual.[65] According to the biopsychosocial-spiritual model, individuals' relationships should be considered when assessing holistically. Illness poses a disruption to the biological relationships, which in turn impacts all the other relational aspects of a person. Genuinely holistic healthcare will address the totality of the patient's relational existence—physical, psychological, social and spiritual concerns.[65 66] Palliative care screening instruments should identify the breadth of these concerns to effectively address the corresponding needs of patients. Second, psychological distress is multifaceted, but is also reflective of the interactions of the biopsychosocial-spiritual model. Many patients with advanced non-communicable diseases experience physical suffering leading to high levels of psychological distress.[67 68] Psychological distress may also stem from uncertainty about the future and fear of death.[69] Third, spiritual distress including deep internal questioning and struggles is prevalent in this group of patients,[70] which may frustrate attempts to treat physical and psychological symptoms and adversely affect the quality of life.[67 71] Finally, the social needs of an individual are crucial as the end of life approaches.[72] The need for support can affect the patient's physical functioning, quality of life, and psychological and spiritual status throughout the course of the disease. However, the need for social and spiritual support, and to a lesser extent psychological support are often overlooked in the evaluated instruments due to a focus on physical symptoms.[73] If a screening instrument only assesses one or two of these domains of care, patients may miss the optimal time to receive palliative care. To ensure timely access to palliative care that is responsive to the biopsychosocial-spiritual model, we recommend that screening instruments comprehensively assess physical, psychological, social and spiritual concerns.

To ensure the integrity of the content, it is equally important to select an appropriate theoretical framework such as the biopsychosocial-spiritual model to guide the development of instruments for palliative care.

In general, screening instruments are meant to have high sensitivity and high specificity. The SPICT used in hospital settings was the best performing screening instrument. In the included articles, SPICT and NECPAL were evaluated by physicians and nurses, whereas TW-PCST was solely evaluated by nurses. However, it is unclear whether physicians are more accurate than nurses in identifying patients in need of palliative care. The sensitivity of SPICT was better than that of NECPAL in hospitals maybe because SPICT does not include the SQ. The SQ relies on HCPs' subjective intuition and is largely influenced by patients' disease trajectory and depends on the HCP's skill in prognostication.[74] The palliative care population involves patients with cancer and non-cancer patients, including those with frailty and dementia.[5 75] The trajectories of both cancer and non-cancerous diseases are highly variable, and the prognosis is often difficult to estimate.[76 77] A previous meta-analysis claimed that the ability to identify the palliative care population SQ was slightly better among patients with cancer compared with patients not diagnosed with cancer.[74] Another reason is the unreliability of HCPs' subjective judgements. The judgements are often based on clinical experience,[56] but some HCPs do not have sufficient clinical experience to make reliable judgements. The use of SQ increases 'false positives', suggesting that a large number of patients who do not necessarily need palliative care are identified as positive.[78]

The clinical performance of the included instruments was assessed based on mortality/prognosis prediction. However, identifying those individuals who would benefit from palliative care should be focused on recognising unmet needs in a holistic needs-based assessment rather than on predicting the rate of physical deterioration or projected survival.[23] When prognosis is used as a contributing characteristic to identify the need for palliative care, the complex and diverse disease trajectories pose difficulties for HCPs in identifying those who could potentially benefit from palliative care needs. On the other hand, use of a mortality/prognosis prediction model may encourage clinicians to focus on when to start 'planning for death' and may lead to delayed reviews of unmet needs and care of goals until the very last stages of a patient's life.[39 76 79] Furthermore, use of mortality/prediction as an indicator of the clinical performance could also mistakenly screen out some patients with palliative care needs.

This review emphasises that the screening instrument is intended to provide a framework for raising HCPs' awareness of the increasing disease burden in patients and to identify patients with potential palliative care needs early. This approach motivates both patients and clinicians to consider palliative care as an option and to conduct holistic assessments at any point the need arises. It ensures that patients receive the appropriate care at the right time, according to their wishes and preferences.

This review focuses on the content, reliability, validity and clinical performance of existing screening instruments for the early identification of people in need of palliative care. Our study has identified instruments which can be applied in various settings, including hospitals, communities and homes. Because there is no uniform reference standard to evaluate whether screening instruments have the ability to identify people with genuine palliative care needs, we used sensitivity and specificity to evaluate the clinical performance of these instruments. Our study showed that the sensitivity of SPICT is the highest performing of the extant screening instruments when used within hospital settings. Palliative care has long been practised in non-hospital settings (eg, community and home), however, only a small number of studies of SPICT have reported its application in these settings.

Strengths and weaknesses

To our knowledge, this is the first comprehensive systematic review focusing on the clinical performance of screening instruments for the early identification of patients with palliative care needs. We used a comprehensive strategy to identify relevant research, including a secondary search using instrument names. We used sensitivity as a reference to compare the clinical performance of the screening instruments.

However, our study has some limitations. First, this review only included studies published in peer-reviewed journals in English or Chinese. Therefore, instruments and studies published in other languages were omitted. Second, the meta-analysis only included a small number of high-quality studies. Therefore, this result should be interpreted with caution. Subgroup analysis was only performed for SPICT based on different care settings and age groups. It is unclear whether there are other factors that can influence the clinical performance of the instrument. More studies are clearly needed to validate these instruments for the early identification of patients with palliative care needs.

CONCLUSION

The seven included instruments in this study have a low to moderate clinical performance and none comprehensively assess physical, psychological, social and spiritual problems. SPICT is the most commonly used instrument and has a relatively better ability to identify patients' palliative care needs early in the hospital setting compared with other settings and other instruments. To better support early identification of palliative care patients, further work is needed to refine the content of the existing instruments to more

systematically and accurately assess patients. Moreover, early identification of palliative care patients should shift from estimating when a patient will die to identifying the unmet palliative care needs.

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Contributors All authors have participated in the study and have read and approved the submitted version of the manuscript. ZX designed the study, developed the search terms, reviewed articles, analysed data and drafted the articles; JD supervised the study design, contributed to the methods and critically revised the articles; JJ reviewed the articles and contributed to data analysis; ST supervised the study design and critically revised the articles; CH supervised the study design, contributed to the methods and critically revised the articles. ST is the guarantor.

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Appendix S1 Search strategy

("palliative care"[MeSH Terms] OR "palliative care"[Title/Abstract] OR "advance care planning"[MeSH Terms] OR "advance care plan*"[Title/Abstract] OR "terminal care"[MeSH Terms] OR "terminal care"[Title/Abstract] OR "terminally ill"[MeSH Terms] OR "terminally ill"[Title/Abstract] OR ("hospices"[MeSH Terms] OR "hospice care"[MeSH Terms]) OR "hospice"[Title/Abstract] OR "hospice care"[MeSH Terms] OR "hospice care"[Title/Abstract] OR "life support care"[MeSH Terms] OR "life support care"[Title/Abstract] OR "death"[MeSH Terms] OR "death"[Title/Abstract] OR "palliat*"[Title/Abstract] OR "advance directives"[Title/Abstract] OR "end of life care"[Title/Abstract] OR "supportive care"[Title/Abstract] OR ("last"[All Fields] AND "months of life"[Title/Abstract]) OR "last year of life"[Title/Abstract] OR "life-limiting"[Title/Abstract] OR "life-threatening"[Title/Abstract] OR "deterioration"[Title/Abstract])
AND
("screening tools"[Title/Abstract] OR "tool*"[Title/Abstract] OR "instrument"[Title/Abstract] OR "assessment"[Title/Abstract] OR "guidance"[Title/Abstract] OR "guideline"[Title/Abstract] OR "indicator"[Title/Abstract] OR "risk assessment"[MeSH Terms] OR "risk assessment"[Title/Abstract] OR "mass screening"[MeSH Terms] OR "mass screening"[Title/Abstract] OR "screen*"[Title/Abstract] OR ("diag*"[All Fields] AND "tool"[Title/Abstract]) OR "evaluation"[Title/Abstract] OR ((("ieee int conf automation sci eng case"[Journal] OR "case phila"[Journal] OR "case"[All Fields]) AND "n3"[All Fields]) AND "finding"[Title/Abstract]))
AND
("early identification"[Title/Abstract] OR "early identifying"[Title/Abstract] OR "early recognition"[Title/Abstract] OR "timely identification"[Title/Abstract] OR "timely assessment"[Title/Abstract] OR (("identif*"[All Fields] AND "n3"[All Fields]) AND "palliative"[Title/Abstract]) OR (("identif*"[All Fields] AND "n3"[All Fields]) AND "tool"[Title/Abstract]) OR (("identif*"[All Fields] AND "n3"[All Fields]) AND "instruments"[Title/Abstract]) OR (("identif*"[All Fields] AND "n3"[All Fields]) AND "dying"[Title/Abstract]) OR ("identif*"[All Fields] AND "n3 patients"[Title/Abstract]))

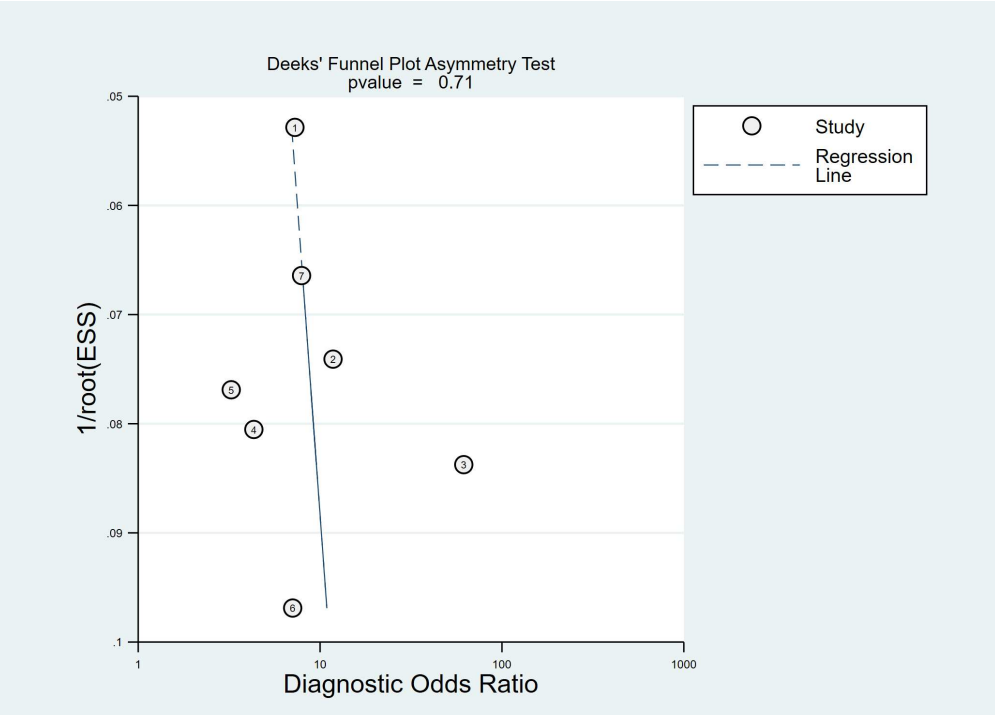
Appendix S2 Risk of bias for the included studies (Cohort study)

	Quality Rating Questions										
First author,Year	1	2	3	4	5	6	7	8	Score 1	Score 2	Mean
Rainone 2007	a*	a*	a*	a*	none	b*	a*	d	6	7	6.5
Haga 2012	b*	a*	a*	a*	none	b*	a*	a*	7	5	6
O'Callaghan 2014	a*	a*	a*	a*	none	a*	a*	a*	7	7	7
Raubenheimer 2019	b*	a*	a*	a*	none	b*	a*	b*	7	7	7
Gómez-Batiste 2017	a*	a*	a*	a*	none	b*	a*	b*	7	7	7
Calsina-Berna 2018	a*	a*	a*	a*	b**	a*	a*	a*	9	7	8
Gastelurrutia 2019	a*	a*	a**	a*	none	a*	a*	d	7	7	7
TabberneroHuguet 2020	c	a*	a*	a*	b*	a*	a*	d	6	8	7
Wang 2019	a*	a*	d	a*	b*	a*	a*	a*	7	7	7
Yen 2020	a*	a*	a*	a*	b**	b*	a*	b*	9	7	8
Yen 2022	a*	a*	a*	a*	b**	b*	a*	b*	9	7	8
Yen 2022	a*	a*	a*	a*	b**	b*	a*	d	8	7	7.5
DeBock 2017	a*	a*	a*	a*	none	a*	a*	d	6	7	6.5
SyChan 2020	a*	a*	a*	a*	none	a*	a*	a*	7	7	7
Piers 2021	b*	a*	a*	a*	none	a*	a*	a*	7	6	6.5
VanWijmen 2021	a*	a*	a**	a*	none	b*	a*	b*	8	7	7.5
Low 2021	b*	a*	a*	a*	none	a*	a*	d	6	8	7

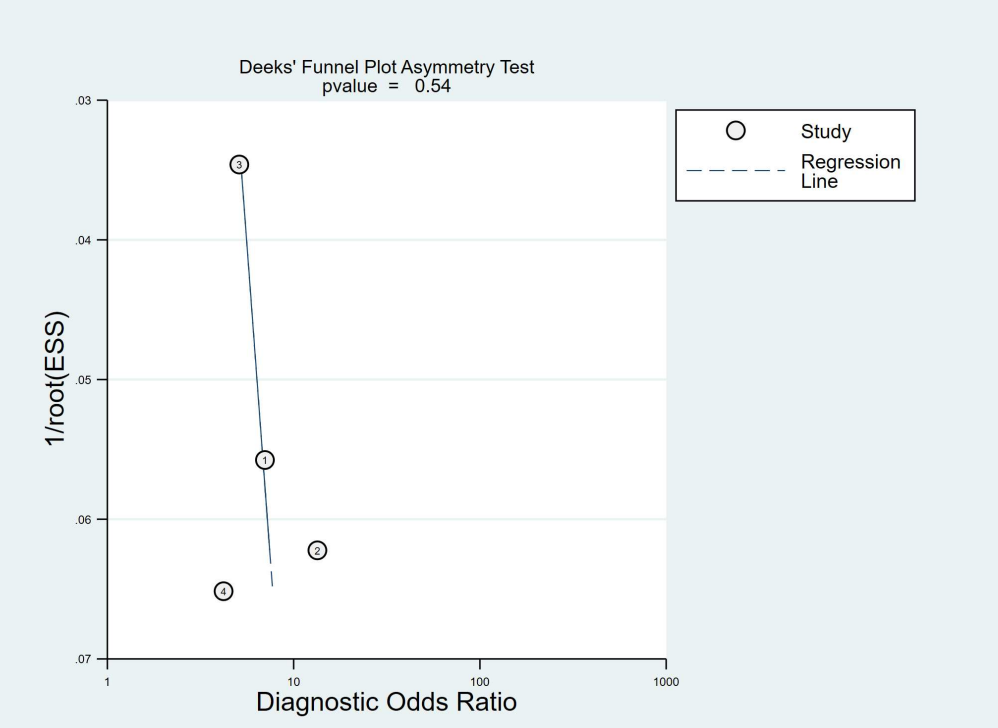
Appendix S2 Risk of bias for the included studies (RCT study)

	Bias					
First author, Year	Selection bias (Random sequence generation)	Selection bias (Allocation concealment)	Blinding of participants and researchers	Detection bias (Blinding of outcome assessment)	Attrition bias (Incomplete outcome data)	Reporting bias (Selective reporting)
Mitchell 2018	High risk	Unclear risk	Low risk	Low risk	Low risk	Unclear risk

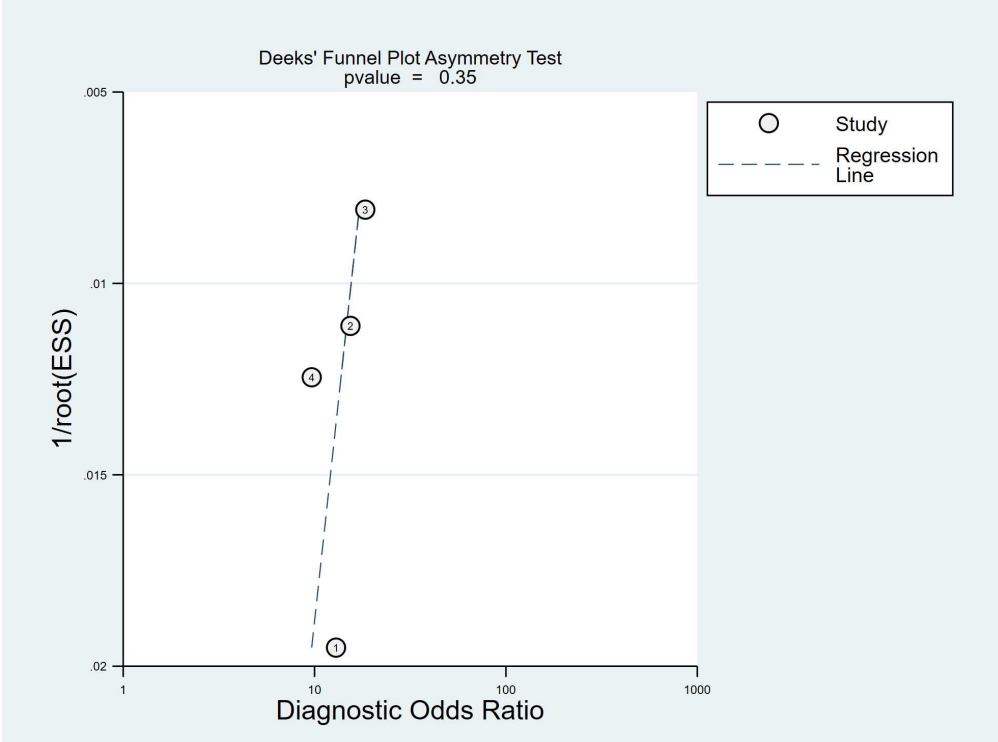
Appendix S3 Publication bias of SPICT



Appendix S3 Publication bias of NECPAL



Appendix S3 Publication bias of TW-PCST



Appendix S4 Main features of the identified screening instruments (Continued)

	GSF-PIG	RADPAC	NECAPL	SPICT	TW-PCST	Rainone	Anticipal
General indicators							
Functional performance	General physical decline; Spends 50% of the day in bed or chair; Experiencing increased dependence on most daily activities;	NM	Karnofsky or Barthel score > 30%; Loss more than 2 activities of daily living; Persistent symptoms;	Poor performance status; Spends 50% of the day in bed or chair;	Assessing performance status using ECOG scale.	Karnofsky score > 50%; Loss ≥2 activities of daily living; ECOG score≤3;	The entry indicates a very poor code
Unplanned hospital admissions	Repeated	NM	More than 2 unplanned hospital admittances at last 6 months.	Unplanned hospital admissions;	More than 6 hospital admissions for the same diagnosis in the past 30 days; An ICU stay exceeding 30 days with a poor prognosis or ineffective treatment;	Recurrent or extended hospital admissions for the same illness in the past 12 months	NM
Symptom burden	Unstable, deteriorating, complex symptom burden	NM	NM	Persistent symptoms despite optimal but ineffective treatment.	Unacceptable pain	NM	NM
Specific clinical indicators	Cancer, General Neurological, CHF, COPD, Liver disease, Frailty, Dementia, Stroke, Kidney disease, Parkinson's disease, Motor Neurological disease, Multiple Sclerosis	Cancer, COPD, CHF	Cancer, COPD, CHF, Dementia, Frailty, Stroke, Chronic Neurological Diseases, Chronic Liver disease, Chronic kidney disease	Cancer, Heart/ vascular disease, kidney disease, Dementia/Frailty, Respiratory disease, Liver disease, Neurological disease	2 points for any of the following: Cancer, COPD, Liver disease, Kidney dialysis, Cardiac disease, Neurologic disease (stroke, coma, dementia), ARDS, Sepsis, or MODS	AIDS, Cancer, CHF, COPD, Dementia	Cancer, Heart/ vascular disease, Dementia, Frailty, Stroke, Kidney disease, Liver disease

(Continued)

Appendix S4 Main features of the identified screening instruments (Continued)

	GSF-PIG	RADPAC	NECPAL	SPICT	TW-PCST	Rainone	Anticpal
Comorbid illness	Significant multi-morbidities	NM	>2 chronic diseases	NM	1 point for each cancer and five comorbidities	NM	Codes indicating multi-organ failure and multiple morbidity
Psychosocial aspects	NM	NM	Cognitive decline: Loss > minimental or > 3 Pfeiffer; Detection of Emotional Distress Scale (DME) > 9	NM	Psycho-spiritual problems out of control	Patients or family members are frustrated after an acute illness attack because the results are not optimal after the best treatment.	NM
Adverse events happen	Seriously fall, bereavement, transfer to nursing home	NM	Geriatric Syndromes (≥ 2 geriatric syndromes (recurrent or persistent)	NM	NM	NM	NM
Choosing palliative care	Choosing no further active treatment	NM	Limitations of therapeutic effort were mentioned by patients, family or team members.	Patients request palliative care or reduce treatment or wish focus on quality of life.	Patients/family/team need help with complex decision making and goal setting.	NM	NM
Others	Considered eligible for DS1500 payment.	NM	Demand: Have the patient, family, or team members made any requests to limit treatment or palliative care? Need: Identified by healthcare professors	The carter needs more help. Care Plan Recommendations.	NM	NM	NM

ARDS, acute respiratory distress syndrome; COPD, chronic obstructive pulmonary disease; CHF, Congestive heart failure; MODS, multiple organ dysfunction syndrome; GSF-PIG, Gold Standards Framework Prognostic Indicator Guidance; NECPAL, Necesidades Paliativas [PalliativeNeeds]; RADPAC, RADboud indicators for PAlliative Care needs; SPICT, Supportive and Palliative Care Indicators Tool; TW-PCST, Taiwanese version Palliative Care Screening Tool; SQ, Surprise Question; DS1500, a medical report that enables advanced diseases patients in the UK to access social care; NR, not reported; NM, not mentioned; NA, not applicated;

Appendix S5 Summary of the psychometric properties of screening instruments for early identification of patients in need of palliative care

	Reference (Country)	Content validity						Structural validity		Internal consistency		Cross-cultural validity		Reliability		Measurement error		Criterion validity	
		Relevance		Comprehensiveness		Comprehensibility													
		MQ	QR	MQ	QR	MQ	QR	MQ	OR	MQ	QR	MQ	QR	MQ	QR	MQ	OR	MQ	QR
GSF-PIG	UK	NR		NR		NR		NR		NR		NR		NR		NR		NR	
	Italia	NR		NR		NR		NR		NR		NR		NR		NR		NR	
RADPAC	Netherland	3	-	3	-	3	-	NR		NR		NR		NR		NR		NR	
NECPAL	Spain	3	+	3	+	3	+	NR		NR		NR		NR		NR		NR	
	Portugal	3	±	3	±	3	?	NR		NR		NR		NR		NR		NR	
	Israel	3	+	2	+	3	?	NR		NR		NR		1	+	NR		NR	
SPICT	UK	3	±	3	-	3	-	NR		NR		NR		NR		NR		NR	
	German	3	±	3	?	3	-	NR		NR		NR		NR		NR		NR	
	Spain	3	±	3	-	3	-	NR		2	+	NR		2	+	NR		NR	
	Italia	2	+	2	+	2	+	NR		1	+	NR		2	+	NR		NR	
	Thailand	2	+	2	+	3	+	NR		2	-	2	+	2	+	NR		NR	
	Denmark	3	±	2	+	3	-	NR		NR		NR		NR		NR		NR	
	Sweden	2	±	3	-	3	-	NR		NR		NR		NR		NR		NR	
	Indonesia	3	?	3	?	3	?	NR		2	+	NR		1	+	NR		NR	
	Japan	3	±	3	?	3	-	NR		NR		NR		NR		NR		NR	
	Chile	3	?	3	?	4	-	NR		1	+	NR		NR		NR		NR	
TW-PCST	China Taiwan	4	?	4	?	4	?	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Rainone	USA	4	?	4	?	4	?	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
AncitiPal	UK	2	-	2	-	3	-	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	

MQ, measurement quality; QR, quality rating; NR, not reported

1 = very good, 2 = sufficient, 3 = doubtful, 4 = inadequate;

+, sufficient; −, insufficient; ±, inconsistent; ? indeterminate

Appendix S6 Details clinical performance of the identified screening instruments reported in performance studies

Reference (Author, Year)	Screening instruments	Time frame of instruments	No. patients assessed (n)	No. Identified/Not identified (n)	No. patients died (n)	No. patient survival(n)	Sensitivity% (95% CI)	Specificity% (95% CI)	LR+ (95% CI)	LR- (95% CI)	PPV% (95% CI)	NPV% (95% CI)	c-statistic (95% CI)	DOR
Haga K et al 2014[49]	GSF-PIG	12-month	138	110 28	36 7	74 21	83.0	22.0	1.06	0.77	33.0	5.0	NR	1.38
O'Callaghan A et al 2014[50]	GSF-PIG	12-month	501	99 402	67 40	32 362	62.6	91.9	7.73	0.41	67.7	90.0	NR	18.85
Raubenheimer PJ et al 2019[51]	GSF-PIG	12-month	822	218 604	122 42	98 562	74.0 (68.0-81.0)	85.0 (83.0-88.0)	5.10 (4.15-6.26)	0.30 (0.23-0.39)	56.0 (49.0-63.0)	93.0 (91.0-95.0)	NR	17.00
Gómez-Batiste X et al 2017[52]	NECPAL	12-month	1059	780 279	261 25	519 254	91.3 (87.2-94.2)	32.9 (29.6-36.3)	1.36	0.26	33.5 (30.2-36.9	91.0 (86.9-94.0)	NR	5.23
Calsina-Berna A et al 2018[53]	NECPAL	12-month	236	97 139	70 53	27 86	56.9	76.1	2.38	0.57	72.2	61.9	0.665	4.18
Gastelurruti P et al 2019[54]	NECPAL	12-month	922	897 625	65 24	232 601	73.0	72.1	2.62	0.37	21.9	96.2	0.73 (0.68-0.78)	7.08
Tabernero Huguet E et al 2020[55]	NECPAL	12-month	363	87 276	54 30	33 246	64.3	88.2	5.70	0.43	62.1	89.1	NR	13.23
De Bock et al 2017[61]	SPICT	12-month	410	228 182	111 21	117 161	84.1	57.9	4.23	0.58	48.7	88.5	NR	7.29
Mitchell GK et al 2018[60]	SPICT	12-month	1525	78 1447	16 31	31 1416	34.0 (25.3-42.8)	95.8 (93.0-98.6)	8.10	0.65	20.5 (12.6-28.4)	97.9 (96.8-99.0)	NR	12.46
van Wijmen MPS et al 2020[62]	SPICT-NL	12-month	3640	101 3539	21 15	80 3524	58.0 (43.0-73.0)	98.0 (97.0-98.0)	29.00	0.43	20.8	99.6	NR	67.44

(Continued)

Appendix S6 Details clinical performance of the identified screening instruments reported in performance studies (Continued)

Reference (Author, Year)	Screening instruments	Time frame of instruments	No. patients assessed (n)	No. Identified/Not identified (n)	No. patients died (n)	No. patient survival(n)	Sensitivity% (95% CI)	Specificity% (95% CI)	LR+ (95% CI)	LR- (95% CI)	PPV% (95% CI)	NPV% (95% CI)	c-statistic (95% CI)	DOR
Piers R et al 2021[64](AGUs)	SPICT-FR and SPICT-NK	12-month	209	124 85	42 9	82 76	82.4	48.1	1.59	0.37	33.9	89.3	0.822	4.30
Piers R et al 2021[64] (CUs)	SPICT-FR and SPICT-NK	12-month	249	101 148	34 20	67 128	63.0	65.6	1.83	0.56	33.7	86.8	0.651	3.28
Low J et al 2021[21]	SPICT	12-month	117	61 56	33 8	28 48	80.5 (65.1-91.2)	63.2 (51.3-73.9)	2.19	0.31	54.1 (40.8-66.9)	85.7 (73.8-93.6)	0.718 (0.636-0.800)	7.06
Chan AS et al 2022[63]	SPICT	6-month	227	137 90	91 18	46 72	83.5	61.0	2.14	0.27	66.4	80.0	NR	7.93
Wang SS et al 2019[56]	TW-PCST	6-month	8493	2568 5925	585 132	1983 5793	81.6	74.5	3.20	0.25	22.8	97.8	0.84 (0.83-0.86)	12.80
Yen YF et al 2020[57]	TW-PCST	3-month	47153	4897 42256	1225 896	3672 41360	57.8	91.8	7.05	0.46	25.0	97.9	NR	15.33
Yen YF et al 2022[59]	TW-PCST	6-month	111483	7428 104055	1973 2005	5455 102050	49.6 (48.0-51.1)	94.9 (94.8-95.1)	9.73	0.53	26.6 (25.8-27.4)	98.1 (98.0-98.2)	0.723	18.36
Yen YF et al 2022[58]	TW-PCST	12-month	21109	2363 18746	806 953	1557 17793	45.8 (43.4-48.2)	92.0 (91.6-92.4)	5.73	0.59	34.1 (32.6-35.7)	94.9 (94.7-95.2)	0.689 (0.677-0.701)	9.71
Rainone F et al 2007[22]	Rainone	NR	839	NR	NR	NR	94.0	97.0	31.33	2.00	36.0	99.0	NR	15.67

DOR, diagnostic odds ratio; LR+, positive likelihood ratio; LR–, negative likelihood ratio; NPV, negative predictive value; PPV, positive predictive value; GSF-PIG, Gold Standards Framework Prognostic Indicator Guidance; NECPAL, Necesidades Paliativas [PalliativeNeeds]; RADPAC, RADboud indicators for PAlliative Care needs; SPICT, Supportive and Palliative Care Indicators Tool; TW-PCST, Taiwanese version Palliative Care Screening Tool; NR = not reported