National Institute for Health and Care Excellence

Draft for consultation

Metastatic spinal cord compression

[L] Evidence reviews for Prognostic tools - overall survival

NICE guideline number tbc

Evidence reviews underpinning recommendations 1.9.2 and 1.9.3 in the NICE guideline

March 2023

Draft for consultation

These evidence reviews were developed by NICE

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Prognostic tools - overall survival

Review question

What is the prognostic value of validated scoring systems for determining survival in people with spinal cord compression caused by spinal metastases or direct malignant infiltration of the spine?

Introduction

Prognostic scores to estimate survival have been proposed to help inform treatment choices for people with spinal cord compression and spinal metastases. The aim of this review was to evaluate these scoring systems by summarising the accuracy of their survival predictions.

Summary of the protocol

See Table 1 for a summary of the Population, Index test (clinical prediction model) and Outcome (PIO) characteristics of this review.

Table 1: Summary of the protocol (PIO table)

Population	• Adults with:
	  ○ metastatic spinal disease
	  ○ direct malignant infiltration of the spine
	• Adults with confirmed spinal cord or nerve root compression because of
	  ○ metastatic spinal disease
	  ○ direct malignant infiltration.

Index test (clinical prediction model)	Scoring systems to predict survival of patients with spinal metastases or direct malignant infiltration, for example: • Tokuhashi • Tomita • Sioutos • Bauer • North • Van der Linden • ECOG performance status
Outcome	**Critical** Accuracy of the scoring system for: • Overall survival **Important** Accuracy of the scoring system for: • Pain • Event-free survival • Survival duration • Neurological and functional status • Quality of life

ECOG: Eastern Cooperative Oncology Group

For further details see the review protocol in appendix A.

Methods and process

This evidence review was developed using the methods and process described in Developing NICE guidelines: the manual. Methods specific to this review question are described in the review protocol in appendix A and the methods document (supplementary document 1).

Declarations of interest were recorded according to NICE's conflicts of interest policy.

Prognostic evidence

Included studies

Twenty-five studies were included for this review, all were retrospective cohort studies (Ahmed 2018, Balain 2013, Denisov 2020, Eap 2015, Gakhar 2012, Gruenberg 2017, Iinuma 2021, Kumar 2014, Mollahoseini 2011, Park 2015, Pelegrini de Almeida 2018, Petteys 2015, Quraishi 2013, Ribas 2016, Tabourel 2021, Tabouret 2015, Tan 2016a, Tan 2016b, Tan 2018, Ulmar 2007, Wang 2012, Westerman 2020, Yang 2021, Yeung 2014, Yu 2015).

These studies reported the following prognostic tools for predicting survival: Bauer, Lei, Modified Bauer, Modified Tokuhashi revised, Oswestry Spinal Metastasis Risk Index, Rades, Revised Tokuhashi, SORG Classic scoring algorithm, SORG nomogram, SORG-ML, SSG, Tokuhashi, Tomita, and Van der Linden.

Seventeen studies were in patients undergoing surgery for spinal metastases (Ahmed 2018, Eap 2015, Gakhar 2013, Gruenberg 2017, Iinuma 2021, Park 2015, Pelegrini de Almeida 2018, Petteys 2015, Quraishi 2013, Ribas 2016, Tabourel 2021, Tabouret 2015, Wang 2012, Westermann 2020, Yang 2021, Yeung 2014, Yu 2015).

Eight studies were in patients with spinal metastases (Balain 2013, Denisov 2020, Kumar 2014, Mollahoseini 2011, Tan 2016a, Tan 2016b, Tan 2018, Ulmar 2007).

Two studies were in people with nasopharyngeal carcinoma (Kumar 2014, Tan 2016a), 2 in people with lung cancer (Tan 2016b, Yu 2015), 1 in renal cell cancer (Petteys 2015), 1 in breast cancer (Tan 2018) and the remaining 19 in people with any primary (Ahmed 2018, Balain 2013, Denisov 2020, Eap 2015, Gakhar 2012, Gruenberg 2017, Iinuma 2021, , Mollahoseini 2011, Park 2015, Pelegrini de Almeida 2018, Quraishi 2013, Ribas 2016, Tabourel 2021, Tabouret 2015, Ulmar 2007, Wang 2012, Westerman 2020, Yang 2021, Yeung 2014).

The studies were carried out in the USA (Ahmed 2018, Petteys 2015), UK (Balain 2013, Gakhar 2013, Quraishi 2013), Germany (Ulmar 2007, Westermann 2020), Denmark (Wang 2012), France (Eap 2015, Tabourel 2021, Tabouret 2015), Russia (Denisov 2020), Argentina (Guenberg 2017), Brazil (Pelegrini de Almeida 2018, Ribas 2016), Singapore (Kumar 2014, Tan 2016a, Tan 2016b, Tan 2018), Japan (Iinuma 2021), Taiwan (Yang 2021), China (Yeung 2014, Yu 201), Iran (Mollahoseini 2011), and Korea (Park 2015).

The included studies are summarised in Table 2.

See the literature search strategy in appendix B and study selection flow chart in appendix C.

Excluded studies

Studies not included in this review are listed, and reasons for their exclusion are provided in appendix K.

Summary of included studies

Summaries of the studies that were included in this review are presented in Table 2.

Table 2: Summary of included studies.

Study	Population	Prognostic tools	Outcomes
Ahmed 2018 Observational study USA	N=176 Patients undergoing surgery for metastatic spine disease. Age, mean, years (SD): 60 (12). Sex: female n=71; male n=105.	• SORG Classic scoring algorithm • SORG nomogram • Tokuhashi • Revised Tokuhashi • Tomita • van der Linden • Katagiri • Bauer • Modified Bauer	Accuracy of the scoring system for spinal stability: • AUC
Balain 2013 Observational study UK	N=199 Patients with spinal metastases. Age, mean, years (SD): 61.6 (12.5). Sex: female n=81; male n=118.	• Modified Bauer • Tokuhashi • Tomita	Accuracy of the scoring system for spinal stability: • AUC
Denisov 2020 Observational study Russia	N=138 Patients with spinal metastases. Age, median, years (95% CI): 57 (56 – 59). Sex: female n=102; male n=36.	• Katagiri • Tokuhashi • Tomita	Accuracy of the scoring system for spinal stability: • AUC
Eap 2015 Observational study France	N=260 Patients with spinal metastases undergoing surgery. Age, mean, years (SD): 59 (11). Sex: female n=143; male n=117.	• Tokuhashi	Accuracy of the scoring system for spinal stability: • Predicted and observed survival
Gakhar 2013 Observational study UK	N=90 Consecutive patients undergoing treatment for spinal metastases (surgery, kyphoplasty, transpedicular biopsy). Age, mean, years (range): 64 (32 – 88).	• Modified Tokuhashi.	Accuracy of the scoring system for spinal stability: • Predicted and observed survival

Study	Population	Prognostic tools	Outcomes
	Sex: female n=45; male n=45.		
Gruenberg 2017 Observational study Argentina	N=105 Patients undergoing surgical treatment for vertebral metastases. Age, mean, years (range): 61.5 (16 – 86). Sex: female n=44; male n=61.	• Tokuhashi	Accuracy of the scoring system for spinal stability: • Predicted and observed survival
Iinuma 2021 Observational study Japan	N=85 Patients undergoing surgery for spinal metastases. Age, mean, years (range): 62.4 (26 – 85). Sex: female n=37; male n=48.	• Tokuhashi	Accuracy of the scoring system for spinal stability: • Predicted and observed survival
Kumar 2014 Observational study Singapore	N=87 Patients with spinal metastases from nasopharyngeal carcinoma. Age, mean, years (range): 52 (26–90). Sex: female n=19; male n=68.	• Modified Bauer. • Revised Tokuhashi • Tomita	Accuracy of the scoring system for spinal stability: • AUC
Mollahoseini 2011 Observational study Iran	N=109 Patients with spinal metastases. Age, mean, years (SD): 57 (12). Sex: female n=56; male n=53.	• Revised Tokuhashi	Accuracy of the scoring system for spinal stability: • Predicted and observed survival
Park 2015 Observational study Korea	N=145 Patients undergoing surgical treatment for spinal metastases. Age, mean, years (SD): 60.0 (10.9).	• Tokuhashi	Accuracy of the scoring system for spinal stability: • Predicted and observed survival

Study	Population	Prognostic tools	Outcomes
	Sex: female n=49; male n=96.		
Pelegrini de Almeida 2018 Observational study Brazil	N=117 Patients undergoing surgical treatment for spinal metastases. Age, mean, years (SD): 56 (12). Sex: female n=68; male n=49.	• Tokuhashi	Accuracy of the scoring system for spinal stability: • Predicted and observed survival
Petteys 2015 Observational study USA	N=30 Patients undergoing surgical treatment for renal cell carcinoma spinal metastases. Age, mean, years (range): 57.6 (29 – 79). Sex: female n=7; male n=23.	• Revised Tokuhashi	Accuracy of the scoring system for spinal stability: • Predicted and observed survival
Quraishi 2013 Observational study UK	N=201 Patients with spinal metastases managed surgically. Age, mean, years (range): 61 (18 – 86). Sex: female n=74; male n=127.	• Revised Tokuhashi	Accuracy of the scoring system for spinal stability: • Predicted and observed survival
Ribas 2016 Observational study Brazil	N=17 Patients undergoing surgery for spinal cord epidural metastasis. Age, mean, years (range): 65 (29-77). Sex: female n=3; male n=14.	• Bauer. • Revised Tokuhashi. • Tomita.	Accuracy of the scoring system for spinal stability: • Predicted and observed survival
Tabourel 2021 Observational study France	N=739 Patients treated surgi-cally for spinal metas-tasis (decompressive and/or stabilisation sur-	• Bauer • Lei • Rades • Revised Tokuhashi • Tomita	Accuracy of the scoring system for spinal stability: • AUC • Predicted and observed survival

Study	Population	Prognostic tools	Outcomes
	gery) Age, mean, years (SD): Age at diagnosis 64.05 (12.1). No other data on age reported. Sex: female n=314; male n=425.	• Van der Linden	
Tabouret 2015 Observational study France	N=148 Patients undergoing surgery for metastatic spinal cord compression. Age, median, years (range): 60 (22 – 87). Sex: female n=71; male n=77.	• Revised Tokuhashi	Accuracy of the scoring system for spinal stability: • Predicted and observed survival
Tan 2016a Observational study Singapore	N=92 Patients with nasopharyngeal carcinoma and skeletal metastases Age, median, years (range): 52 (26 – 90). Sex: female n=19; male n=73.	• Bauer • Katagiri • Scandinavian Sarcoma Group	Accuracy of the scoring system for spinal stability: • AUC
Tan 2016b Observational study Singapore	N=180 Patients with spinal metastases from the lung Age, mean, years (SD): 62.6 (11.6). Sex: female n=74, male n=106.	• Modified Tokuhashi • Tomita • modified Bauer • Oswestry score	Accuracy of the scoring system for spinal stability: • AUC
Tan 2018 Observational study Singapore	N=185 Patients with breast cancer spinal metastases Age, mean, years (range): 59.4 (28 – 93). Sex: female n=185, male n=0.	• Revised Tokuhashi • Modified Revised Tokuhashi	Accuracy of the scoring system for spinal stability: • AUC

Study	Population	Prognostic tools	Outcomes
Ulmar 2007 Observational study Germany	N=217 Patients with spinal metastases Age, mean, years (SD): not reported. Sex: female n=103; n=114 male.	• Tokuhashi • Revised Tokuhashi	Accuracy of the scoring system for spinal stability: • Predicted and observed survival
Wang 2012 Observational study Denmark	N=448 Patients with confirmed spinal metastases who underwent surgical treatment. Age, mean, years (range): 63 (24 – 89). Sex: female n=177; male n=271.	• Tokuhashi • Revised Tokuhashi	Accuracy of the scoring system for spinal stability: • Predicted and observed survival
Westermann 2020 Observational study Germany	N=223 Patients who had surgery for spinal metastases. Age, mean, years (SD): 62.3 (13.3). Sex: female n=95; male n=128.	• Tomita • Van der Linden • Bauer modified • Oswestry Spinal Risk Index • Tokuhashi • Tokuhashi revised • Modified Tokuhashi revised	Accuracy of the scoring system for spinal stability: • AUC • Predicted and observed survival
Yang 2021 Observational study Taiwan	N=427 Patients who had surgery for spinal metastases Age, median, years (IQR): 60 (52 – 67). Sex: female n=166; male n=261.	• SORG machine-learning algorithm	Accuracy of the scoring system for spinal stability: • AUC
Yeung 2014 Observational study China	N=128 Patients with spinal metastases Age, mean, years (SD): 60.2 (12.0). Sex: female n=37; male	• Modified Tokuhashi	Accuracy of the scoring system for spinal stability: • Predicted and observed survival

Study	Population	Prognostic tools	Outcomes
	n=91.		
Yu 2015 Observational study China	N=151 Patients with spinal metastases from lung cancer Age, mean, years (range): 57 (38 – 76). Sex: female n=64 male n=87.	• Revised Tokuhashi	Accuracy of the scoring system for spinal stability: • Predicted and observed survival

AUC: area under the receiver operating characteristic curve; IQR: Interquartile range; SD: standard deviation; SORG: skeletal oncology research group

See the evidence tables in appendix D, the forest plots in appendix E and study data in appendix L.

Summary of the evidence

Evidence about the overall predictive accuracy of the scoring systems was summarised using the area under the ROC curve (AUC) statistic. AUC ranges from 0 to 1.0, where a value of 0.5 suggests no predictive accuracy and 1.0 indicates perfect predictive accuracy. AUC values above 0.70 could be considered acceptable and can be interpreted as: when presented with 2 random patients the scoring system will correctly identify the patient with poorer prognosis 70% of the time.

Several scoring systems had been validated in multiple studies. These gave estimates of AUC of 0.58 for Bauer, 0.5 to 0.71 for Modified Bauer, 0.69 Katagiri, 0.32 to 0.67 Oswestry Spinal Metastasis Risk Index, 0.74 Tokuhashi, 0.48 to 0.82 Revised Tokuhashi, 0.70 Modified Revised Tokuhashi, 0.38 to 0.77 Tomita and 0.68 Van der Linden scoring systems. The evidence quality for these ranged from very low to moderate.

Several other scoring systems had relatively high AUC but had only been validated in one study. These were SORG-ML, SORG Classic Scoring Algorithm and SORG nomogram. The evidence quality for these ranged from very low to high.

The AUC statistic, however, does not give an indication of how useful the scoring system will be in practice. To be used clinically the scoring systems use threshold scores to divide patients into groups based on their prognosis. The Revised Tokuhashi for example has three groups with expected survival of 6 months or less, 6 to 12 months and more than 12 months respectively. Evidence about the accuracy of these prognostic groups was also summarized (see appendix E for Forest plots and appendix F for full GRADE tables) – by calculating the proportion of patients within each prognostic group whose survival was accurately predicted by each scoring system.

Taking the Revised Tokuhashi Score as an example:

- In the group predicted to survive 6 months or less, 54% survived 6 months or less
- In the group predicted to survive 6 to 12 months, 34% survived between 6 to 12 months (but no longer)
- In the group predicted to survive more than 12 months, 78% survived more than 12 months

There was considerable variation between studies but overall the evidence suggests the scoring systems are an imperfect way to classify patients into prognostic groups. In general

survival predictions in the best and worst prognostic groups were more accurate than in the intermediate groups. The evidence quality for these outcomes was very low to moderate.

See appendix F for full GRADE tables.

Economic evidence

Included studies

A systematic review of the economic literature was conducted but no economic studies were identified which were applicable to this review question.

A single economic search was undertaken for all topics included in the scope of this guideline. See supplement 2 for details.

Excluded studies

Economic studies not included in this review are listed, and reasons for their exclusion are provided in supplement 2.

Economic model

No economic modelling was undertaken for this review because the committee agreed that other topics were higher priorities for economic evaluation.

The committee's discussion and interpretation of the evidence

The outcomes that matter most

The critical outcome for this review was accuracy of the scoring system for predicting overall survival. Some patients with metastatic spinal disease are frail with poor health and an assessment of likely prognosis is an important consideration when deciding on complex surgery and other treatments. The committee thought that these scoring systems might also be able to predict outcomes which correlate with prognosis including pain, event-free survival, duration of survival, neurological and functional status and quality of life. The accuracy of these predictions was an important outcome.

The quality of the evidence

The quality of the evidence was assessed using GRADE and ranged from very low to high. This was predominantly due to imprecision and serious heterogeneity unresolved by subgroup analysis. In addition, some of the studies were at serious risk of bias and some had populations that were indirectly relevant due to only including patients with a specific type of cancer.

No evidence was found on the accuracy of the scoring systems to predict pain, event-free survival, neurological and functional status and quality of life.

As a result of the uncertainty in the evidence the committee relied on their experience and expertise of using the scoring systems when making recommendations.

Benefits and harms

Based on the evidence and their experience the committee recommended the use of validated scoring systems with good evidence of accuracy and gave the Revised Tokuhashi scoring system as an example. The committee discussed how accurate assessment of prognosis should lead to better treatment decisions and ultimately improve quality of life, for example

people with spinal metastases without MSCC (who have non-mechanical spinal pain) with a better prognosis have a higher likelihood to benefit from stereotactic ablative body radiotherapy than those with a poorer prognosis (see evidence review M). Although low quality evidence indicated that the Revised Tokuhashi scoring system was not very accurate in predicting those who would survive less than 1 year there was moderate quality evidence showing moderate accuracy in identifying those with better long-term prognosis. This was why they recommended the Revised Tokuhashi scoring system as a example, however they acknowledged that other scoring systems (such as the SORG and SSG algorithms) being developed and improved and show moderate accuracy but do not yet have the same weight of evidence as the Revised Tokuhashi.

The committee also discussed whether they should recommend against the use of some of the scoring systems that had relatively low accuracy. However, they decided not to do this because there are ongoing revisions to various systems and this may improve those that are currently less accurate. Having a recommendation against their use may then cause confusion.

The committee noted that there was variation in accuracy, but discussed that scoring systems have a role in thinking about prognosis and informing decisions about treatment (both oncological and surgical) because they formalise and standardise information on key factors which can then be recorded and audited. They also acknowledged that the scoring systems had modest accuracy at best (AUC > 0.70 and <0.90). With the exception of the best prognosis category, their categorical predictions of survival were more often wrong than right. It was discussed that decisions about how long someone is likely to survive are complex and many other factors need to be taken into account that are unique to every person. So the committee agreed that clinicians should not take the number on a scoring system as a determining factor in isolation. To avoid decisions being made purely on a number resulting from a scoring system and encourage an individualised assessment, the committee recommended that they should not be used in isolation but alongside consideration of other clinical and personal factors.

Cost effectiveness and resource use

The recommendations mirror current practice where scoring scales are already widely used to assess prognosis. In the small number of cases where these systems are not in place the recommendations should lead to better decision making around treatments potentially avoiding inappropriate and costly treatments. This will reduce costs and improve quality of life for people with MSCC.

Recommendations supported by this evidence review

This evidence review supports recommendations 1.9.2 and 1.9.3 in the NICE guideline.

References – included studies

Prognostic

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Ribas, 2016

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Appendices

Appendix A Review protocols

Review protocol for review question: What is the prognostic value of validated scoring systems for determining survival in people with spinal cord compression caused by spinal metastases or direct malignant infiltration of the spine?

Table 3: Review protocol

ID	Field	Content
0.	PROSPERO registration number	CRD42022326756
1.	Review title	The prognostic value of scoring systems for survival in people with spinal metastases or direct malignant infiltration of the spine.
2.	Review question	What is the prognostic value of validated scoring systems for determining survival in people with spinal cord compression caused by spinal metastases or direct malignant infiltration of the spine?
3.	Objective	To establish the prognostic value of validated scoring systems in evaluating survival in people with spinal metastases or direct malignant infiltration of the spine, with or without spinal cord compression.
4.	Searches	The following databases will be searched: • Cochrane Central Register of Controlled Trials (CENTRAL) • Cumulative Index to Nursing and Allied Health Literature (CINAHL) • Database of Abstracts of Reviews of Effects (DARE) • Embase • Epistemonikos • International Health Technology Assessment (IHTA) database • MEDLINE & MEDLINE In-Process Searches will be restricted by: • Date: 1990 onwards (see rationale under Section 10) • English language studies

ID	Field	Content
		• Human studies Other searches: Inclusion lists of systematic reviews With the agreement of the guideline committee, the searches will be re-run between 6-8 weeks before final submission of the review and further studies retrieved for inclusion. The full search strategies for MEDLINE database will be published in the final review.
5.	Condition or domain being studied	Spinal metastases, direct malignant infiltration of the spine, spinal cord compression

6.	Population	Inclusion:
		• Adults with:
		  ○ metastatic spinal disease
		  ○ direct malignant infiltration of the spine
		• Adults with confirmed spinal cord or nerve root compression because of
		  ○ metastatic spinal disease
		  ○ direct malignant infiltration.
		
		Exclusion:
		• Adults with suspected metastatic spinal disease and suspected direct malignant infiltration of the spine.
		• Adults with spinal cord compression because of primary tumours of the spinal cord, meninges or nerve roots.
		• Adults with spinal cord compression because of non-malignant causes.
		• Adults with primary bone tumours of the spinal column.
		• Children and young people under the age of 18.

7.	Presence or absence of a prognostic, risk or predictive factor	Scoring systems to predict survival of patients with spinal metastases or direct malignant infiltration, for example: • Tokuhashi • Tomita

ID	Field	Content
		• Sioutos • Bauer • North • Van der Linden • ECOG performance status

8.	Confounding factors	• Age
		• Sex
		• Primary tumour type
		• Performance status
		• Bone metastases
		• Number of involved vertebrae
		• Visceral metastases
		• Neurological status on presentation:
		  ○ mobility
		  ○ bladder or bowel dysfunction
		• Tumour location on spine
		• Spine alignment
		• Bone lesion
		• Spinal deformity
		• Other oncology treatments

9.	Types of study to be included	Observational studies (where neither control nor intervention were assigned by the investigator) including: • Systematic reviews of observational studies. • Prospective and retrospective cohort studies • Case control studies • Prospective study designs will be prioritised over retrospective study designs • Population-based studies and multicentre studies will be prioritised

ID	Field	Content
10.	Other exclusion criteria	Inclusion: • Full text papers • Validated clinical prediction tools will be prioritised for inclusion (where the scoring system has been evaluated in a separate population than that used to derive the model) Exclusion: • Conference abstracts • Articles published before 1990. MRI has regularly used in diagnosis since the early 1990s. IMRT was not commercially available until 1994. • Papers that do not include methodological details will not be included as they do not provide sufficient information to evaluate risk of bias/ study quality • Studies using qualitative methods only • Non-English language articles
11.	Context	Metastatic spinal cord compression in adults: risk assessment, diagnosis and management (2008) NICE guideline will be updated by this review question
12.	Primary outcomes (critical outcomes)	Accuracy of the scoring system for: • Overall survival
13.	Secondary outcomes (important outcomes)	Accuracy of the scoring system for: • Pain • Event-free survival • Survival duration • Neurological and functional status • Quality of life
14.	Data extraction (selection and coding)	All references identified by the searches and from other sources will be uploaded into EPPI and de-duplicated. Titles and abstracts of the retrieved citations will be screened to identify studies that potentially meet the inclusion criteria outlined in the review protocol.

ID	Field	Content
		Dual sifting will be performed on at least 10% of records; 90% agreement is required. Disagreements will be resolved via discussion between the two reviewers, and consultation with senior staff if necessary. The full set of records will not be dual screened because the population, interventions and relevant study designs are relatively clear and should be readily identified from titles and abstracts. Full versions of the selected studies will be obtained for assessment. Studies that fail to meet the inclusion criteria once the full version has been checked will be excluded at this stage. Each study excluded after checking the full version will be listed, along with the reason for its exclusion. A standardised form will be used to extract data from studies. The following data will be extracted: study details (reference, country where study was carried out, type and dates), participant characteristics, inclusion and exclusion criteria, details of the interventions if relevant, setting and follow-up, relevant outcome data and source of funding. One reviewer will extract relevant data into a standardised form, and this will be quality assessed by a senior reviewer. PICOTS will be extracted from each study. For prediction models, development stage and validation status will be extracted.
15.	Risk of bias (quality) assessment	Risk of bias of individual studies will be assessed using the preferred checklist as described in Developing NICE guidelines: the manual. Quality assessment of individual studies will be performed using the following: • CHARMS checklist for systematic reviews of prediction models. • PROBAST tool for clinical prediction models The quality assessment will be performed by one reviewer and this will be quality assessed by a senior reviewer.
16.	Strategy for data synthesis	Depending on the availability of the evidence, the findings will be summarised narratively or quantitatively.

ID	Field	Content
		Data Synthesis Where possible meta-analysis to combine the effect estimates across studies for each clinical prediction model will be conducted if studies have comparable populations. We will extract either OR or HR; however we will conduct separate meta-analysis for those studies reporting OR and those reporting HR, as it is inappropriate to pool OR and HR. If no meta-analysis is conducted a narrative summary of the available results for each factor will be provided. Calibration and discrimination will be assessed for clinical description models. Heterogeneity in the effect estimates of the individual studies will be assessed using the I2 statistic. I2 values of greater than 50% and 80% will be considered as significant and very significant heterogeneity, respectively. In the case of serious or very serious unexplained heterogeneity (remaining after pre-specified subgroup and stratified analyses) meta-analysis will be done using a random effects model. Default MIDs will be used for odds ratios, unless the committee pre-specifies published or other MIDs for specific outcomes • For odds ratios and hazard ratios: 0.8 and 1.25. Validity The confidence in the findings across all available evidence will be evaluated for each outcome using an adaptation of the 'Grading of Recommendations Assessment, Development and Evaluation (GRADE) toolbox' developed by the international GRADE working group: http://www.gradeworkinggroup.org/
17.	Analysis of sub-groups	Evidence will be stratified by: • Ambulant versus non ambulant patients • Sex

ID	Field	Content			
		Where evidence is stratified or subgrouped the committee will consider on a case by case basis if separate recommendations should be made for distinct groups. Separate recommendations may be made where there is evidence of a differential effect of interventions in distinct groups. If there is a lack of evidence in one group, the committee will consider, based on their experience, whether it is reasonable to extrapolate and assume the interventions will have similar effects in that group compared with others.			
18.	Type and method of review	☐	Intervention		
		☐	Diagnostic		
		☒	Prognostic		
		☐	Qualitative		
		☐	Epidemiologic		
		☐	Service Delivery		
		☐	Other (please specify)		
19.	Language	English			
20.	Country	England			
21.	Anticipated or actual start date	09/09/23			
22.	Anticipated completion date	23/08/23			
23.	Stage of review at time of this submission	Review stage		Started	Completed
		Preliminary searches		☑	☑
		Piloting of the study selection process		☑	☑
		Formal screening of search results against eligibility criteria		☑	☑
		Data extraction		☑	☑
		Risk of bias (quality) assessment		☑	☑

ID	Field	Content
		Data analysis ☑ ☑
24.	Named contact	5a. Named contact: National Institute for Health and Care Excellence (NICE) 5b Named contact e-mail: metastaticspinal@nice.org.uk 5e Organisational affiliation of the review: National Institute for Health and Care Excellence (NICE)
25.	Review team members	NICE Technical Team
26.	Funding sources/sponsor	This systematic review is being completed by NICE.
27.	Conflicts of interest	All guideline committee members and anyone who has direct input into NICE guidelines (including the evidence review team and expert witnesses) must declare any potential conflicts of interest in line with NICE's code of practice for declaring and dealing with conflicts of interest. Any relevant interests, or changes to interests, will also be declared publicly at the start of each guideline committee meeting. Before each meeting, any potential conflicts of interest will be considered by the guideline committee Chair and a senior member of the development team. Any decisions to exclude a person from all or part of a meeting will be documented. Any changes to a member's declaration of interests will be recorded in the minutes of the meeting. Declarations of interests will be published with the final guideline.
28.	Collaborators	Development of this systematic review will be overseen by an advisory committee who will use the review to inform the development of evidence-based recommendations in line with section 3 of Developing NICE guidelines: the manual. Members of the guideline committee are available on the NICE website: https://www.nice.org.uk/guidance/CG75
29.	Other registration details	N/A
30.	Reference/URL for published protocol	https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=326756
31.	Dissemination plans	NICE may use a range of different methods to raise awareness of the guideline. These include standard approaches such as: • notifying registered stakeholders of publication • publicising the guideline through NICE's newsletter and alerts • issuing a press release or briefing as appropriate, posting news articles on the NICE website, using social media channels, and publicising the guideline within NICE.

ID	Field	Content	
32.	Keywords		
33.	Details of existing review of same topic by same authors	N/A	
34.	Current review status	☒	Ongoing
		☐	Completed but not published
		☐	Completed and published
		☐	Completed, published and being updated
		☐	Discontinued
35..	Additional information	N/A	
36.	Details of final publication	www.nice.org.uk	

CDSR: Cochrane Database of Systematic Reviews; CENTRAL: Cochrane Central Register of Controlled Trials; DARE: Database of Abstracts of Reviews of Effects; GRADE: Grading of Recommendations Assessment, Development and Evaluation; HTA: Health Technology Assessment; MID: minimally important difference; NHS: National health service; NICE: National Institute for Health and Care Excellence; RCT: randomised controlled trial; RoB: risk of bias; SD: standard deviation

Appendix B Search strategy (clinical/economic)

Literature search strategies for review question: What is the prognostic value of validated scoring systems for determining survival in people with spinal cord compression caused by spinal metastases or direct malignant infiltration of the spine?

Database: Medline – OVID interface

#	Searches
1	Spinal Cord Compression/
2	exp Spinal Cord Neoplasms/ or Spinal Neoplasms/
3	((cauda equina or cervical* or cervicothoracic or cord* or coccyx or duralsac* or dural sac* or intervertebr* or lumbar or lumbosac* or lumbo sac* or medulla* or orthothoracic or sacral or sacrum or spinal or spine* or thecal sac* or thoracic or vertebr* or epidural or extradural or extra dural) adj3 (infiltrat* or invad* or invasion or metast* or oligometast*)).ti,ab.
4	(((cauda equina or cervical* or cervicothoracic or cord* or coccyx or duralsac* or dural sac* or intervertebr* or lumbar or lumbosac* or lumbo sac* or medulla* or orthothoracic or sacral or sacrum or spinal or spine* or thecal sac* or thoracic or vertebr* or epidural or extradural or extra dural or ((axon* or neuron* or nerve*) adj2 root)) adj3 (collaps* or compress* or pinch* or press*)) and (adeno* or cancer* or carcinoma* or chordoma* or intraepithelial* or intra epithelial* or malignan* or metast* or neoplas* or oligometast* or tumo?r*)).ti,ab.
5	(mescc or mscc).ti,ab.
6	or/1-5
7	Algorithms/ or exp Decision Support Techniques/ or Health Status Indicators/ or exp "Severity of Illness Index"/ or Models, Statistical/ or Nomograms/
8	(algorithm* or framework* or index or indices or instrument* or model* or nomogra* or protocol* or rule* or scale* or score* or scoring or statistic* or system* or tool*).ti,ab,kw.
9	(anzuategui or bauer or bollen or buddhasothorn or BSH-MSCC or ECOG or frankel or karnofsky or katagiri or harrington or lei or linden or MSTFI or NESMS or NOMS or north or OSRI or rades or SINS or sioutos or SORG or tokuhashi or tomita or weinstein or WBB).ti,ab,kw.
10	or/7-9
11	6 and 10
12	exp Prognosis/
13	(predict* or prognos*).ti.
14	((predict* or prognos*) adj2 (calculat* or calibrat* or classif* or criteria or discriminat* or estimat* or evaluat* or factor* or measur* or multivariab* or multi variab* or outcome* or reclassif* or stratif* or valid* or value* or variab*)).ab.
15	exp Mortality/ or Survival/ or exp Survival Analysis/
16	((predict* or prognos*) adj3 (death? or life expectan* or mortality or surviv*)).ti,ab.
17	validation study.pt.
18	or/12-17
19	11 and 18
20	meta-analysis/ or meta-analysis as topic/ or "systematic review"/
21	(meta analy* or metanaly* or metaanaly* or ((evidence or systematic*) adj2 (overview* or review*))).ti,ab.
22	(reference list* or bibliograph* or hand search* or manual search* or relevant journals).ab.
23	(search strategy or search criteria or systematic search or study selection or data extraction or (search* adj4 literature)).ab.
24	(medline or pubmed or cochrane or embase or psychlit or psyclit or psychinfo or psycinfo or cinahl or science citation index or bids or cancerlit).ab.
25	cochrane.jw.
26	or/20-25
27	19 and 26
28	Observational Studies as Topic/
29	Observational Study/
30	Epidemiologic Studies/
31	exp Case-Control Studies/
32	exp Cohort Studies/
33	Cross-Sectional Studies/
34	Controlled Before-After Studies/
35	Historically Controlled Study/
36	Interrupted Time Series Analysis/
37	Comparative Study.pt.
38	case control$.tw.
39	case series.tw.
40	(cohort adj (study or studies)).tw.
41	cohort analy$.tw.
42	(follow up adj (study or studies)).tw.
43	(observational adj (study or studies)).tw.
44	longitudinal.tw.
45	prospective.tw.
46	retrospective.tw.
47	cross sectional.tw.

#	Searches
48	or/28-47
49	19 and 48
50	27 or 49
51	letter/ or editorial/ or news/ or exp historical article/ or Anecdotes as Topic/ or comment/ or case report/ or (letter or comment*).ti.
52	randomized controlled trial/ or random*.ti,ab.
53	51 not 52
54	(animals/ not humans/) or exp animals, laboratory/ or exp animal experimentation/ or exp models, animal/ or exp rodentia/ or (rat or rats or mouse or mice).ti.
55	53 or 54
56	50 not 55
57	limit 56 to english language
58	limit 57 to yr="1990 -Current"

Health economics search

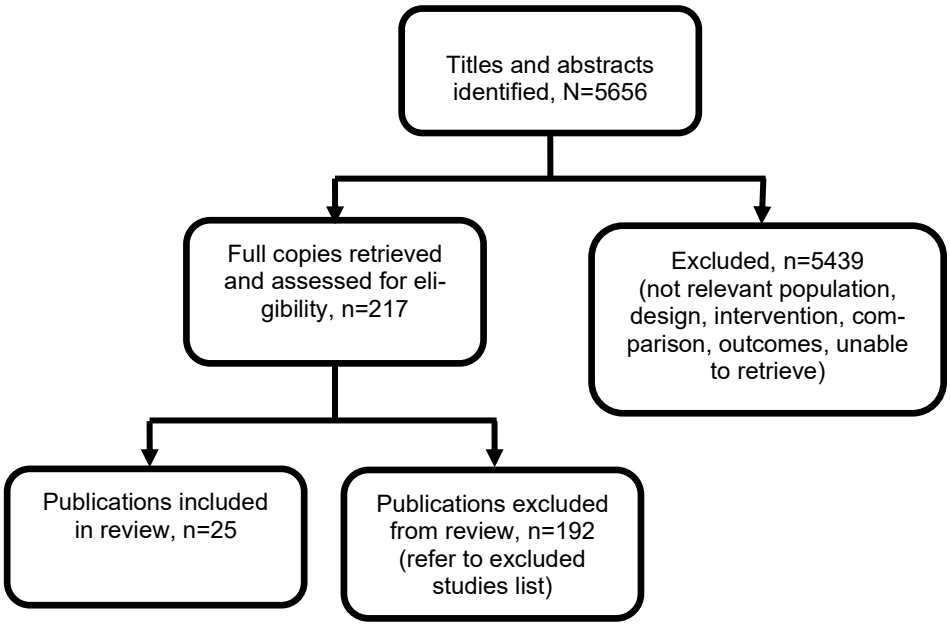
Database: Medline – OVID interface

#	Searches
1	exp Spinal Cord Neoplasms/ or Spinal Neoplasms/
2	((spine or spinal or vertebr*) adj2 (adeno* or cancer* or carcinoma* or intraepithelial* or intra epithelial* or malignan* or neoplas* or tumo?r*)).tw.
3	((spine or spinal or vertebr*) and (metast* or oligometast*)).tw.
4	or/1-3
5	Spinal Cord Compression/
6	((cauda equina or cervical* or cervicothoracic or cord* or coccyx or duralsac* or dural sac* or intervertebr* or lumbar or lumbosac* or lumbo sac* or medulla* or orthothoracic or sacral or sacrum or spinal or spine* or thecal sac* or thoracic or vertebr* or epidural or extradural or extra dural or ((axon* or neuron* or nerve*) adj2 root)) and (collaps* or compress* or pinch* or press*) and (adeno* or cancer* or carcinoma* or chordoma* or intraepithelial* or intra epithelial* or malignan* or metast* or neoplas* or oligometast* or tumo?r*)).tw.
7	(myelopath* or myeloradiculopath* or radiculopath*).tw,hw. or (radicular adj2 (disorder* or syndrome*)).tw.
8	(mescc or mscc).tw.
9	or/5-8
10	((adeno* or cancer* or carcinoma* or intraepithelial* or intra epithelial* or malignan* or metast* or neoplas* or tumo?r*) adj3 (escap* or infiltrat* or invasiv* or metast* or spread*) adj5 (cauda equina or cervical* or cervicothoracic or cord* or coccyx or duralsac* or dural sac* or intervertebr* or lumbar or lumbosac* or lumbo sac* or medulla* or orthothoracic or sacral or sacrum or spinal or spine* or thecal sac* or thoracic or vertebr* or epidural or extradural or extra dural or ((axon* or neuron* or nerve*) adj2 root))).tw.
11	or/4,9-10
12	Economics/ or Value of life/ or exp "Costs and Cost Analysis"/ or exp Economics, Hospital/ or exp Economics, Medical/ or Economics, Nursing/ or Economics, Pharmaceutical/ or exp "Fees and Charges"/ or exp Budgets/
13	(cost* or economic* or pharmacoeconomic*).ti.
14	(budget* or financ* or fee or fees or price* or pricing* or (value adj2 (money or monetary))).ti,ab.
15	(cost* adj2 (effective* or utilit* or benefit* or minimi* or unit* or estimat* or variable*)).ab.
16	or/12-15
17	11 and 16
18	limit 17 to english language
19	limit 18 to yr="2005 -Current"

Appendix C Prognostic evidence study selection

Study selection for: What is the prognostic value of validated scoring systems for determining survival in people with spinal cord compression caused by spinal metastases or direct malignant infiltration of the spine?

Figure 1: Study selection flow chart



Appendix D Evidence tables

Evidence tables for review question: What is the prognostic value of validated scoring systems for determining survival in people with spinal cord compression caused by spinal metastases or direct malignant infiltration of the spine?

Ahmed, 2018 Ahmed A, Goodwin C, Heravi A, et al. Predicting survival for metastatic spine disease: a comparison of nine scoring systems. Spine Journal, 18, 1804-1814, 2018

Study details	
Country/ies where study was carried out	USA
Study type	Retrospective cohort study
Study dates	2003 to 2016
Inclusion criteria	Patient age: 18–100 years at the time of surgery; complete and detailed electronic medical records with clinical presentation, imaging, and operative notes available; patient who underwent surgical resection of a metastatic spine lesion; pathologic confirmation of primary tumour aetiology; known survival or most recent follow-up.
Exclusion criteria	Incomplete medical records.
Patient characteris-tics	N=176 Age, mean, years (SD): 60 (12) Sex [proportion of female, male]: female n=71, male n=105. Primary cancer types [proportion of each]: hepatocellular (1%), lung (19%), breast ((21%), diffuse large B-cell lymphoma (1%), melanoma (3%), Merkel cell (1%), multiple myeloma (9%), pancreatic adenocarcinoma (1%), plasmacytoma (2%), prostate (15%), RCC (20%), sarcoma (1%), squamous cell (1%), thyroid (1%), and bladder cancer (1%). Ambulant patients [proportion who were ambulant]: Not reported. 60% were ECOG score 0-2 Patients with neurological symptoms [proportion with neurological symptoms]: 59% had neurologic deficit on ASIA scale Patients with bladder or bowel symptoms [proportion with bladder/bowel symptoms]: Not reported

Predictors	• SORG Classic scoring algorithm • SORG nomogram • Tokuhashi • Revised Tokuhashi • Tomita • van der Linden • Katagiri • Bauer • Modified Bauer
Type of prediction study	Model external validation study
Duration of follow-up	1 year
Setting	Tertiary care
Sources of funding	No funds received.
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	Low
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	Low
Overall Risk of bias and Applicability	Risk of bias	Low
Overall Risk of bias and Applicability	Concerns about applicability	Low

Balain, 2013 Balain B, Jaiswal A, Trivedi J, et al. The Oswestry Risk Index: an aid in the treatment of metastatic disease of the spine. Bone and Joint Journal, 95b, 210-6, 2013

Study details

Country/ies where study was carried out	UK
Study type	Prospective cohort study
Study dates	2010
Inclusion criteria	Patients with spinal metastases
Exclusion criteria	Unclear
Patient characteristics	N=199 Age, mean, years (SD): 61.6 (12.5). Sex: female n=81; male n=118. Primary cancer site: Breast - 33 Prostate - 31 Bronchus - 20 Kidney - 18 Myeloma - 18 Adenocarcinoma (unknown origin) - 13 Lymphoma - 12 Others (<10 each) - 54
Predictors	Tokuhashi, Tomita and modified Bauer scores
Type of prediction study	Prediction model external validation
Duration of follow-up	60 months
Setting	Secondary care
Sources of funding	Unclear
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	Low
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	Low
Overall Risk of bias and Applicability	Risk of bias	Low
Overall Risk of bias and Applicability	Concerns about applicability	Low

Denisov, 2020 Denisov A, Zaborovsky N, Ptashnikov D, et al. A Comparison of prognostic scales for patients with metastatic spine disease. Orthopedic Reviews, 12, 8822, 2020

Study details

Country/ies where study was carried out	Russia
Study type	Retrospective cohort study
Study dates	2011 - 2014
Inclusion criteria	Patients with spinal metastases
Exclusion criteria	Unclear
Patient characteristics	N=138 Age, median, years (95% CI): median 57 (56 – 59). Sex – female/male: female n=102; male n=36. Primary tumour site: (Number of patients)

	Breast 86 Lung 16 Colon 10 Kidney 6 Skin 6 Uterine body 4 Prostate 4 Stomach 4 Liver 2
Predictors	Tokuhashi, Tomita and Katagiri scores
Type of prediction study	Prediction model external validation
Duration of follow-up	12 months
Setting	Tertiary care
Sources of funding	Unclear
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	Low
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	Low
Overall Risk of bias and Applicability	Risk of bias	Low

Section	Question	Answer
Overall Risk of bias and Applicability	Concerns about applicability	Low

Eap, 2015 Eap C, Tardieux E Goasgen O, et al. Tokuhashi score and other prognostic factors in 260 patients with surgery for vertebral metastases. Orthopaedics and Traumatology, Surgery and Research, 2015, 101, 483-8, 2015

Study details

Country/ies where study was carried out	France
Study type	Retrospective cohort study
Study dates	1988 to 2008
Inclusion criteria	Age older than 18 years and metastatic spinal disease requiring surgical treatment (for example, nerve root or spinal cord compression, risk of neurological compromise)
Exclusion criteria	Patients younger than 18 years of age, under guardianship, or having missing data. Also, non-metastatic spinal tumours (for example, primary tumours or spinal involvement with haematological malignancies), history of spinal biopsy, and intra-dural metastases.
Patient characteristics	N=260 Age, mean, years (SD): 59 (11). Sex: female n=143; male n=117. Age (number of patients): <50 years - 48 50-60 years - 88 60-70 years - 75 >70 years - 49 Primary tumour: Lung 22% Prostate 7% Breast 39% Colorectal 4% Kidney 10% Bladder 3%

	Other 10% Unidentified 6%
Predictors	Tokuhashi score
Type of prediction study	Prediction model development external validation
Duration of follow-up	12 months
Setting	Tertiary care
Sources of funding	Unclear
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	Low
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	Low
Overall Risk of bias and Applicability	Risk of bias	Low
Overall Risk of bias and Applicability	Concerns about applicability	Low

Gakhar, 2013 Gakhar H, Swamy G, Bommireddy R, et al. A study investigating the validity of modified Tokuhashi score to decide surgical intervention in patients with metastatic spinal cancer. European Spine Journal, 22, 565-8, 2013

Study details

Country/ies where	UK.

study was carried out	
Study type	Retrospective cohort study
Study dates	2007 - 2010.
Inclusion criteria	Not reported.
Exclusion criteria	Not reported.
Patient characteristics	N=90 consecutive patients undergoing treatment for metastatic spinal cancer (surgery, kyphoplasty, transpedicular biopsy). All patients had surgical stabilization. This included the posterior only approach, anterior only approach, or both anterior and posterior approach in combination staged or simultaneous. Age, mean, years (range): 64 (32 – 88). Sex [proportion of female/male]: female n=45; male n=45. Primary cancer types [proportion with each]: Breast n=19/90, Haematologic n=30/90 (myeloma n=17/90, lymphoma n=13/90) Renal n=9/90 Lung n=9/90 Prostate n=8 Other n=15 Ambulant patients [proportion who were ambulant]: Not reported. Patients with neurological symptoms [proportion with neurological symptoms]: 42/90 (at presentation). Patients with bladder or bowel symptoms [proportion with bladder/bowel symptoms]: Not reported.
Predictors	Modified Tokuhashi scoring system. (Tokuhashi Y, Matsuzaki H, Oda H, Oshima M, Ryu J [2005] A revised scoring system for preoperative evaluation of metastatic spine tumor prognosis. Spine 30, 2186–2191 [Phila Pa 1976])
Duration of follow-up	At least one year or until death.
Setting	Patients undergoing treatment for metastatic spinal cancer (surgery, kyphoplasty, transpedicular biopsy). No further details reported.
Sources of funding	Not reported.
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	Low
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	High. *Low number of participants (N=90), PROBAST guidance is at least 100 participants for validation studies.*
Overall Risk of bias and Applicability	Risk of bias	High. Risk of bias due to analysis (low number of participants).
Overall Risk of bias and Applicability	Concerns about applicability	Low

Gruenberg, 2017 Gruenberg M, Mereles M, Willhuber G, et al. Usefulness of Tokuhashi Score in Survival Prediction of Patients Operated for Vertebral Metastatic Disease. Global Spine Journal; 2017, 260-265, 2017

Study details

Country/ies where study was carried out	Argentina
Study type	Retrospective cohort study
Study dates	2004-2014

Inclusion criteria	Patients with vertebral metastasis who underwent surgical treatment
Exclusion criteria	None
Patient characteristics	N=105 patients undergoing surgical treatment for vertebral metastases. Age, mean, years (range): 61.5 (16 – 86). Sex: female n=44; male n=61. Primary tumour site: Kidney - 23% Lung - 19% Breast - 18% Neurological involvement - 56%
Predictors	Tokuhashi score
Type of prediction study	Prediction model external validation
Duration of follow-up	12 months
Setting	Tertiary care
Sources of funding	None.
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	Low
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low

Section	Question	Answer
Analysis	Risk of bias for analysis	Low
Overall Risk of bias and Applicability	Risk of bias	Low
Overall Risk of bias and Applicability	Concerns about applicability	Low

Iinuma, 2021
Iinuma M, Akazawa T, Torii Y, et al. Optimization of the revised tokuhashi scoring system: New prognostic criteria for metastatic spinal tumor in surgical cases. Spine Surgery and Related Research, 5, 81-85, 2021

Study details

Country/ies where study was carried out	Japan
Study type	Retrospective cohort study
Study dates	May 2009 to July 2018
Inclusion criteria	Patients with metastatic spinal tumours who underwent spinal surgery
Exclusion criteria	None
Patient characteris-tics	N=85 patients undergoing surgery for spinal metastases. Age, mean, years (range): 62.4 (26 – 85). Sex: female n=37; male n=48. Primary cancer: Breast - 22 Prostate - 14 Lung - 14 Hepatocellular - 7 Renal - 7 Gastric - 4 Colon - 4 Pancreatic - 3 Thyroid - 2

	Bile duct - 2 Ureteral - 2 Malignant melanoma - 1 Duodenal - 1 Bladder - 1 Unknown - 1
Predictors	Tokuhashi score
Type of prediction study	Prediction model external validation
Duration of follow-up	12 months
Setting	Tertiary care
Sources of funding	Unclear
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	Low
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	High. O*utcome data missing for 18/85 participants; low number of participants (N=85) - PROBAST guidance is at least 100 participants for*

Section	Question	Answer
		validation studies.
Overall Risk of bias and Applicability	Risk of bias	High. Risk of bias due to missing outcome data and low number of participants.
Overall Risk of bias and Applicability	Concerns about applicability	Low

Kumar, 2014
Kumar N, Tan J, Zaw A, et al. Evaluation of scoring systems and prognostic factors in patients with spinal metastases from nasopharyngeal carcinoma. Spine Journal, 14, 46-53, 2014

Study details

Country/ies where study was carried out	Singapore.
Study type	Retrospective cohort study
Study dates	January 2007 - December 2011.
Inclusion criteria	• Histologically proven nasopharyngeal carcinoma. • Diagnosis of spinal metastases was made radiologically by one or more of the following modalities: magnetic resonance imaging, computed tomography, and bone scan. In certain cases, bone biopsy was also procured.
Exclusion criteria	Patients with incomplete data.
Patient characteristics	N=87 patients with spinal metastases from nasopharyngeal carcinoma. Age, mean, years (range): 52 (26 – 90). Sex [proportion of female, male]: female n=19; male n=68. Primary cancer types [proportion with each]: All patients had nasopharyngeal carcinoma. Ambulant patients [proportion who were ambulant]: Not reported. Patients with neurological symptoms [proportion with neurological symptoms]: Palsy – none n=79; Incomplete n=8; Complete n=0 Patients with bladder or bowel symptoms [proportion with bladder/bowel symptoms]: Not reported.

	Treatment: conservative n=50; radiotherapy n=30; surgery n=7.
Predictors	• Modified Bauer. • Tokuhashi (revised) • Tomita
Duration of follow-up	12 months or until death.
Sources of funding	None reported.
Results	See Appendix L

Critical appraisal – PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	High. *Patients with nasopharyngeal carcinoma only.*
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	High. *Low number of participants (N=87). PROBAST guidance is at least 100 participants for validation studies.*
Overall Risk of bias and Applicability	Risk of bias	High. Risk of bias due to low numbers of participants.
Overall Risk of bias and Applicability	Concerns about applicability	High. Only included patients with nasopharyngeal carcinoma.

Mollahoseini, 2011 Mollahoseini R, Farhan F, Khajoo A, et al. Is Tokuhashi score suitable for evaluation of life expectancy before surgery in iranian patients with spinal metastases? Journal of Research in Medical Sciences, 16, 1183-1188, 2011

Study details

Country/ies where study was carried out	Iran.
Study type	Prospective cohort study
Study dates	February 2007 to March 2009.
Inclusion criteria	Patients with spinal metastatic tumours.
Exclusion criteria	Not reported.
Patient characteristics	N=109 patients undergoing surgical treatment for spinal metastases. Age, mean, years (SD): 57 (12). Sex [proportion of female/male]: female n=56; male n=53. Primary cancer types [proportion with each]: Lung, osteosarcoma, stomach, bladder, oesophagus, pancreas n=18 Liver, gallbladder, unidentified n=4 Others n=13 Kidney, uterus n=2 Rectum n=3 Thyroid, breast, prostate, carcinoid tumour n=69 Ambulant patients [proportion who were ambulant]: Not reported. Patients with neurological symptoms [proportion with neurological symptoms]: Complete palsy (Frankel A, B) n=10. Incomplete palsy (Frankel C, D) n=13. None (Frankel E) n=89. Patients with bladder or bowel symptoms [proportion with bladder/bowel symptoms]: Not reported.
Predictors	Revised Tokuhashi scoring system.
Type of prediction study	Prediction model external validation
Duration of follow-up	12 months.

Setting	Patients with metastatic spinal tumours attending oncology and radiotherapy clinics at one centre in Tehran.
Sources of funding	Not reported.
Other information	The Tokuhashi revised evaluating system score estimated that after surgery, 38 patients should be alive less than 6 months, 39 patients 6-12 months and 32 patients may be alive more than 12 months. The actual survival time after 1 year follow up was as following: 39 patients less than 6 months, 28 patients 6-12 months and 42 patients more than 12 months. Based on this result patients were divided into three groups: 1) Patients whom their survival was accurately predicted (28 + 16 + 23 = 67 members, 61.47%). 2) Patients whom Tokuhashi revised score overestimated their survival (7 + 4 + 5 = 16, 14.68%). 3) Patients whom Tokuhashi revised score underestimated their survival (7 + 3 + 16 = 26, 23.85%). There was not any significant difference between second (overestimation) and third (underestimation) groups (p = 0.116).
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	High. *71/180 patients were excluded but no reasons were given for this.*
Selection of participants	Concerns about applicability of selection of participants	Low
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	Low
Overall Risk of bias and Applicability	Risk of bias	High. Risk of bias due to selection of participants.
Overall Risk of bias and Applicability	Concerns about applicability	Low

Park, 2015

Park S, Lee C, Chung S, et al. How Accurately Can Tokuhashi Score System Predict Survival in the Current Practice for Spinal Metastases? Journal of Spinal Disorders and Techniques, 28, e219-e224, 2015

Study details

Country/ies where study was carried out	Korea.
Study type	Prospective cohort study
Study dates	January 2007 and March 2013.
Inclusion criteria	145 consecutive patients with spinal metastases who underwent surgical treatment in a single institute. Although TS system was used as a reference in deciding whether the surgery should be performed or not, the final decision was made after discussion with medical and radiation oncologists. The number of vertebral metastasis was confirmed by whole spine magnetic resonance imaging. Information about extraspinal bony or visceral metastasis was determined by the latest findings of bone scan, brain/chest/abdomen computed tomography, and/or positron emission tomography.
Exclusion criteria	Not reported.
Patient characteristics	N=145 patients undergoing surgical treatment for spinal metastases. Age, mean, years (SD): 60.0 (10.9). Sex [proportion of female, male]: female n=49; male n=96. Primary cancer types [proportion with each]: Lung n=38 Liver n=21 Kidney n=14 Breast n=9 Colon n=8 Rectum n=7 Prostate n=6 Lymphoma n=5 Nasopharynx n=5 Oesophagus n=4 Gallbladder n=4

	Thymus n=4 Thyroid n=4 Unknown n=3 Stomach n=3 Ampulla of Vater n=2 Cervix n=2 Skin n=2 Adrenal gland n=1 Bladder n=1 Ovary n=1 Uterus n=1. Ambulant patients [proportion who were ambulant]: Not reported. Patients with neurological symptoms [proportion with neurological symptoms]: Not reported. Patients with bladder or bowel symptoms [proportion with bladder/bowel symptoms]: Not reported.
Predictors	Tokuhashi Score.
Type of prediction study	Prediction model external validation
Duration of follow-up	The data were censored at March 2014, thus all patients could be followed up for minimum 1-year or until their death.
Setting	Tertiary care
Sources of funding	Not reported.
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	Low
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low

Section	Question	Answer
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	Low
Overall Risk of bias and Applicability	Risk of bias	Low
Overall Risk of bias and Applicability	Concerns about applicability	Low

Pelegrini de Almeida, 2018 Pelegrini de Almeida L, Vidaletti T, Martins de Lima C, at al. Reliability of Tokuhashi Score to Predict Prognosis: Comparison of 117 Patients. World Neurosurgery, 111, e1-e6, 2018

Study details	
Country/ies where study was carried out	Brazil.
Study type	Retrospective cohort study
Study dates	October 2008 - October 2015.
Inclusion criteria	• Patients with spine metastasis who underwent surgery • Clinical, neurologic, and radiologic information in the medical record • Minimum 1-year follow-up to establish survival or death.
Exclusion criteria	• Patients who did not undergo surgery • No histologic confirmation of the spinal lesion • Patients lost in the follow-up.
Patient characteristics	N=117 patients undergoing surgical treatment for spinal metastases. Age, mean, years (SD): 56 (12). Sex [proportion of female, male]: female n=68; male n=49. Primary cancer types [proportion with each]: Breast n=30 Lung n=17 Prostate n=12 Multiple myeloma n=10 Kidney n=9 Lymphoma n=8

	Colon n=5 Uterus n=4 Testicle n=3 Stomach n=2 Liver n=2 Skin melanoma n=2 Pancreatic n=2 Epidermoid n=2 Adrenal n=1 Others n=8 Ambulant patients [proportion who were ambulant]: Not reported. Patients with neurological symptoms [proportion with neurological symptoms]: Pre-operative Frankel score: Frankel A n=9 Frankel B n=20 Frankel C n=33 Frankel D n=39 Frankel E n=16 Patients with bladder or bowel symptoms [proportion with bladder/bowel symptoms]: Not reported.
Predictors	Tokuhashi score.
Type of prediction study	Prediction model external validation
Duration of follow-up	12 months.
Setting	Tertiary care
Sources of funding	None.
Other information	Surgery was performed if the radiology was concordant with the neurologic presentation and there was 1 of the following features: spinal instability, progressive deformity, symptomatic spinal cord compression with progressive neurologic deficit, intractable pain, and tumour resistance to radiotherapy and chemotherapy. The surgical planning was subtotal tumor removal and spinal cord or spinal nerve decompression, and stabilization with pedicle screws when instability was detected. All patients underwent laminectomy with or without instrumentation. Stabilization with pedicle screws with or without anterior reconstruction was necessary in 52 cases (44.4%).
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	Low
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	Low
Overall Risk of bias and Applicability	Risk of bias	Low
Overall Risk of bias and Applicability	Concerns about applicability	Low

Petteys, 2015 Petteys R, Spitz S, Rhee J, et al. Tokuhashi score is predictive of survival in a cohort of patients undergoing surgery for renal cell carcinoma spinal metastases. European Spine Journal, 24, 2142-9, 2015

Study details

Country/ies where study was carried out	United States.
Study type	Retrospective cohort study
Study dates	January 2000 - December 2011.
Inclusion criteria	All patients who underwent spinal surgery for metastatic disease at a single institution from January 2000 to December 2011. Indications for surgery included: • severe back or extremity pain • clinical or radiographic evidence of instability • neurological dysfunction • need for diagnosis in the case of unknown spinal lesions.

Exclusion criteria	Not reported.
Patient characteristics	N=30 Patients undergoing surgical treatment for renal cell carcinoma spinal metastases. Age, mean, years (range): 57.6 (29 – 79). Sex [proportion of female, male]: female n=7; male n=23. Primary cancer types [proportion with each]: All patients had renal cell carcinoma. Ambulant patients [proportion who were ambulant]: Not reported. Patients with neurological symptoms [proportion with neurological symptoms]: None (Frankel E) n=21. Some degree of palsy (Frankel C – D) n=8. Complete paralysis (Frankel A – B) n=1. Patients with bladder or bowel symptoms [proportion with bladder/bowel symptoms]: Not reported.
Predictors	Revised Tokuhashi score.
Type of prediction study	Prediction model external validation
Duration of follow-up	12 months.
Setting	All patients who underwent spinal surgery for metastatic disease at a single institution from January 2000 to December 2011. N=30 patients underwent 40 procedures.
Sources of funding	Not reported.
Other information	Prior to surgery, all patients were evaluated with magnetic resonance imaging and computed tomography scanning of the spine to confirm the extent of tumour involvement in the spine. Systemic metastases were also identified using computed tomography of the chest, abdomen, and pelvis and nuclear scintigraphy or positron emission tomography. Computed tomography or magnetic resonance imaging of the brain was performed when clinically indicated. Indications for surgery included severe back or extremity pain, clinical or radiographic evidence of instability, neurological dysfunction, and the need for diagnosis in the case of unknown spinal lesions. The operative approach was determined by the primary operating surgeons and ranged from decompressive laminectomy to en-bloc resection with negative surgical margins via posterior only, anterior–posterior intralesional, or extralesional approaches. Internal fixation and stabilization were performed in all but one patient. Preoperative arterial embolization was performed in 24 out of 30 cases. The indications for surgery included significant pain in 21 of 30 patients (70 %), neurological dysfunction in 9 patients (30 %),

	and isolated metastasis or lesion progression on routine imaging. Preoperative medical treatments including spinal radiation therapy and chemo/immunotherapy were performed in 15 (50 %) and 12 (40 %) patients, respectively. Transarterial embolization was also performed in 24 (80 %) patients prior to tumour resection. Preoperative embolization was not performed in 6 out of 30 cases. In two of these cases, the procedure was aborted due to fear of inducing spinal cord ischemia. In four cases, the primary cancer was unknown at the time of surgery. Tokuhashi scores were then calculated for each patient and grouped by expected survival (Table 3). There were 15 patients with a preoperative score of 12–15, seven patients had an intermediate score of 9–11, and eight patients had a score of 0–8. Preoperative score predicted actual survival in 53 % of patients but was accurate in 10/15 (67 %) patients in the high score group and 5/7 (71 %) patients in the intermediate score group.
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	High. *Renal cell carcinoma patients only.*
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	High. *Low number of participants, (N=30). PROBAST guidance is at least 100 participants for validation studies])*
Overall Risk of bias and Applicability	Risk of bias	High. Risk of bias due to low number of participants.

Section	Question	Answer
Overall Risk of bias and Applicability	Concerns about applicability	High. Only included patients with r*enal cell carcinoma.*

Quraishi, 2013
Quraishi N, Manoharan S, Arealis G, et al. Accuracy of the revised Tokuhashi score in predicting survival in patients with metastatic spinal cord compression (MSCC). European Spine Journal, 22, 21-6, 2013

Study details

Country/ies where study was carried out	United Kingdom.
Study type	Retrospective cohort study
Study dates	October 2003 - October 2011.
Inclusion criteria	Patients undergoing urgent or semi-urgent surgical intervention for metastatic spinal cord compression.
Exclusion criteria	• < 18 years. • Patients managed by non operative means.
Patient characteris-tics	N=201 patients with spinal metastases managed surgically. Age, mean, years (range): 61 (18 – 86). Sex [proportion of female, male]: female n=74; male n=127. Primary cancer types [proportion with each]: Breast n=29 Haematological n=28 Renal n=26 Prostate n=26 Lung n=23 Gastro-intestinal n=11 Sarcoma n=9 Others n=49 Ambulant patients [proportion who were ambulant]: Not reported. Patients with neurological symptoms [proportion with neurological symptoms]: Frankel score at presentation –

	All patients Frankel A n=9 Frankel B n=6 Frankel C n=33 Frankel D n=107 Frankel E n=46. Group 1 (Tokuhashi score 0 – 8) Frankel A n=6 Frankel B n=4 Frankel C n=16 Frankel D n=40 Frankel E n=18 Group 2 (Tokuhashi score 9 – 11) Frankel A n=3 Frankel B n=1 Frankel C n=13 Frankel D n=50 Frankel E n=16 Group 3 (Tokuhashi score 12 – 15) Frankel A n=0 Frankel B n=1 Frankel C n=4 Frankel D n=17 Frankel E n=12 Patients with bladder or bowel symptoms [proportion with bladder/bowel symptoms]: Not reported.
Predictors	Revised Tokuhashi.
Type of prediction study	Prediction model external validation
Duration of follow-up	> 3 years.
Setting	Secondary care

Sources of funding	Not reported
Other information	All patients included in the study had surgical intervention in the form of decompression and stabilisation. Posterior decompression and stabilisation was performed in 171 patients (with vertebrectomy in 31), combined anterior and posterior approaches were used in 18 patients and 12 had an anterior approach only.
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	High. *Only patients undergoing urgent or semi-urgent surgical intervention were included.*
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	Low
Overall Risk of bias and Applicability	Risk of bias	Low
Overall Risk of bias and Applicability	Concerns about applicability	High. *Only included those undergoing urgent or semi-urgent procedures.*

Ribas, 2016 Ribas E, Mathias Junior L, Guirado V, et al. Survival score scales of patients operated with spinal metastases: retrospective application in a Brazilian population. Arquivos de neuro-psiquiatria, 74, 44-9, 2016

Study details

Country/ies where study was carried	Brazil.

out	
Study type	Retrospective cohort study
Study dates	July 2008 - March 2010.
Inclusion criteria	• < 18 years • Referred to neurosurgery due to neurological presentation related to spinal cord epidural metastasis • complete radiological investigation.
Exclusion criteria	• Paediatric patients • Incomplete radiological investigation
Patient characteris-tics	N=17 patients undergoing surgery for spinal cord epidural metastasis. Age, mean, years (range): 65 (29 – 77). Sex [proportion of female, male]: female n=3; male n=14. Primary cancer types [proportion with each]: Colorectal n=1 Kidney n=3 Liver n=1 Lung n=3 Prostate n=6 Thyroid n=3 Ambulant patients [proportion who were ambulant]: Not reported. Patients with neurological symptoms [proportion with neurological symptoms: All patients had spinal cord compression symptoms at time of surgery. Frankel A n=0 Frankel B n=1 Frankel C n=9 Frankel D n=4 Frankel E n=3 Patients with bladder or bowel symptoms [proportion with bladder/bowel symptoms]: Not reported.
Predictors	• Bauer. • Revised Tokuhashi. • Tomita.
Type of prediction study	Prediction model external validation

Duration of follow-up	Seventeen patients were followed-up by a mean period of 8.85 months (range: 1-27). At the end of follow-up, 13 (76%) patients had already died with a mean actual survival time of 5.03 months (range: 1-27 months) and four patients were still alive, all of them for more than one year after surgery.
Setting	Secondary care
Sources of funding	Not reported.
Other information	The decision to operate, and the operative technique, were made independently by neurosurgical staff and not using any score scale as a protocol. Surgeries were designed to partially (or sub-totally) remove the tumor and decompress neurological structures, in order to re-establish neurological function and alleviate pain. Vertebral fixation and stabilization was done only if signs of spinal instability were noted. All patients were submitted to thoracic and abdominal CT scan to screen for other metastases, and bone scan was made if bone metastases were suspected, before surgery or during follow-up if there was not a complete radiological screening before operation because of the emergency need in some cases. Seven patients (29%) were lost during follow-up and, finally, all necessary information to complete the three score systems about 17 patients could be noted and is presented in this study. Surgical technique was chosen independently without a protocol, resulting in 58% of surgeries performed only to decompress the spinal cord and not aiming to radically resect the tumour.
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	Low
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low

Section	Question	Answer
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	High. *Low number of participants (N=17). PROBAST guidance is at least 100 participants for validation studies])*
Overall Risk of bias and Applicability	Risk of bias	High. Risk of bias due to low number of participants.
Overall Risk of bias and Applicability	Concerns about applicability	Low

Tabourel, 2021 Tabourel G, Terrier L, Dubory A, et al. Are spine metastasis survival scoring systems outdated and do they underestimate life expectancy? Caution in surgical recommendation guidance. Journal of Neurosurgery – Spine, 35, 527-534, 2021

Study details	
Country/ies where study was carried out	France.
Study type	Prospective cohort study
Study dates	January 2014 - 2017.
Inclusion criteria	Not reported.
Exclusion criteria	Not reported.
Patient characteristics	N=739 consecutive patients treated for spinal metastasis at multiple institutions. Age, mean, years (SD): At diagnosis 64.05 (12.1). No other data on age reported. Sex [proportion of female, male]: female n=314; male n=425. Primary cancer types [proportion with each]: Lung n=210 Breast n=123 Blood cancer n=81 GI n=79 Prostate n=72 Renal n=55

	Thyroid n=51 ENT n=23 Melanoma n=19 Bladder n=18 Other n=7 Ambulant patients [proportion who were ambulant]: Not reported. Patients with neurological symptoms [proportion with neurological symptoms: Not reported. Patients with bladder or bowel symptoms [proportion with bladder/bowel symptoms]: Not reported.
Predictors	• Bauer • Lei • Rades • Revised Tokuhashi • Tomita • Van der Linden NB. Accuracy data generated from analysis of patients who underwent surgery (n=174) rather than database as a whole.
Type of prediction study	Prediction model external validation
Duration of follow-up	36 months.
Setting	Tertiary care
Sources of funding	Not reported.
Other information	Intervention = simple decompressive and/or or stabilisation surgery.
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	Low
Predictors or their assessment	Risk of bias for predictors or their assessment	Low

Section	Question	Answer
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	Low
Overall Risk of bias and Applicability	Risk of bias	Low
Overall Risk of bias and Applicability	Concerns about applicability	Low

Tabouret, 2015 Tabouret E, Cauvin C, Fuentes S, et al. Reassessment of scoring systems and prognostic factors for metastatic spinal cord compression. Spine Journal, 15, 944-50, 2015

Study details

Country/ies where study was carried out	France.
Study type	Retrospective cohort study
Study dates	January 2004 - November 2010.
Inclusion criteria	• ≥ 18 years • Clinically and neuroimaging proven spinal cord or radicular metastatic compression, regardless of primary cancer. • Patients with multiple compressions could be included. The indication for surgery was spinal cord compression proven by magnetic resonance imaging associated with pain and/or neurologic manifestations.
Exclusion criteria	Not reported.
Patient characteristics	N=148 patients undergoing surgery for metastatic spinal cord compression. Age, median, years (range): 60 (22 – 87). Sex [proportion of female, male]: female n=71, male n=77. Primary cancer types [proportion with each]: Solid tumours, n=125. Breast n=27 Lung n=25

	Kidney n=20 Prostate n=17 Colorectal n=10 Urothelial n=5 Sarcoma n=5 Undetermined n=3 Pancreas n=3 Thyroid n=2 Otorhinolaryngologic carcinoma n=2 Adenoid cystic carcinoma n=1 Adrenocortical carcinoma n=1 Melanoma n=1 Ovarian n=1 Hepatocellular n=1 Cardia n=1 Haematologic malignancies, n=23 Myeloma n=13 Non-Hodgkin Lymphoma n=10. Ambulant patients [proportion who were ambulant]: Not reported. Patients with neurological symptoms [proportion with neurological symptoms]: Preoperative Frankel Scores - A n=4; B n=4; C n=11; D n=51; E n=74. Patients with bladder or bowel symptoms [proportion with bladder/bowel symptoms]: Not reported. Nb. n=56 patients had cardiovascular comorbidities.
Predictors	Revised Tokuhashi scoring system.
Type of prediction study	Prediction model external validation
Duration of follow-up	24 months
Setting	Consecutive patients who underwent surgical treatment of spinal cord compression at one clinic in France.
Sources of funding	Not reported.
Other information	The type of surgery was decided after multidisciplinary discussion, involving oncologists, radiotherapists, and neurosurgeons. Surgical strategy (vertebrectomy, laminectomy and spinal fixation, kyphoplasty) was influenced by the risk of instability of vertebral metastatic lesions.

Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	Low
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	Low
Overall Risk of bias and Applicability	Risk of bias	Low
Overall Risk of bias and Applicability	Concerns about applicability	Low

Tan, 2016a Tan J, Zaw A, Malhotra R, et al. Survival prognostication in patients with skeletal metastases from nasopharyngeal carcinoma: An evaluation of the Scandinavian sarcoma group, Katagiri and Bauer scoring systems. Annals of the Academy of Medicine Singapore, 45, 51-60, 2016

Study details

Country/ies where study was carried out	Singapore
Study type	Retrospective cohort study
Study dates	2007 to 2011
Inclusion criteria	Patients with nasopharyngeal carcinoma and skeletal metastases, treated at a single institution.
Exclusion criteria	Not reported
Patient characteris-tics	N=92 patients with nasopharyngeal carcinoma and skeletal metastases.

	Age, median, years (range): 52 (26 – 90). Sex [proportion of female, male]: female n=19; male n=73. Primary cancer types [proportion with each]: 100% Nasopharyngeal carcinoma Ambulant patients [proportion who were ambulant]: Not reported. Patients with neurological symptoms [proportion with neurological symptoms]: Not reported. Patients with bladder or bowel symptoms [proportion with bladder/bowel symptoms]: Not reported.
Predictors	• Bauer • Katagiri • Scandinavian Sarcoma Group (SSG)
Type of prediction study	Model external validation study
Duration of follow-up	At least 12 months for survivors.
Setting	Tertiary care
Sources of funding	Not reported
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	*High. Only included patients with nasopharyngeal cancer.*
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low

Section	Question	Answer
Analysis	Risk of bias for analysis	High. *Low number of participants (N=92). PROBAST guidance is at least 100 participants for validation studies])*
Overall Risk of bias and Applicability	Risk of bias	High. Risk of bias due to low numbers of participants.
Overall Risk of bias and Applicability	Concerns about applicability	*High. Only included patients with nasopharyngeal cancer.*

Tan, 2016b Tan J, Tan K, Zaw A, et al. Evaluation of Scoring Systems and Prognostic Factors in Patients With Spinal Metastases From Lung Cancer. Spine, 41, 638-44, 2016

Study details

Country/ies where study was carried out	Singapore
Study type	Retrospective cohort study
Study dates	May 2001 - April 2012
Inclusion criteria	Electronic diagnostic codes were used to identify patients with spinal metastases
Exclusion criteria	Patients with incomplete clinical/radiological investigations, or were lost to follow-up with time of death unknown
Patient characteristics	N=180 Patients with spinal metastases from the lung Age, mean, years (SD): 62.6 (11.6) Sex: male (number) n=106 Palsy (Frankel score): None - 95, 52.8% Incomplete - 81, 45.0% Complete - 4, 2.2%
Predictors	• modified Tokuhashi • Tomita • modified Bauer • Oswestry score

Type of prediction study	Model external validation
Duration of follow-up	6 months
Setting	Tertiary care
Sources of funding	None
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	High. Only included patients with lung cancer.
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	Low
Overall Risk of bias and Applicability	Risk of bias	Low
Overall Risk of bias and Applicability	Concerns about applicability	High. Only included patients with lung cancer.

Tan, 2018 Tan K, Tan J, Zaw A, et al. Evaluation of Prognostic Factors and Proposed Changes to the Modified Tokuhashi Score in Patients With Spinal Metastases From Breast Cancer. Spine, 43, 512-519, 2018

Study details

Country/ies where study was carried out	Singapore
Study type	Retrospective cohort study

Study dates	2001 to 2017
Inclusion criteria	Female patients with breast cancer and spinal metastases presenting to a single institution
Exclusion criteria	Incomplete clinical/radiological findings, unknown time of death (loss to follow-up)
Patient characteristics	N=185 patients with breast cancer and spinal metastases Age, median, years (range): 59.4 (28 – 93). Sex [proportion of female/male]: female n=185, male n=0. Primary cancer types [proportion of each]: breast n=185. Ambulant patients [proportion who were ambulant]: All had good or moderate KPS Patients with neurological symptoms [proportion with neurological symptoms]: not reported Patients with bladder or bowel symptoms [proportion with bladder/bowel symptoms]: not reported
Predictors	• Revised Tokuhashi Score • Modified Revised Tokuhashi Score
Type of prediction study	Model external validation study
Duration of follow-up	Not reported
Setting	Tertiary care
Sources of funding	No funds were received in support of this work.
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	High. Only included patients with breast cancer.
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assess-	Low

Section	Question	Answer
	ment	
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	Low
Overall Risk of bias and Applicability	Risk of bias	Low
Overall Risk of bias and Applicability	Concerns about applicability	High. Only included patients with breast cancer.

Ulmar, 2007 Ulmar, B, Huch, K, Naumann U, et al. Evaluation of the Tokuhashi prognosis score and its modifications in 217 patients with vertebral metastases. European Journal of Surgical Oncology, 33, 914-9, 2007

Study details

Country/ies where study was carried out	Germany
Study type	Retrospective cohort study
Study dates	1984 to 2005
Inclusion criteria	Patients treated surgically at a single institution for spinal metastases.
Exclusion criteria	Not reported
Patient characteristics	N=217 patients with spinal metastases Age, mean, years (SD): not reported. Sex [proportion of female, male]: female n=103; n=114 male. Primary cancer types [proportion of each]: breast 29%, renal 18%, lung 10%, unknown primary 9%, prostate 8%, thyroid % Ambulant patients [proportion who were ambulant]: Not reported. 27% had poor KPS Patients with neurological symptoms [proportion with neurological symptoms]: Not reported. 45% had complete or incomplete spinal cord palsy on Frankel scale Patients with bladder or bowel symptoms [proportion with bladder/bowel symptoms]: Not reported.
Predictors	• Tokuhashi scoring system (T12)

	• Revised Tokuhashi scoring system (T15)
Type of prediction study	Model external validation study.
Duration of follow-up	At least 12 months for survivors.
Setting	Tertiary care
Sources of funding	Not reported
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Unclear
Selection of participants	Concerns about applicability of selection of participants	High. Patient enrolment predates the MRI era.
Predictors or their assessment	Risk of bias for predictors or their assessment	High. Different imaging used for different participants.
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Unclear
Outcome or its determination	Risk of bias for outcome or its determination	Unclear
Outcome or its determination	Concerns about applicability of outcome or its determination	Unclear
Analysis	Risk of bias for analysis	Unclear
Overall Risk of bias and Applicability	Risk of bias	High. Risk of bias due to assessment of predictors.
Overall Risk of bias and Applicability	Concerns about applicability	High. Concerns regarding applicability of patients (enrolment predates MRI era).

Wang, 2012 Wang M, Bunger C, Li H, et al. Predictive value of Tokuhashi scoring systems in spinal metastases, focusing on various primary tumor groups: evaluation of 448 patients in the Aarhus spinal metastases database. Spine, 37, 573-8, 2012

Study details

Country/ies where study was carried out	Denmark
Study type	Prospective cohort study
Study dates	1992-1994
Inclusion criteria	Patients with confirmed spinal metastases who underwent surgical treatment in the study institution and were available for follow-up
Exclusion criteria	Primary spinal tumours. Follow-up of <12 months
Patient characteristics	N=448 patients with confirmed spinal metastases who under-went surgical treatment Age, mean, years (range): 63 (24 – 89). Sex [proportion of female, male]: female n=177; male n=271. Primary cancer types [proportion with each]: prostate (23.9%), breast (20.5%), lung (12.5%), renal (7.8%), colon (5.5%), unknown primary (14.5%) Ambulant patients [proportion who were ambulant]: Not reported. Patients with neurological symptoms [proportion with neurological symptoms]: Not reported. Patients with bladder or bowel symptoms [proportion with bladder/bowel symptoms]: Not reported.
Predictors	• Tokuhashi scoring system (T12) • Revised Tokuhashi scoring system (T15)
Type of prediction study	Model external validation study.
Duration of follow-up	At least 12 months for survivors.
Setting	Tertiary care
Sources of funding	No funds received in support.
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	Low
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	Low
Overall Risk of bias and Applicability	Risk of bias	Low
Overall Risk of bias and Applicability	Concerns about applicability	Low

Westermann, 2020 Westermann L, Olivier A, Samel C, et al. Analysis of seven prognostic scores in patients with surgically treated epidural metastatic spine disease. Acta Neurochirurgica, 162, 109-11, 2020

Study details

Country/ies where study was carried out	Germany
Study type	Retrospective cohort study
Study dates	2008 to 2015
Inclusion criteria	Patients who underwent surgery for extradural metastases in the spine at an orthopaedic department of a university hospital. Age between 18 and 100 years at the time of surgery; complete electronic or digitalized medical records with clinical presentation, imaging, and operative notes available; surgical treatment; pathology proof of malignant cells from a viable biopsy; known date of death; or a minimum follow-up period of 12 months if alive with disease at the end of the study
Exclusion criteria	No further interventions such as biopsies or other percutaneous palliative interventions (for example, kyphoplasty), primary tumour of the spine, and revision surgery after prior external surgery for metastatic spine disease of the same locus.
Patient characteristics	N=223 patients who had surgery for spinal metastases Age, mean, years (SD): 62.3 (13.3). Sex [proportion of female, male]: female n=95; male n=128.

	Primary cancer types [proportion with each]: Not reported. Ambulant patients [proportion who were ambulant]: Not reported. Patients with neurological symptoms [proportion with neurological symptoms]: Not reported. Patients with bladder or bowel symptoms [proportion with bladder/bowel symptoms]: Not reported.
Predictors	• Tomita • Van der Linden (VDL) • Bauer modified (BM) • Oswestry Spinal Risk Index (OSRI) • Tokuhashi original (T90) • Tokuhashi revised (TR05) • Modified Tokuhashi revised
Type of prediction study	Model external validation study
Duration of follow-up	At least 12 months for survivors
Setting	Tertiary care
Sources of funding	Not reported
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	Low
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	Low
Overall Risk of bias and Applicability	Risk of bias	Low

Section	Question	Answer
Overall Risk of bias and Applicability	Concerns about applicability	Low

Yang, 2021 Yang J, Chen C, Fourman M, et al. International external validation of the SORG machine learning algorithms for predicting 90-day and one-year survival of patients with spine metastases using a Taiwanese cohort. Spine Journal, 21, 1670-16, 2021

Study details	
Country/ies where study was carried out	Taiwan
Study type	Retrospective cohort study
Study dates	2010 to 2018
Inclusion criteria	Age ≥ 18 years at the time of surgery, a diagnosis of spinal metastatic disease (solid tumour metastases, multiple myeloma, and lymphoma) with neurologic symptoms or an (impending) fracture, date of death recorded in the electronic medical record or the most recent follow-up available, and surgical resection.
Exclusion criteria	Patients without complete treatment reported at the study institution were excluded.
Patient characteristics	N=427 patients who had surgery for spinal metastases Age, median, years (IQR): 60 (52 – 67). Sex [proportion of female, male]: female n=166; male n=261. Primary cancer types [proportion of each]: not reported Ambulant patients [proportion who were ambulant]: Not reported. 56% had ECOG PS of 3-4 Patients with neurological symptoms [proportion with neurological symptoms]: Not reported. 65% had impairment on ASIA scale Patients with bladder or bowel symptoms [proportion with bladder/bowel symptoms]: Not reported
Predictors	SORG machine-learning algorithm
Type of prediction study	Model external validation study
Duration of follow-up	12 months
Setting	Tertiary care

Sources of funding	None reported
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	Low
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	Low
Overall Risk of bias and Applicability	Risk of bias	Low
Overall Risk of bias and Applicability	Concerns about applicability	Low

Yeung, 2014 Yeung Y, Cheung K, Lam T, et al. A Study of the Predictive Value of the Modified Tokuhashi Score in Metastatic Spinal Tumour Causing Cord Compression in a Southern Chinese Population; Journal of Orthopaedics, Trauma and Rehabilitation, 18, 15-21, 2014

Study details

Country/ies where study was carried out	China
Study type	Retrospective cohort study
Study dates	2001-2011
Inclusion criteria	Patients with spinal metastases and spinal cord compression, seen at a single institution.
Exclusion criteria	Follow-up < 12 months, haematological malignancy, uncertainty over diagnosis of malignancy, uncertainty over diagnosis of cord-compression
Patient characteris-tics	N=128 patients with spinal metastases.

	Age, mean, years (SD): 60.2 (12.0) Sex [proportion of female, male]: female n=37; male n=91. Primary cancer types [proportion of each]: lung (29.7%), breast (14.8%), prostate (9.4%), liver (7.8%), and nasopharynx (7.8%) Ambulant patients [proportion who were ambulant]: Not reported. 23/151 had poor KPS Patients with neurological symptoms [proportion with neurological symptoms]: 11/128 had complete spinal cord palsy, 87/128 had incomplete spinal cord palsy by Frankel grading. Patients with bladder or bowel symptoms [proportion with bladder/bowel symptoms]: Not reported
Predictors	Modified Tokuhashi score
Type of prediction study	Model external validation study
Duration of follow-up	At least 12 months for surviving patients.
Setting	Tertiary care
Sources of funding	Not reported
Results	See Appendix L

Critical appraisal - PROBAST tool

Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	Low
Selection of participants	Concerns about applicability of selection of participants	Low
Predictors or their assessment	Risk of bias for predictors or their assessment	Low
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	Low
Overall Risk of bias and Applicability	Risk of bias	Low
Overall Risk of bias and Applicability	Concerns about applicability	Low

Yu, 2015 Yu W, Tang L, Lin F, et al. Accuracy of Tokuhashi score system in predicting survival of lung cancer patients with vertebral metastasis. Journal of Neuro-oncology, 125, 427-33, 2015

Study details

Country/ies where study was carried out	China
Study type	Retrospective cohort study
Study dates	2008 to 2013
Inclusion criteria	Patients with lung cancer and vertebral metastases at seen a single institute.
Exclusion criteria	Not reported.
Patient characteristics	N=151 patients with spinal metastases from lung cancer. Age, mean, years (range): 57 (38 – 76). Sex [proportion of female, male]: female n=64 male n=87. Primary cancer types [proportion of each]: 100% lung cancer Ambulant patients [proportion who were ambulant]: 100% ambulant Patients with neurological symptoms [proportion with neurological symptoms]: Not reported Patients with bladder or bowel symptoms [proportion with bladder/bowel symptoms]: Not reported
Predictors	Revised Tokuhashi score
Type of prediction study	Model external validation study
Duration of follow-up	Minimum of 12 months - patients followed up until death.
Setting	Tertiary care
Sources of funding	Not reported
Results	See Appendix L

Critical appraisal - PROBAST tool

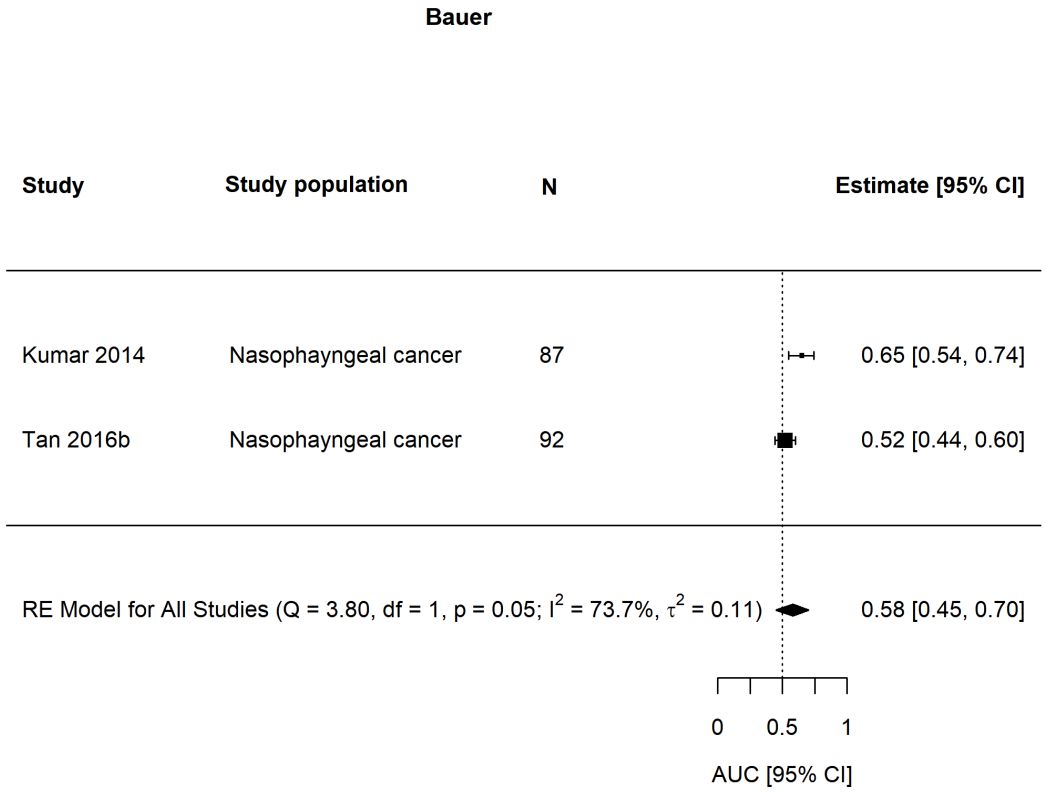
Section	Question	Answer
Selection of participants	Risk of bias for selection of participants	High. *Very limited information on inclusion and exclusion criteria.*
Selection of participants	Concerns about applicability of selection of participants	High. Only included lung cancer patients.
Predictors or their assessment	Concerns about applicability of predictors or their assessment	Low
Outcome or its determination	Risk of bias for outcome or its determination	Low
Outcome or its determination	Concerns about applicability of outcome or its determination	Low
Analysis	Risk of bias for analysis	Low
Overall Risk of bias and Applicability	Risk of bias	High. *Very limited information on inclusion and exclusion criteria.*
Overall Risk of bias and Applicability	Concerns about applicability	High. Only included lung cancer patients.

Appendix E Forest plots

Forest plots for review question: What is the prognostic value of validated scoring systems for determining survival in people with spinal cord compression caused by spinal metastases or direct malignant infiltration of the spine?

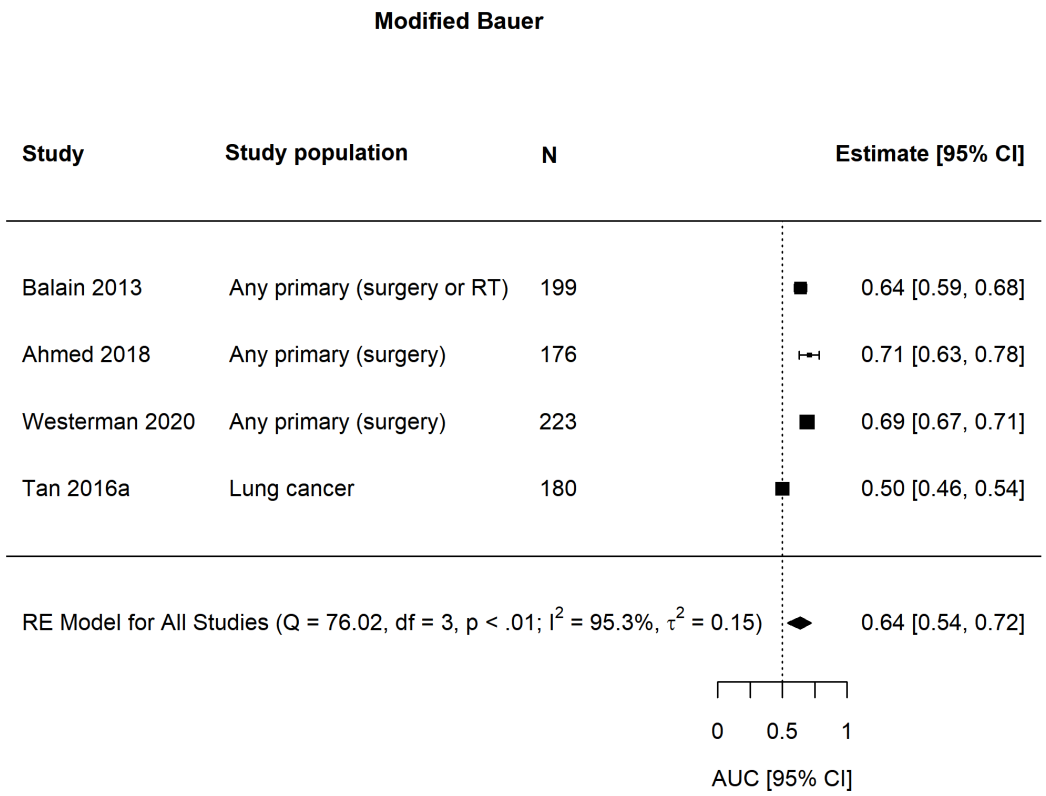
This section includes forest plots only for outcomes that are meta-analysed. Outcomes from single studies are not presented here; the quality assessment for such outcomes is provided in the GRADE profiles in appendix F.

Figure 2: AUC of Bauer for prediction of length of survival



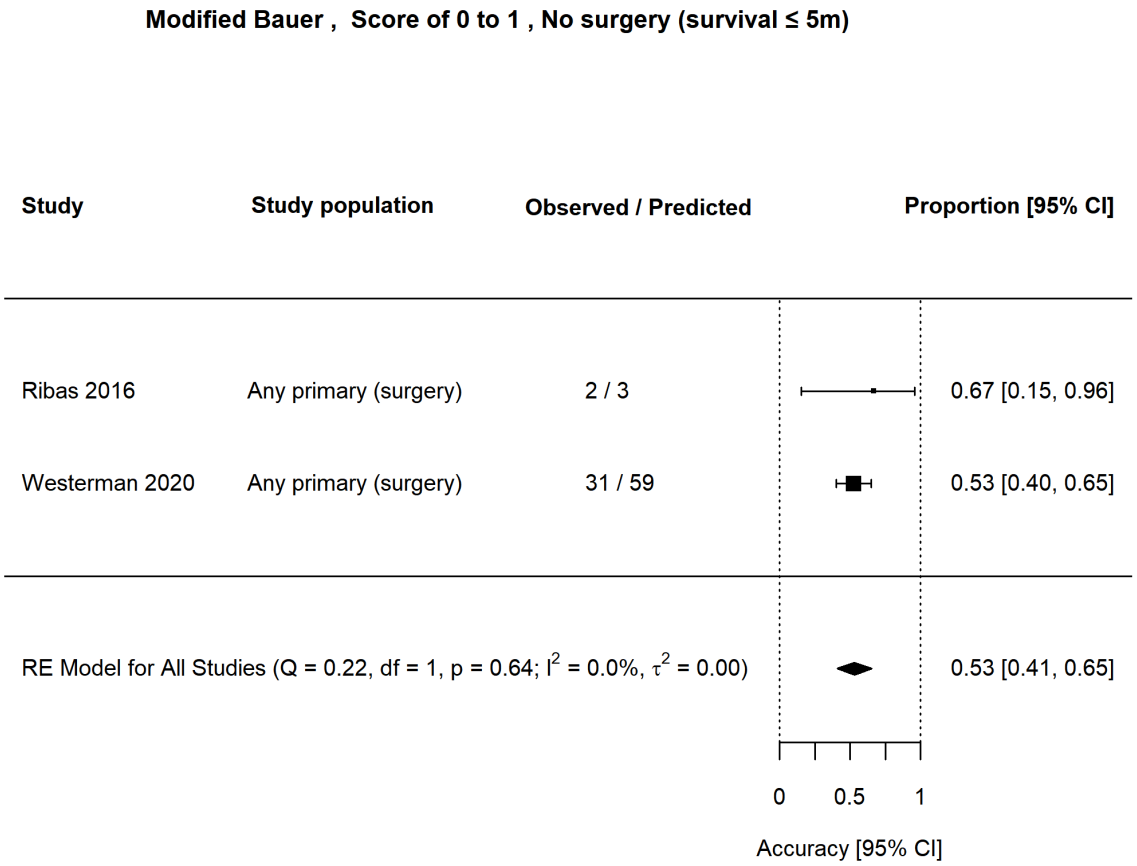
AUC: area under the ROC curve; CI confidence interval

Figure 3: AUC of Modified Bauer for prediction of length of survival



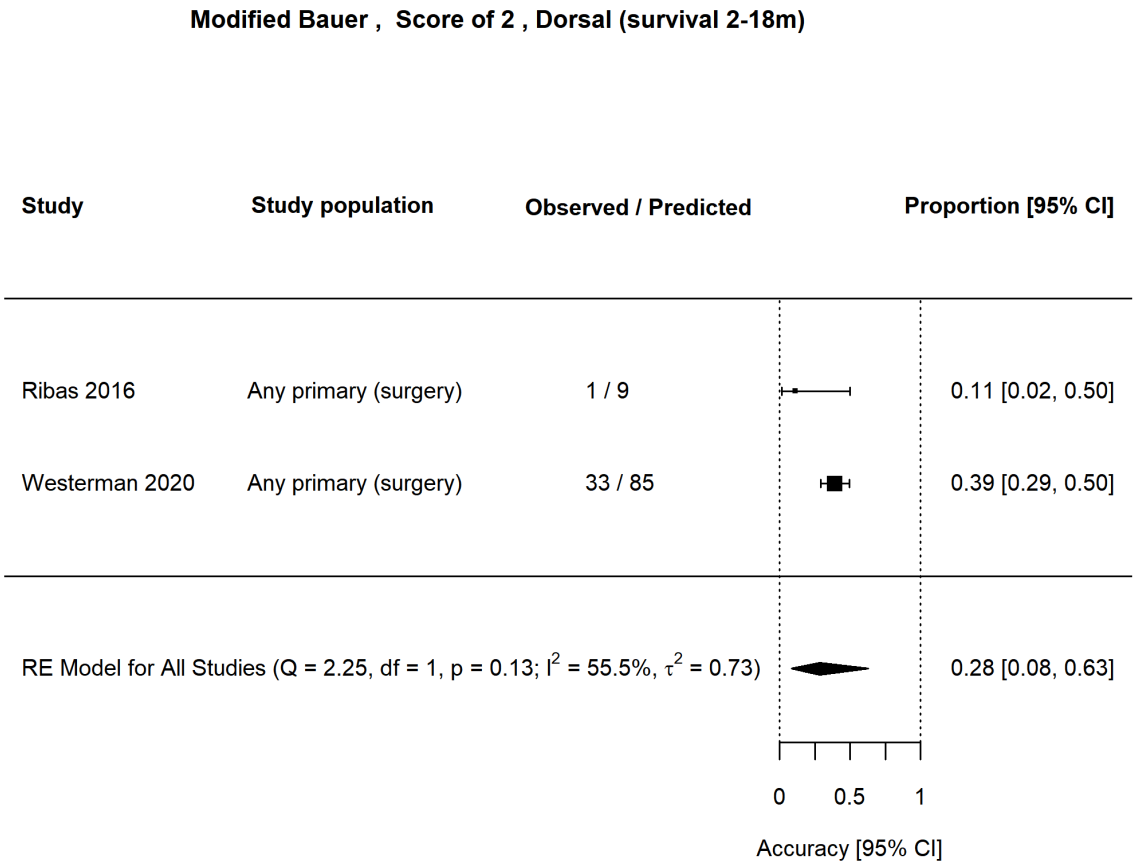
AUC: area under the ROC curve; CI confidence interval

Figure 4: Calibration accuracy of Modified Bauer in patients with score 0 -1: No surgery (survival ≤ 5m)



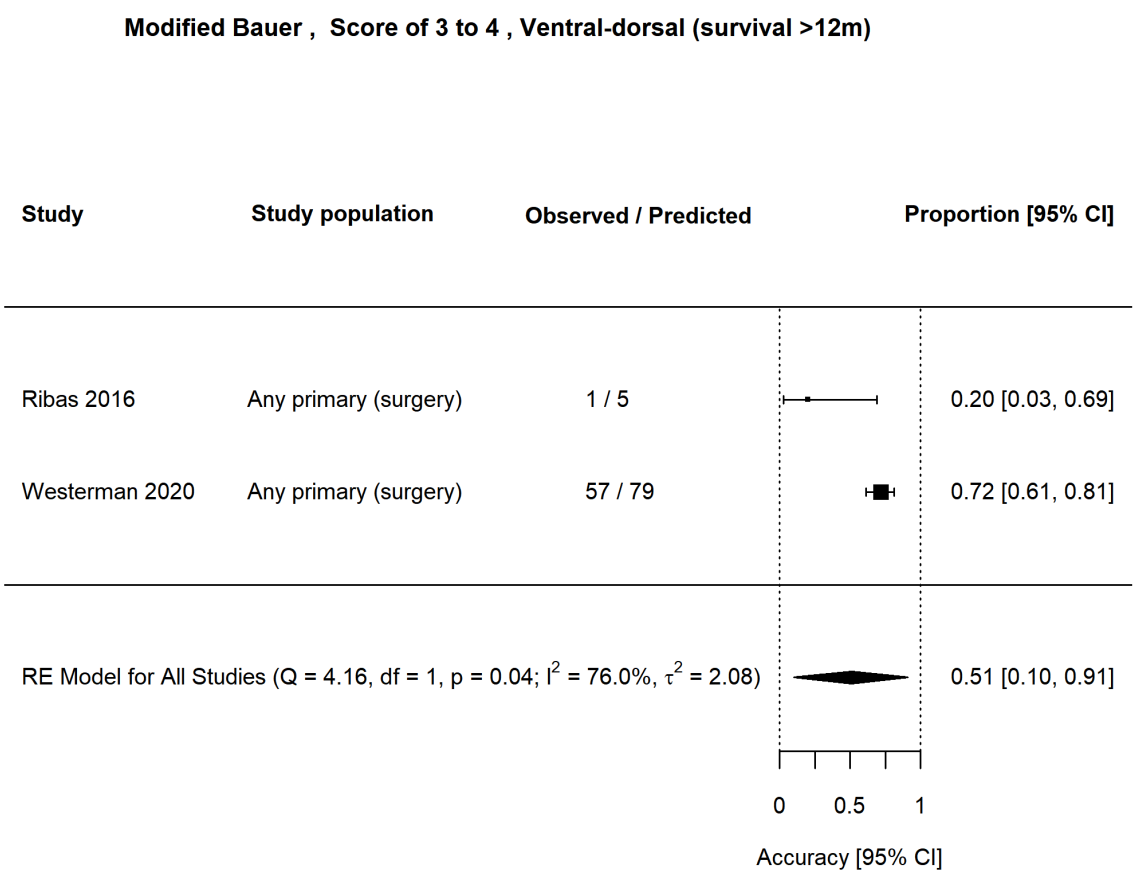
Proportion of patients predicted to survive ≤ 5 months who survived ≤ 5 months

Figure 5: Calibration accuracy of Modified Bauer in patients with score 2: Dorsal (survival 2-18m)



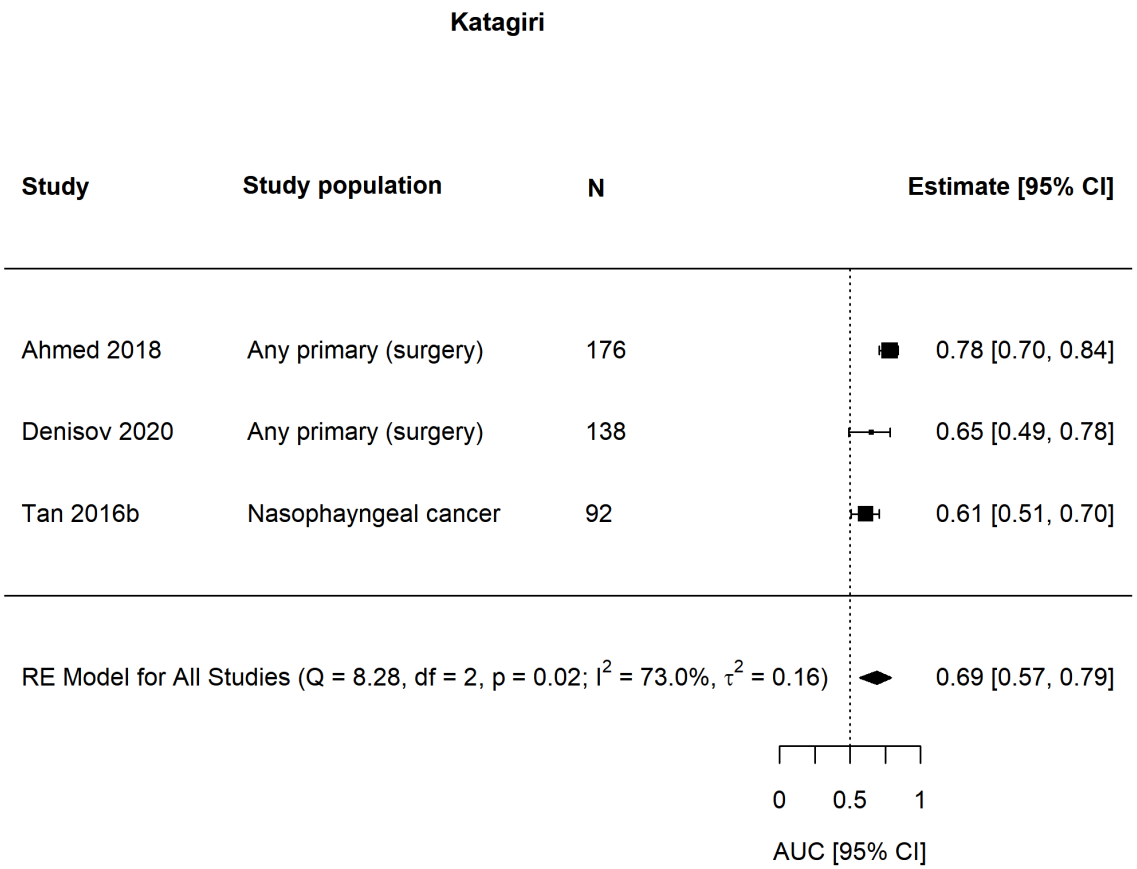
Proportion of patients predicted to survive 2-18 months who survived 2-18 months (but not longer)

Figure 6: Calibration accuracy of Modified Bauer in patients with score 3-4: Ventral-dorsal (survival >12m)



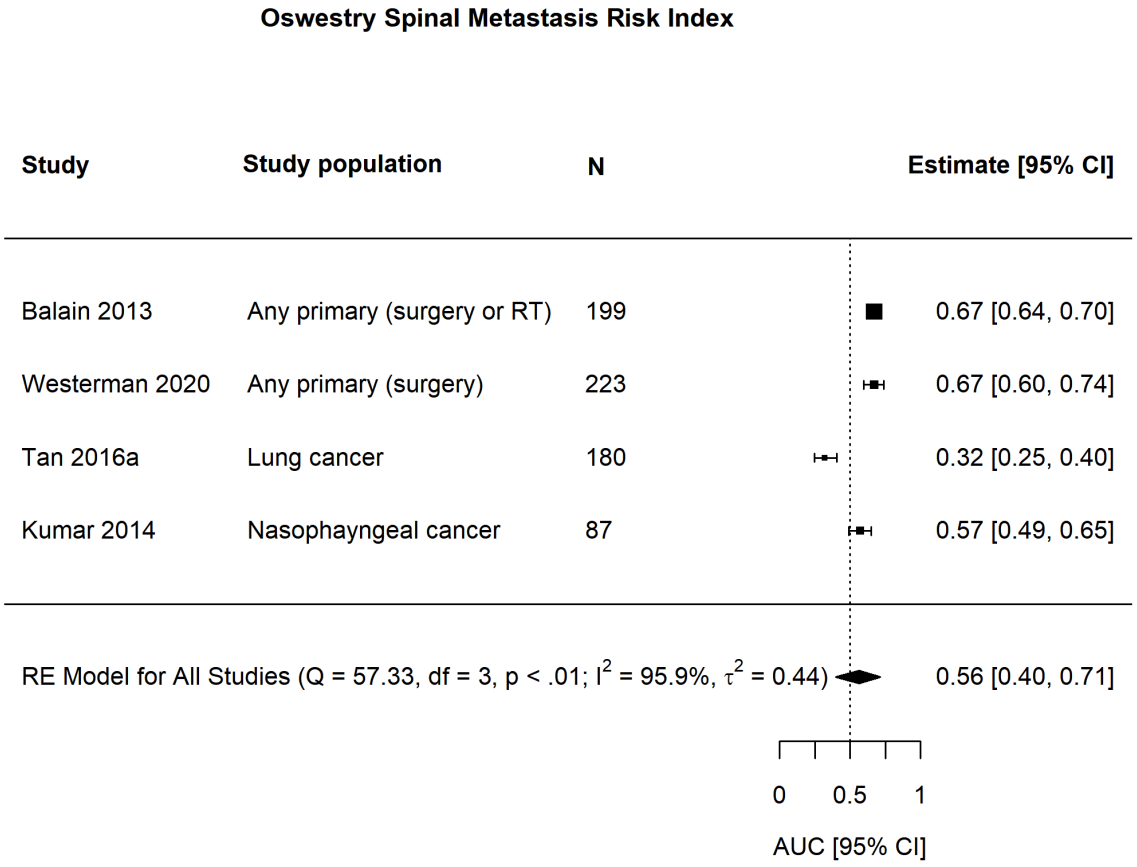
Proportion of patients predicted to survive >12 months who survived >12 months

Figure 7: AUC of Katagiri for prediction of length of survival



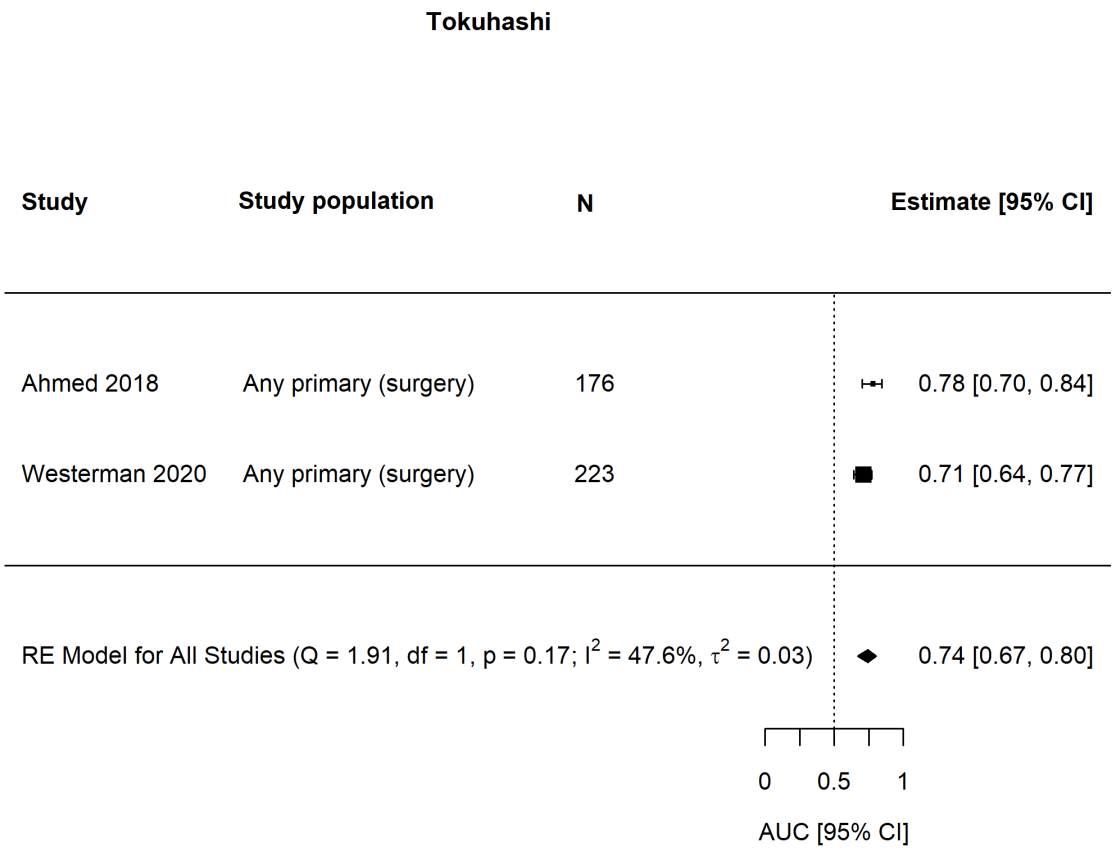
AUC: area under the ROC curve; CI confidence interval

Figure 8: AUC of Oswestry Spinal Metastasis Risk Index for prediction of length of survival



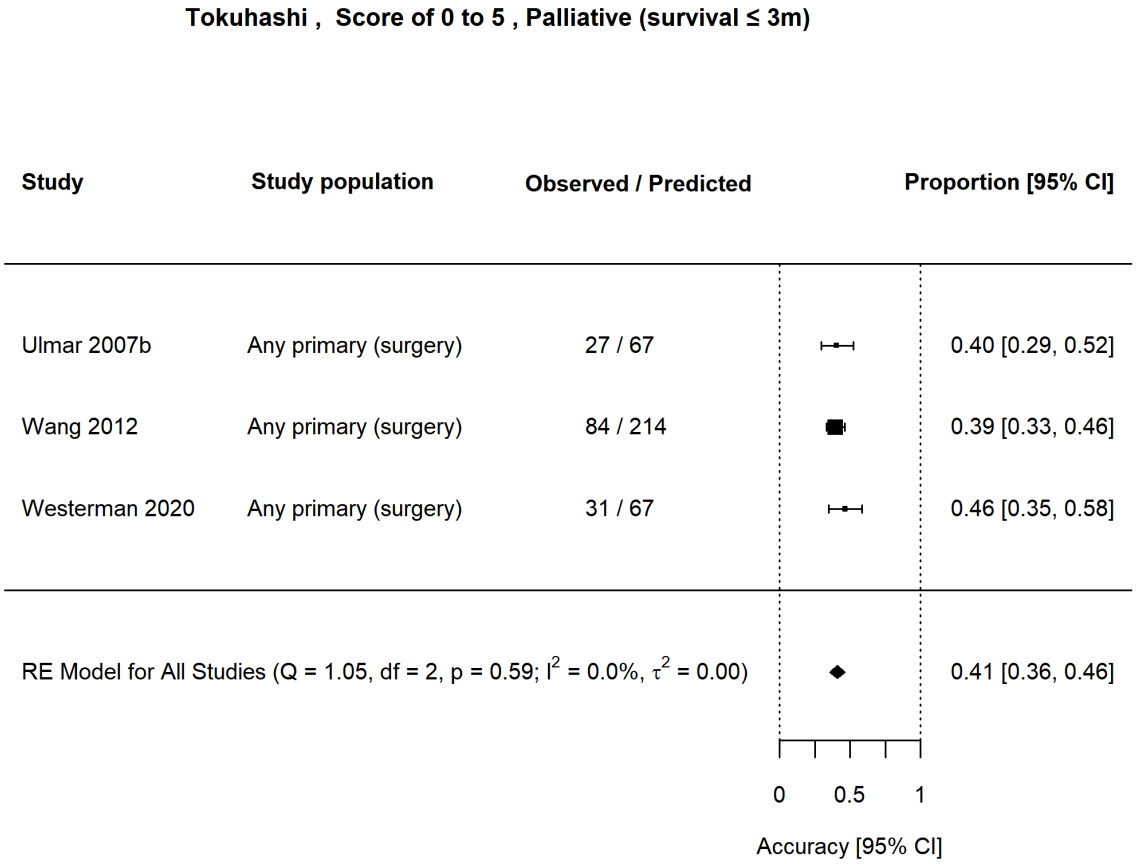
AUC: area under the ROC curve; CI confidence interval

Figure 9: AUC of Tokuhashi for prediction of length of survival



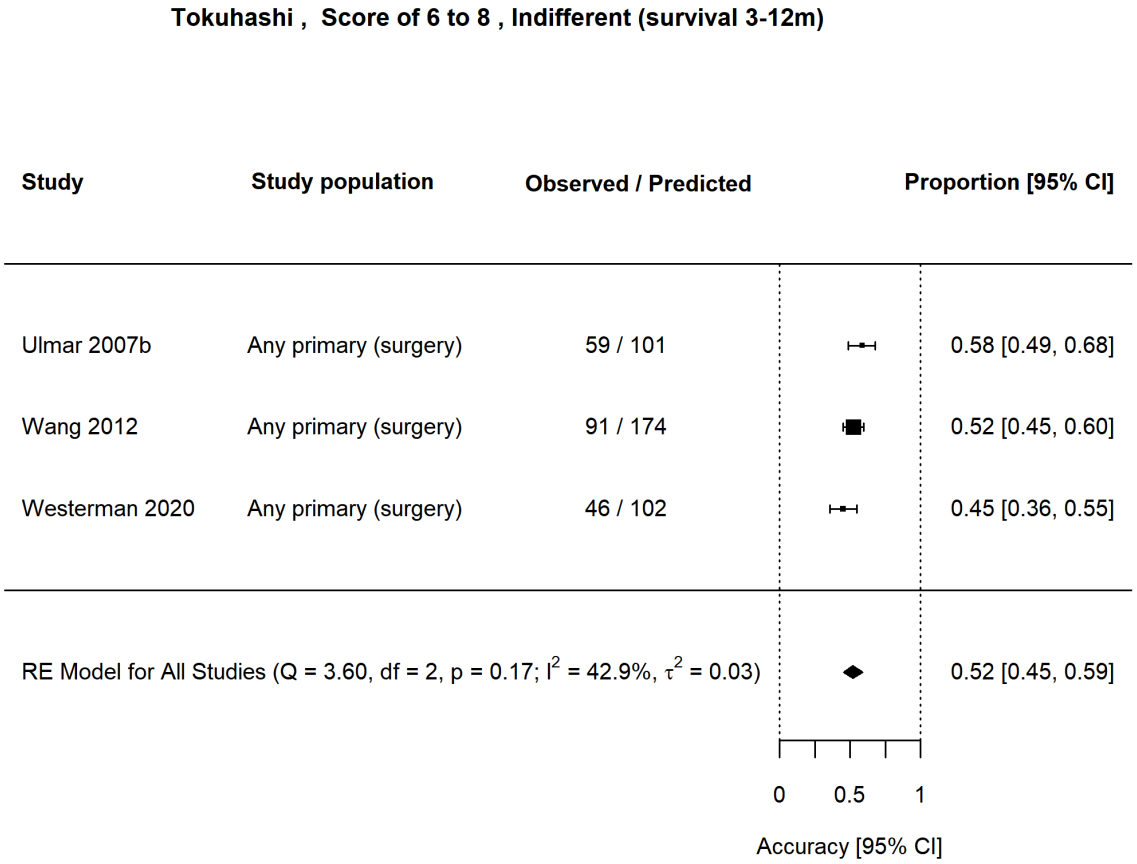
AUC: area under the ROC curve; CI confidence interval

Figure 10: Calibration accuracy of Tokuhashi Score in patients with score 0-5: Palliative (survival ≤ 3m)



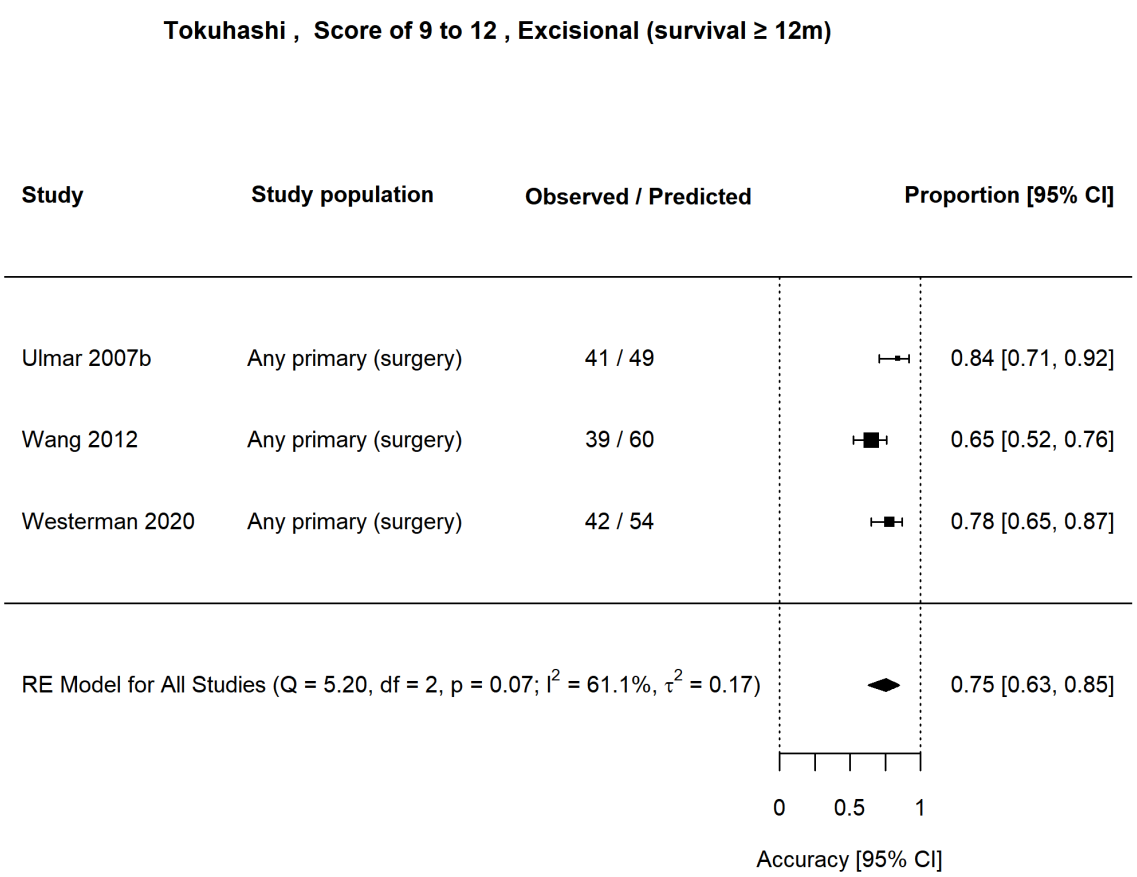
Proportion of patients predicted to survive <3 months who survived <3 months

Figure 11: Calibration accuracy of Tokuhashi Score in patients with score 6-8: Indifferent (survival 3-12m)



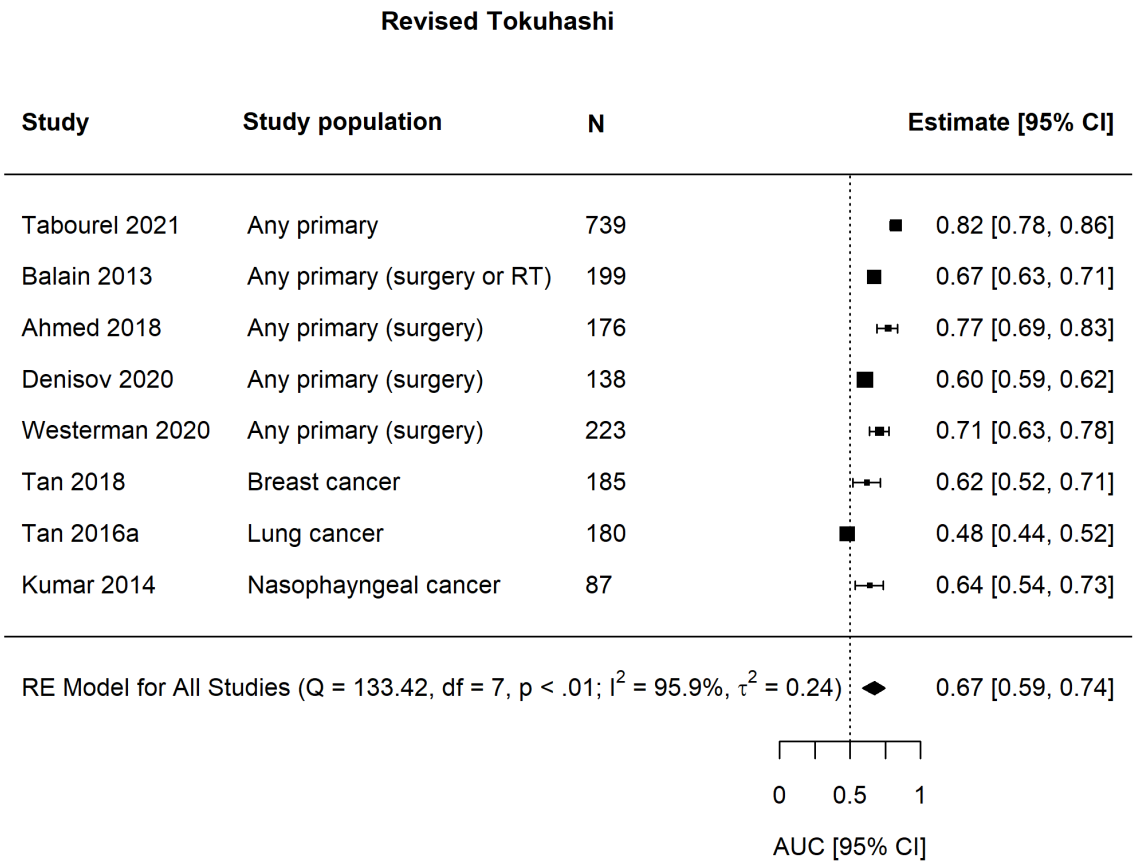
Proportion of patients predicted to survive 3-12 months who survived 3-12 months (and no longer)

Figure 12: Calibration accuracy of Tokuhashi Score in patients with score 9-12: Excisional (survival ≥ 12m)



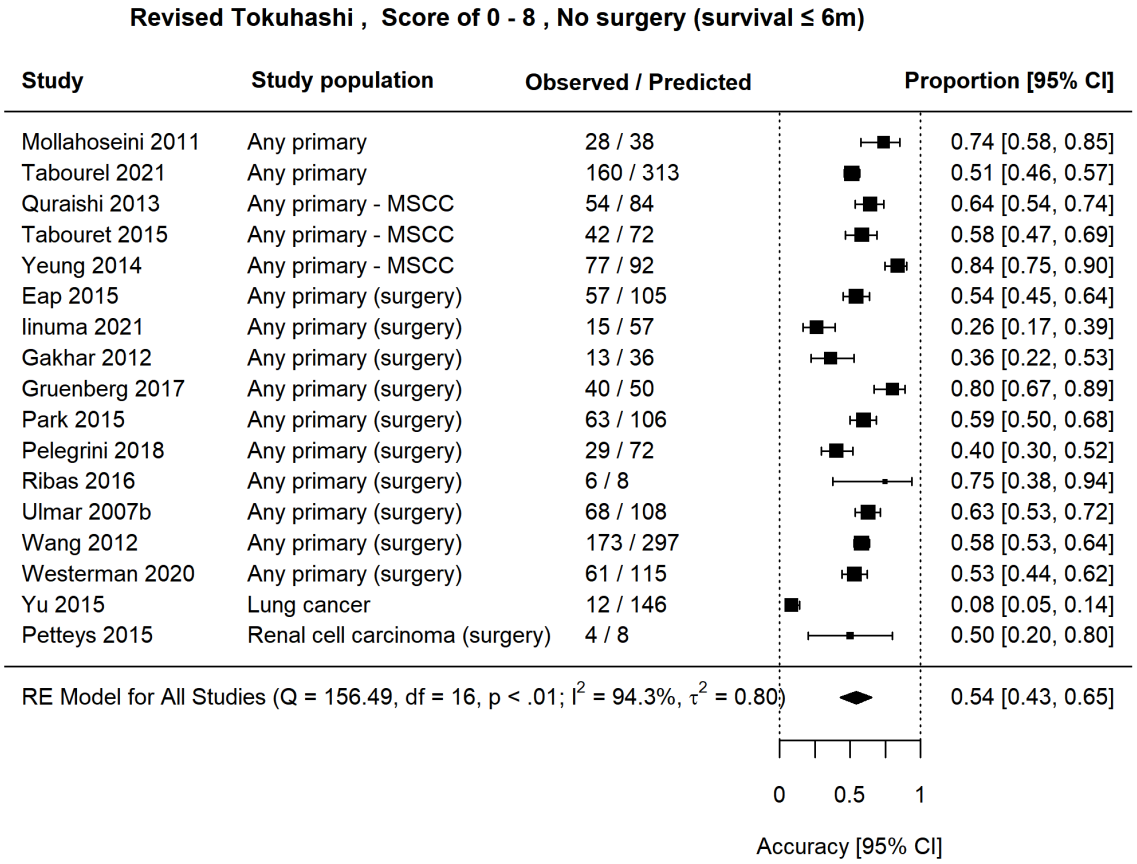
Proportion of patients predicted to survive >12 months who survived >12 months

Figure 13: AUC of Revised Tokuhashi Score for prediction of length of survival



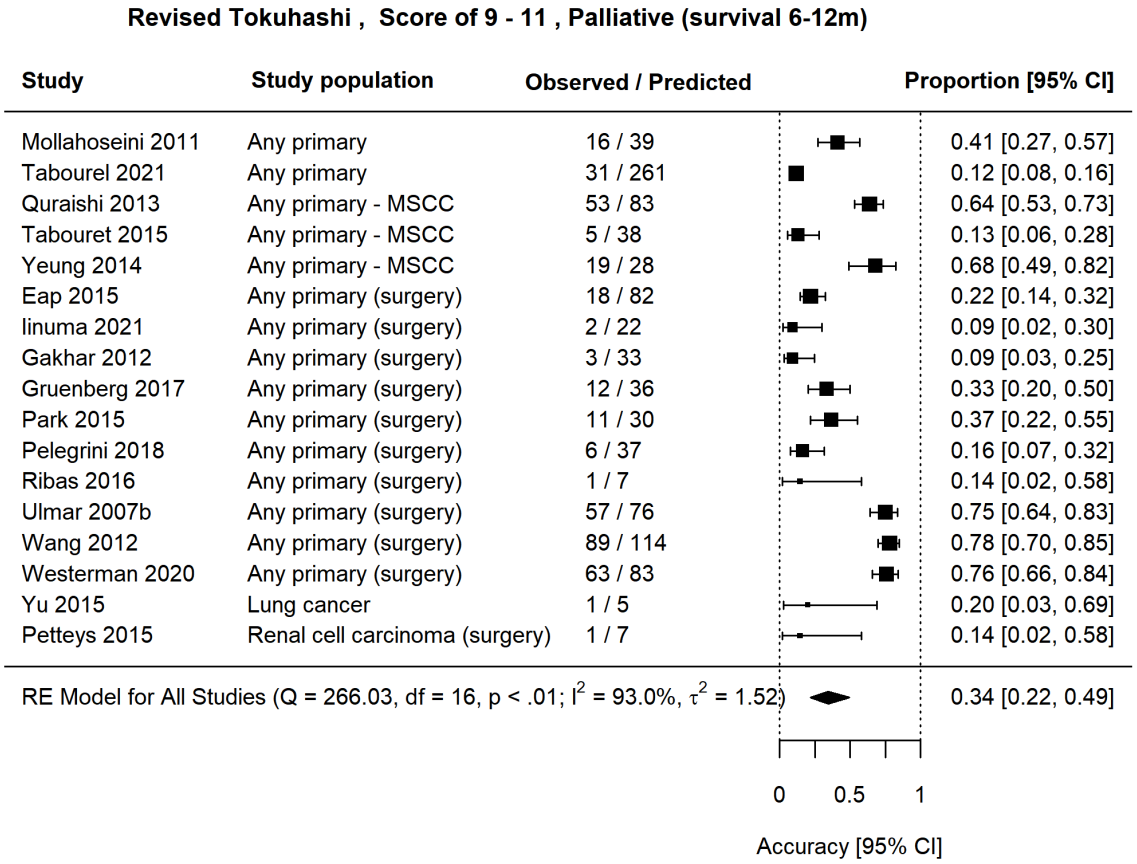
AUC: area under the ROC curve; CI confidence interval

Figure 14: Calibration accuracy of Revised Tokuhashi Score in patients with score 0-8: No surgery (survival ≤ 6m)



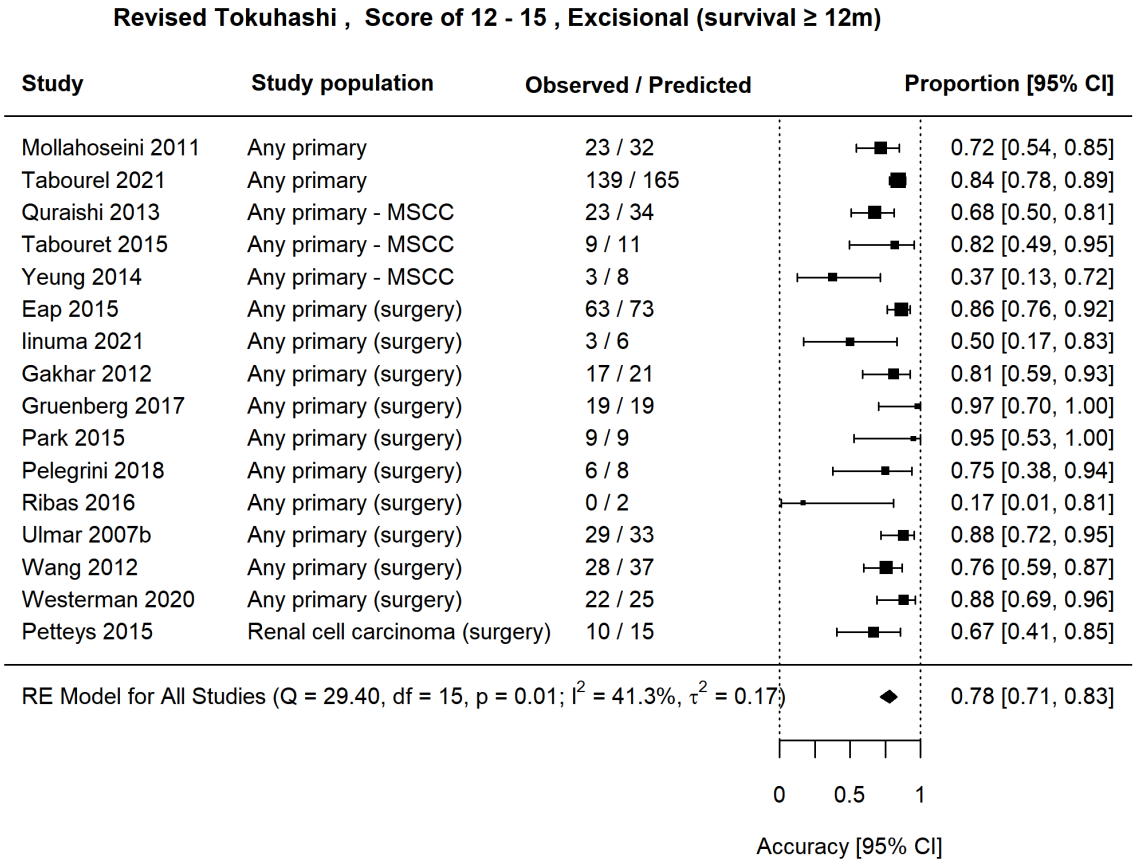
Proportion of patients predicted to survive <6 months who survived <6 months

Figure 15: Calibration accuracy of Revised Tokuhashi Score in patients with score 9-11: Palliative (survival 6-12m)



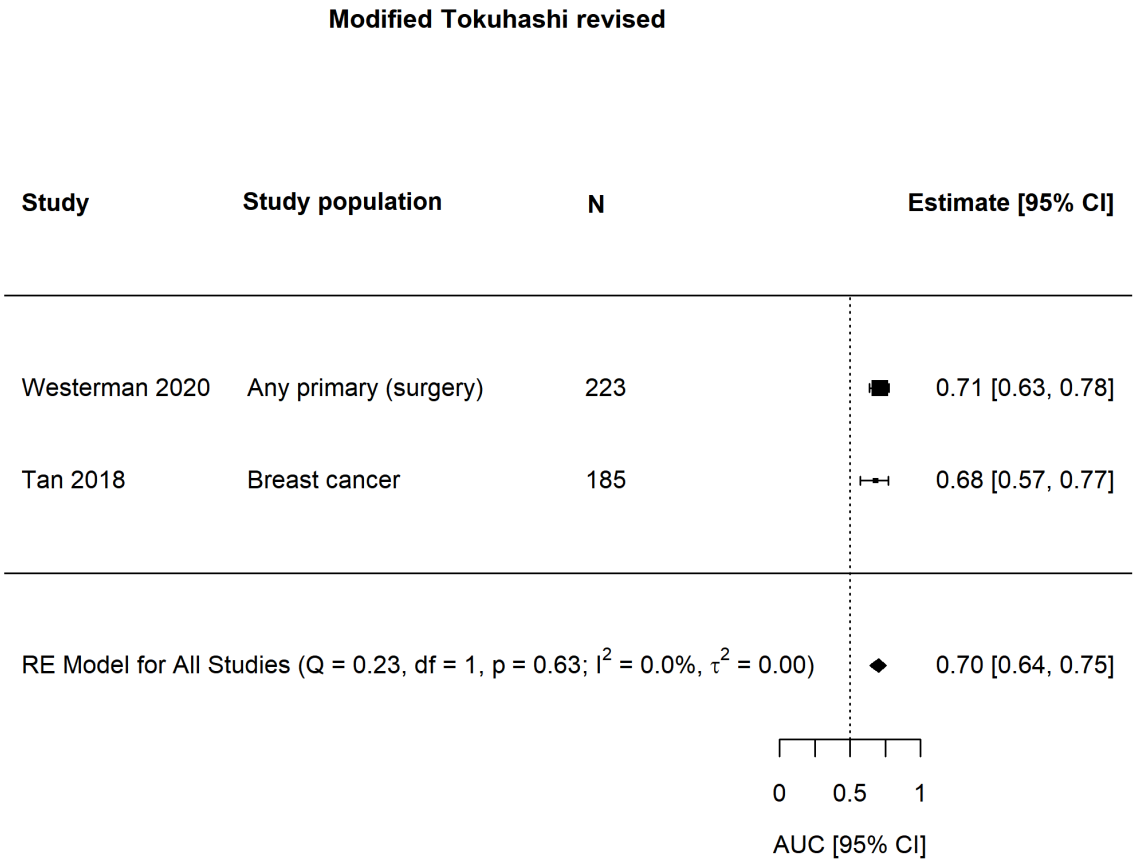
Proportion of patients predicted to survive 6-12 months who survived 6-12 months (and no longer)

Figure 16: Calibration accuracy of Revised Tokuhashi Score in patients with score 12-15: Excisional (survival ≥ 12m)



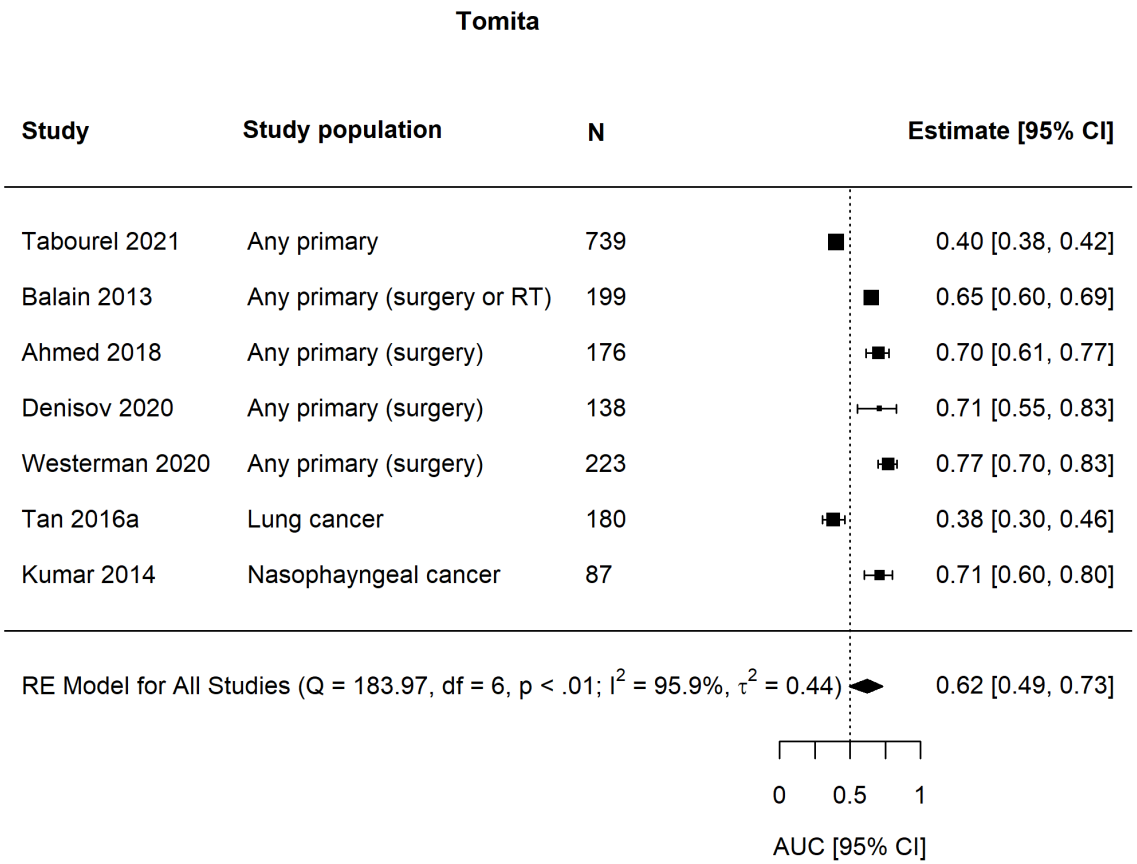
Proportion of patients predicted to survive >12 months who survived >12 months

Figure 17: AUC of Modified Revised Tokuhashi Score for prediction of length of survival



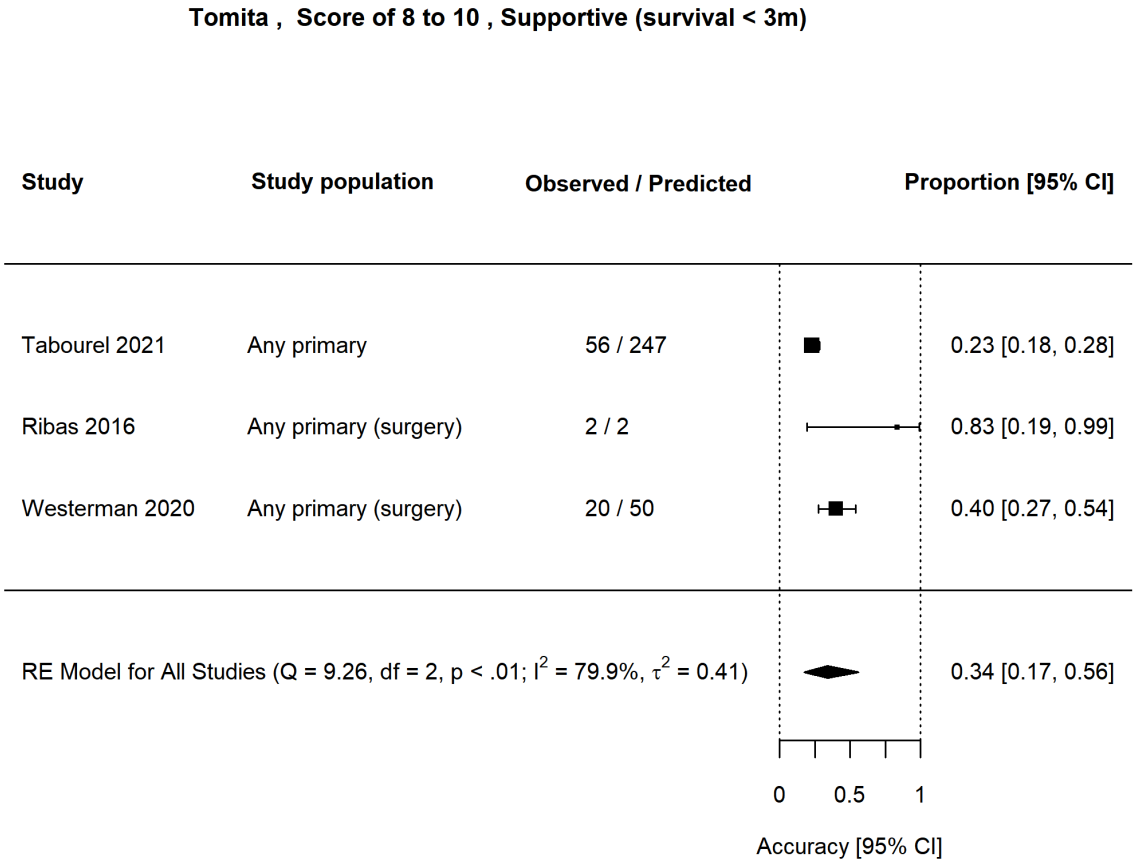
AUC: area under the ROC curve; CI confidence interval

Figure 18: AUC of Tomita Score for prediction of length of survival



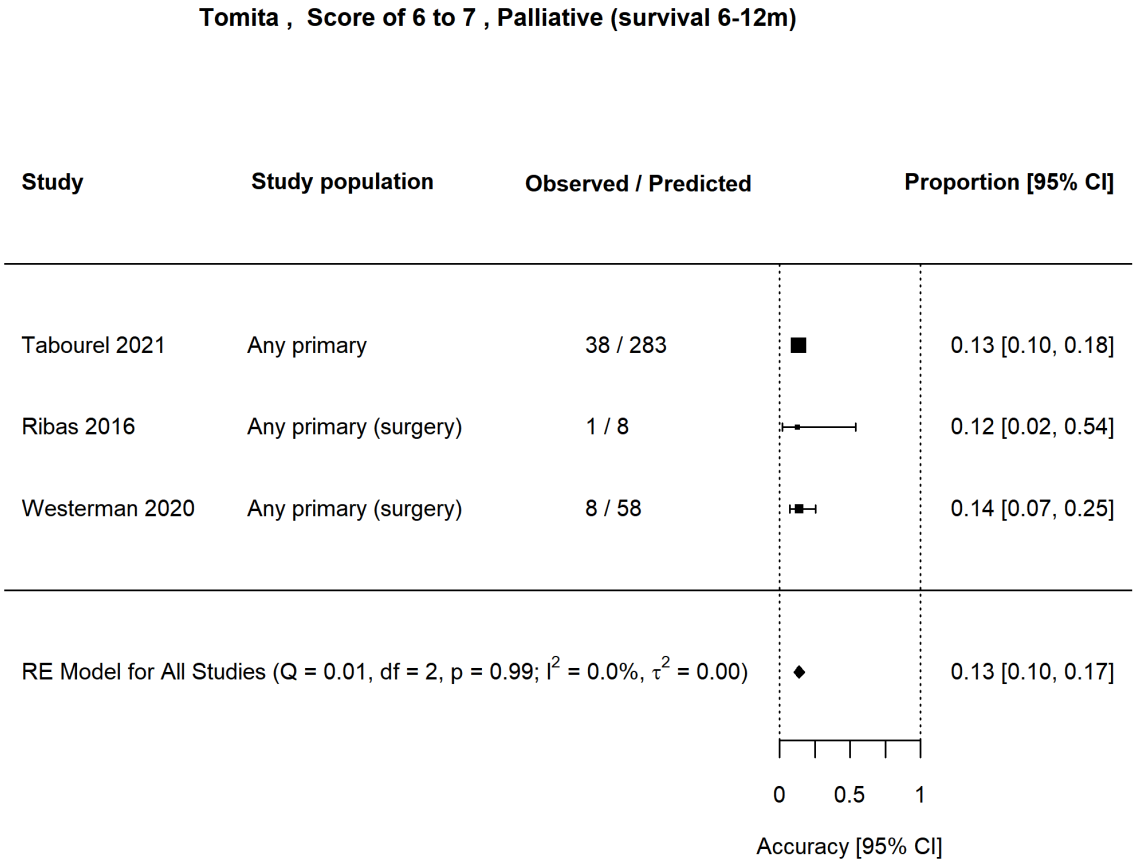
AUC: area under the ROC curve; CI confidence interval

Figure 19: Calibration accuracy of Tomita Score in patients with score 8-10: Supportive (survival < 3m)



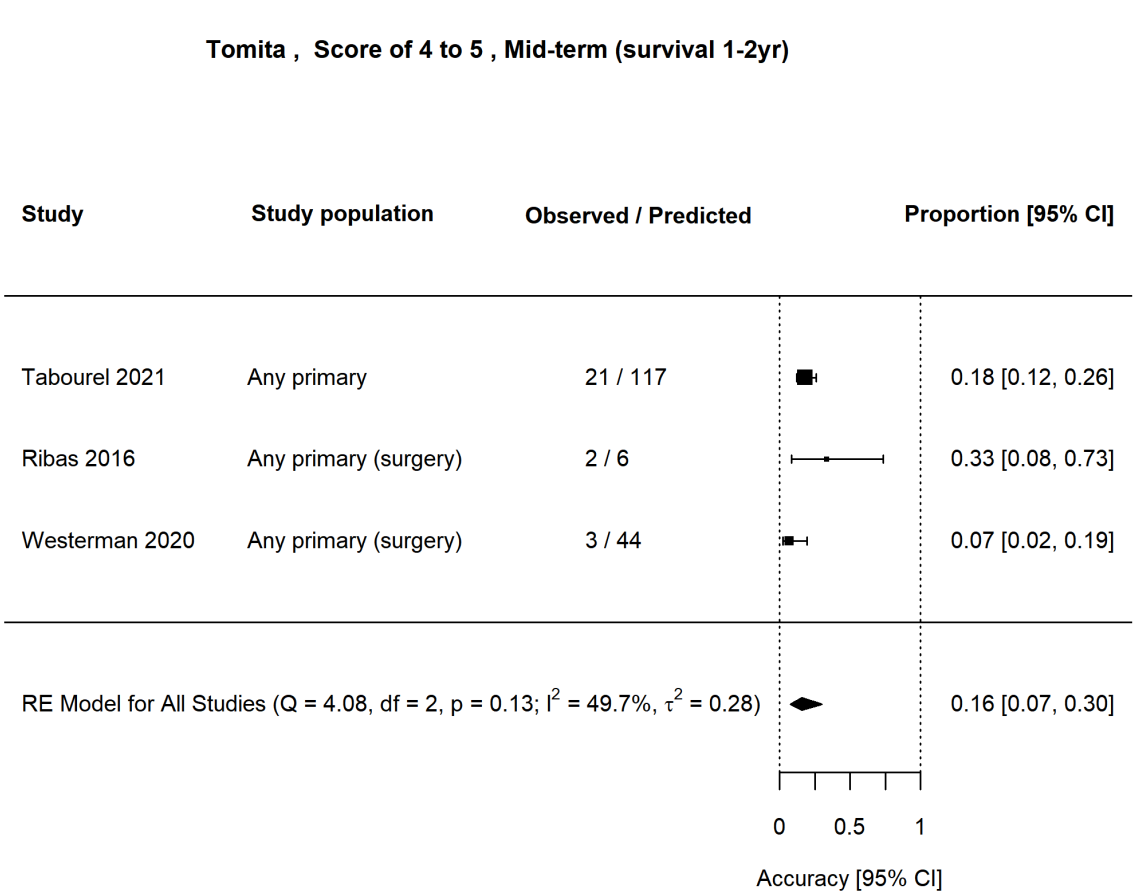
Proportion of patients predicted to survive <3 months who survived <3 months

Figure 20: Calibration accuracy of Tomita Score in patients with score 6-7: Palliative (survival 6-12m)



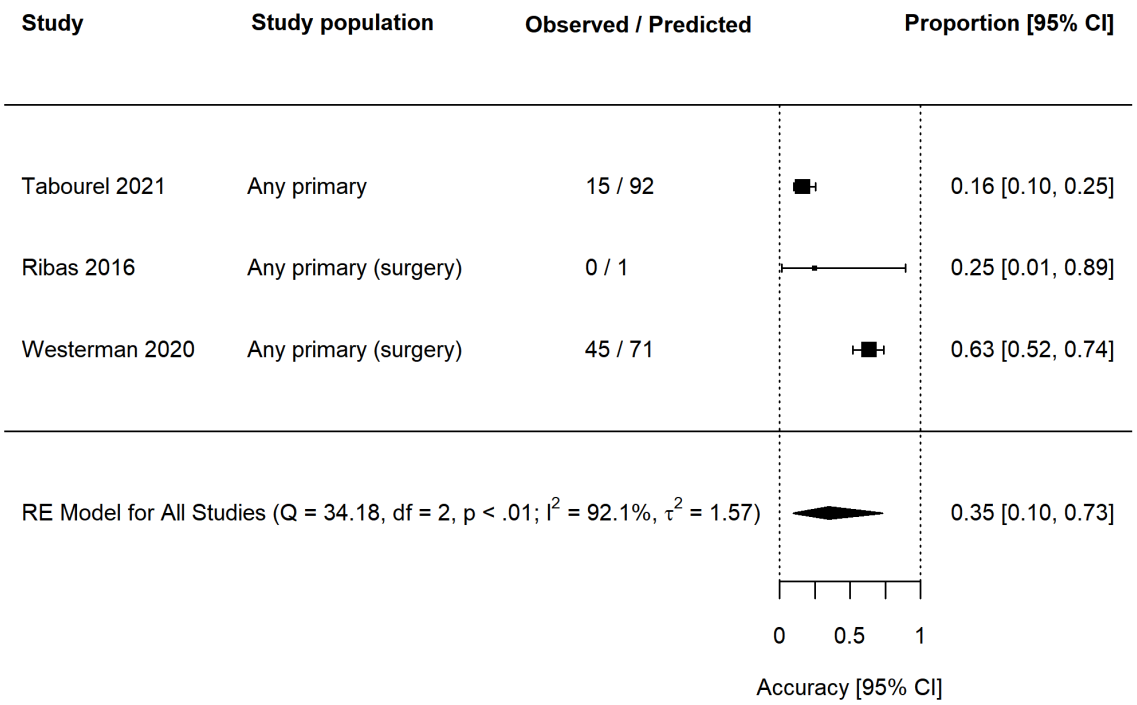
Proportion of patients predicted to survive 6-12 months who survived 6-12 months (and no longer)

Figure 21: Calibration accuracy of Tomita Score in patients with score 4-5: Mid-term (survival 1-2yr)



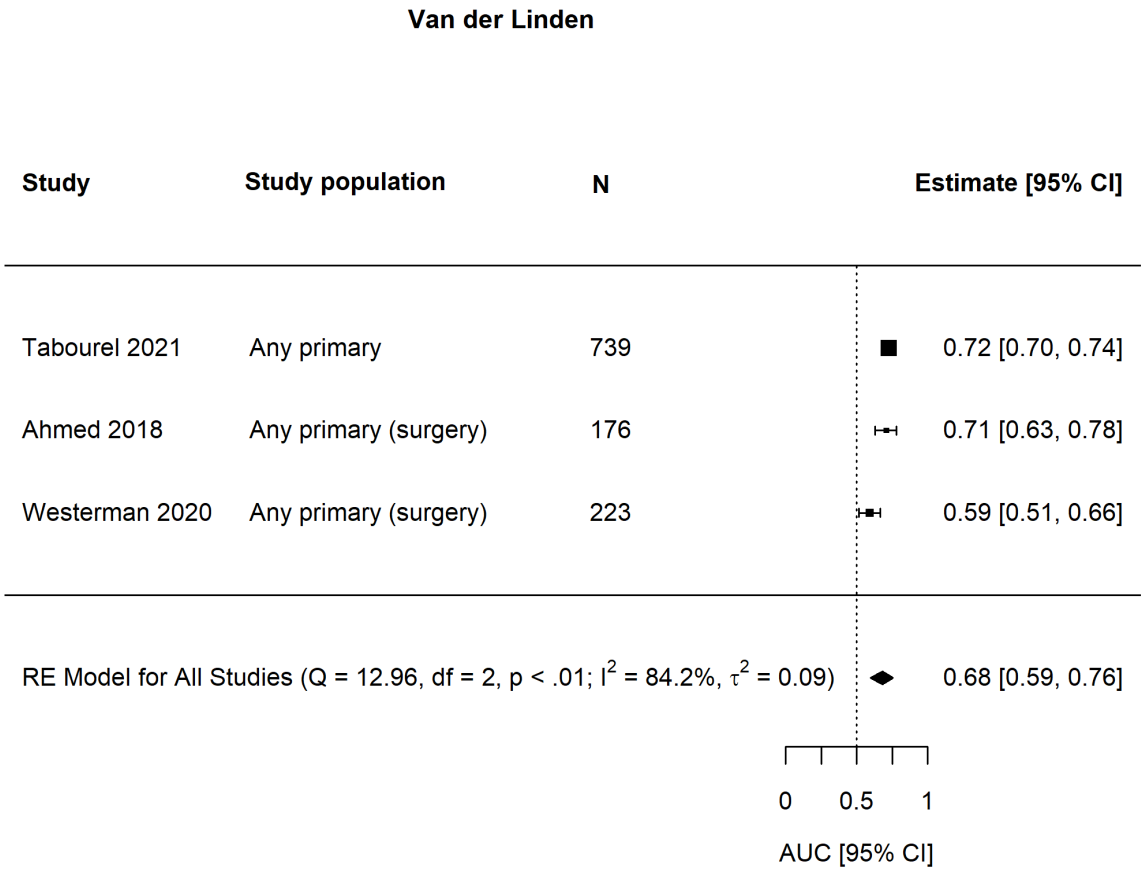
Proportion of patients predicted to survive 1-2 years who survived 1-2 years (and no longer)

Figure 22: Calibration accuracy of Tomita Score in patients with score 2-3: Long-term (survival >2yr)



Proportion of patients predicted to survive >2 years who survived >2 years

Figure 23: AUC of Van der Linden for prediction of length of survival



AUC: area under the ROC curve; CI confidence interval

Appendix F Modified GRADE tables

GRADE tables for review question: What is the prognostic value of validated scoring systems for determining survival in people with spinal cord compression caused by spinal metastases or direct malignant infiltration of the spine?

Table 4: Evidence profile for Bauer

No. of studies	Study design	Sample size	Effect size (95% CI)	Risk of bias	Inconsistency	Indirectness	Imprecision	Quality	Importance
AUC for prediction of survival									
2[1]	Retrospective cohort	179	AUC 0.58 [0.45 to 0.70]	serious[4]	serious[2]	serious[5]	very serious[2]	VERY LOW	CRITICAL

AUC: area under ROC curve; CI, confidence interval
1. Kumar 2014, Tan 2016a
2. Serious heterogeneity unexplained by subgroup analysis
3. 95% CI crosses 2 MIDs (thresholds for AUC were 0.50,0.70,0.90)
4. Serious risk of bias in the evidence contributing to the outcomes as per PROBAST
5. Population is indirect due to nasopharyngeal cancer only

Table 5: Evidence profile for Modified Bauer

No. of studies	Study design	Sample size	Effect size (95% CI)	Risk of bias	Inconsistency	Indirectness	Imprecision	Quality	Importance
AUC for prediction of survival									
4[1]	Retrospective cohort	778	AUC range 0.5 to 0.71	no serious risk of bias	very serious[3]	no serious indirectness	very serious[4]	VERY LOW	CRITICAL
Accuracy of Modified Bauer in patients with score 0 -1: No surgery (survival ≤ 5m)									
2[2]	Retrospective cohort	62	Accuracy 0.53 [0.40 to 0.65]	no serious risk of bias	no serious incon-sistency	no serious indirectness	very serious[5]	LOW	CRITICAL
Accuracy of Modified Bauer in patients with score 2: Dorsal (survival 2-18m)									
2[2]	Retrospective cohort	94	Accuracy 0.28 [0.08 to 0.63]	no serious risk of bias	serious[6]	no serious indirectness	very serious[5]	VERY LOW	CRITICAL
Accuracy of Modified Bauer in patients with score 3 to 4: Ventral-dorsal (survival > 12m)									
2[2]	Retrospective cohort	84	0.51 [0.10 to 0.91]	no serious risk of bias	serious[6]	no serious indirectness	very serious[5]	VERY LOW	CRITICAL

AUC: area under ROC curve; CI, confidence interval
1. Ahmed 2018, Balain 2013, Tan 2016b, Westerman 2020

2. Ribas 2016, Westerman 2020
3. Very serious heterogeneity unexplained by subgroup analysis
4. 95% CI crosses 2 MIDs (thresholds for AUC were 0.50,0.70,0.90)
5. Sample size < 100
6. Serious heterogeneity unexplained by subgroup analysis

Table 6: Evidence profile for Katagiri

No. of studies	Study design	Sample size	Effect size (95% CI)	Risk of bias	Inconsistency	Indirectness	Imprecision	Quality	Importance
AUC for prediction of survival									
3[1]	Retrospective cohort	406	AUC 0.69 [0.57 to 0.79]	no serious risk of bias	serious[2]	no serious indirectness	serious[3]	LOW	CRITICAL

AUC: area under ROC curve; CI, confidence interval
1. Ahmed 2018, Denisov 2020, Tan 2016a
2. Serious heterogeneity unexplained by subgroup analysis
3. 95% CI crosses 1 MID (thresholds for AUC were 0.50,0.70,0.90)

Table 7: Evidence profile for Lei

No. of studies	Study design	Sample size	Effect size (95% CI)	Risk of bias	Inconsistency	Indirectness	Imprecision	Quality	Importance
AUC for prediction of survival									
Tabourel 2021	Retrospective cohort	739	AUC 0.69 [0.66 to 0.71]	no serious risk of bias	no serious incon-sistency	no serious indirectness	serious[1]	MODERATE	CRITICAL

AUC: area under ROC curve; CI, confidence interval

1. 95% CI crosses 1 MID (thresholds for AUC were 0.50,0.70,0.90)

Table 8: Evidence profile for Oswestry Spinal Metastasis Risk Index

No. of studies	Study design	Sample size	Effect size (95% CI)	Risk of bias	Inconsistency	Indirectness	Imprecision	Quality	Importance
AUC for prediction of survival									
4[1]	Retrospective cohort	689	AUC range 0.32 to 0.67	serious[2]	very serious[3]	no serious indirectness	very serious[4]	VERY LOW	CRITICAL
Accuracy of Oswestry Spinal Metastasis Risk Index in patients with score 1m (survival <2m)									
Westerman 2020	Retrospective cohort	10	Accuracy 0.5 [0.19 to 0.69]	no serious risk of bias	no serious incon-sistency	no serious indirectness	very serious[5]	LOW	CRITICAL
Accuracy of Oswestry Spinal Metastasis Risk Index in patients with score 2m (survival 1-3m)									

No. of studies	Study design	Sample size	Effect size (95% CI)	Risk of bias	Inconsistency	Indirectness	Imprecision	Quality	Importance
Westerman 2020	Retrospective cohort	36	Accuracy 0.11 [0.01 to 0.12]	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[5]	LOW	CRITICAL
Accuracy of Oswestry Spinal Metastasis Risk Index in patients with score 4m (survival 3-5m)									
Westerman 2020	Retrospective cohort	52	Accuracy 0.13 [0.04 to 0.18]	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[5]	LOW	CRITICAL
Accuracy of Oswestry Spinal Metastasis Risk Index in patients with score 6m (survival 4-9m)									
Westerman 2020	Retrospective cohort	111	Accuracy 0.07 [0.02 to 0.1]	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[6]	MODERATE	CRITICAL
Accuracy of Oswestry Spinal Metastasis Risk Index in patients with score 23m (survival >12m)									
Westerman 2020	Retrospective cohort	14	Accuracy 0.79 [0.57 to 1.36]	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[4]	LOW	CRITICAL

AUC: area under ROC curve; CI, confidence interval
1. Balain 2013, Kumar 2014, Tan 2016a, Westerman 2020
2. Serious risk of bias in the evidence contributing to the outcomes as per PROBAST
3. Very serious heterogeneity unexplained by subgroup analysis.
4. 95% CI crosses 2 MIDs (thresholds for AUC were 0.50,0.70,0.90)
5. Sample size <100
6. Sample size <300

Table 9: Evidence profile for Rades

No. of studies	Study design	Sample size	Effect size (95% CI)	Risk of bias	Inconsistency	Indirectness	Imprecision	Quality	Importance
AUC for prediction of survival									
Tabourel 2021	Retrospective cohort	739	AUC 0.58 [0.56 to 0.60]	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	HIGH	CRITICAL

AUC: area under ROC curve; CI, confidence interval

Table 10: Evidence profile for SORG-ML

No. of studies	Study design	Sample size	Effect size (95% CI)	Risk of bias	Inconsistency	Indirectness	Imprecision	Quality	Importance
AUC for prediction of survival									
Yang 2021	Retrospective cohort	427	AUC 0.74 [0.69 to 0.79]	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	MODERATE	CRITICAL

AUC: area under ROC curve; CI, confidence interval

1. 95% CI crosses 1 MID (thresholds for AUC were 0.50,0.70,0.90)

Table 11: Evidence profile for SORG Classic scoring algorithm

No. of studies	Study design	Sample size	Effect size (95% CI)	Risk of bias	Inconsistency	Indirectness	Imprecision	Quality	Importance
AUC for prediction of survival									
Ahmed 2018	Retrospective cohort	176	AUC 0.77 [0.7 to 0.84]	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[1]	MODERATE	CRITICAL

AUC: area under ROC curve; CI, confidence interval ratio

1. 95% CI crosses 1 MID (thresholds for AUC were 0.50,0.70,0.90)

Table 12: Evidence profile for SORG nomogram

No. of studies	Study design	Sample size	Effect size (95% CI)	Risk of bias	Inconsistency	Indirectness	Imprecision	Quality	Importance
AUC for prediction of survival									
Ahmed 2018	Retrospective cohort	176	AUC 0.78 [0.71 to 0.85]	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	HIGH	CRITICAL

AUC: area under ROC curve; CI, confidence interval

Table 13: Evidence profile for SSG

No. of studies	Study design	Sample size	Effect size (95% CI)	Risk of bias	Inconsistency	Indirectness	Imprecision	Quality	Importance
AUC for prediction of survival									
Tan 2016a	Retrospective cohort	92	AUC 0.59 [0.51 to 0.67]	very serious[1]	no serious inconsistency	serious[2]	no serious imprecision	VERY LOW	CRITICAL

AUC: area under ROC curve; CI, confidence interval
1. Very serious risk of bias in the evidence contributing to the outcomes as per PROBAST
2. Population is indirect due to inclusion of nasopharyngeal cancer only

Table 14: Evidence profile for Tokuhashi

No. of studies	Study design	Sample size	Effect size (95% CI)	Risk of bias	Inconsistency	Indirectness	Imprecision	Quality	Importance
AUC for prediction of survival									
2[1]	Retrospective cohort	399	AUC 0.74 [0.67 to 0.80]	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[3]	MODERATE	CRITICAL
Accuracy of Tokuhashi Score in patients with score 0-5: Palliative (survival ≤ 3m)									
3[2]	Retrospective cohort	348	Accuracy 0.41 [0.36 to 0.46]	serious[6]	no serious inconsistency	serious[7]	no serious imprecision	LOW	CRITICAL

Accuracy of Tokuhashi Score in patients with score 6-8: Indifferent (survival 3-12m)									
3[2]	Retrospective cohort	377	Accuracy 0.52 [0.45 to 0.59]	serious[6]	no serious incon-sistency	serious[7]	no serious imprecision	LOW	CRITICAL
Accuracy of Tokuhashi Score in patients with score 9-12: Excisional (survival ≥ 12m)									
3[2]	Retrospective cohort	163	Accuracy 0.75 [0.63 to 0.85]	serious[6]	serious incon-sistency[5]	serious[7]	serious[4]	VERY LOW	CRITICAL

AUC: area under ROC curve; CI, confidence interval
1. Ahmed 2018, Westerman 2020
2. Ulmar 2007, Wang 2012, Westerman 2020
3. 95% CI crosses 1 MID (thresholds for AUC were 0.50,0.70,0.90)
4. Sample size < 300
5. Serious heterogeneity unexplained by subgroup analysis
6. Serious risk of bias in the evidence contributing to the outcomes as per PROBAST
7. Population is indirect in Ulmar 2007 due to inclusion of some participants from the pre-MRI era

Table 15: Evidence profile for Revised Tokuhashi

No. of studies	Study design	Sample size	Effect size (95% CI)	Risk of bias	Inconsistency	Indirectness	Imprecision	Quality	Importance
AUC for prediction of survival									
8[1]	Retrospective cohort	1927	AUC range 0.48 to 0.82	no serious risk of bias	very serious[4]	serious[7]	serious[5]	VERY LOW	CRITICAL
Accuracy of Revised Tokuhashi Score in patients with score 0-8: No surgery (survival ≤ 6m)									
17[2]	Retrospective cohort	1707	Accuracy Range 0.08 to 0.84	serious[7]	very serious[4]	no serious indirectness	no serious imprecision	VERY LOW	CRITICAL
Accuracy of Revised Tokuhashi Score in patients with score 9-11: Palliative (survival 6-12m)									
17[2]	Retrospective cohort	981	Accuracy Range 0.09 to 0.78	serious[7]	very serious[4]	no serious indirectness	no serious imprecision	VERY LOW	CRITICAL
Accuracy of Revised Tokuhashi Score in patients with score 12-15: Excisional (survival ≥ 12m)									
16[3]	Retrospective cohort	498	Accuracy 0.78 [0.71 to 0.83]	serious[7]	no serious incon-sistency	no serious indirectness	no serious imprecision	MODERATE	CRITICAL

AUC: area under ROC curve; CI, confidence interval
1. Ahmed 2018, Balain 2013,Denisov 2020,Kumar 2014,Tabourel 2021,Tan 2016a,Tan 2018,Westerman 2020
2. Eap 2015, Gakhar 2012, Gruenberg 2017, Iinuma 2021, Mollahoseini 2011, Park 2015, Pelegrini de Almeida 2018, Petteys 2015, Quraishi 2013, Ribas 2016, Tabourel 2021, Tabouret 2015, Ulmar 2007, Wang 2012, Westerman 2020, Yeung 2014, Yu 2015
3. Eap 2015, Gakhar 2012, Gruenberg 2017, Iinuma 2021, Mollahoseini 2011, Park 2015, Pelegrini de Almeida 2018, Petteys 2015, Quraishi 2013, Ribas 2016, Tabourel 2021, Tabouret 2015, Ulmar 2007, Wang 2012, Westerman 2020, Yeung 2014
4. Very serious heterogeneity unexplained by subgroup analysis
5. 95% CI includes 1 MID (thresholds for AUC were 0.50,0.70,0.90)
6. Population is indirect in 3 of the studies which are limited to a single type of cancer
7. Serious risk of bias in the evidence contributing to the outcomes as per PROBAST

Table 16: Evidence profile for Modified Revised Tokuhashi

No. of studies	Study design	Sample size	Effect size (95% CI)	Risk of bias	Inconsistency	Indirectness	Imprecision	Quality	Importance
AUC for prediction of survival									
2[1]	Retrospective cohort	408	AUC 0.70 [0.64 to 0.75]	no serious risk of bias	no serious inconsistency	serious[5]	serious[2]	LOW	CRITICAL
Accuracy of Revised Tokuhashi Score in patients with score 0-8: No surgery (survival ≤ 6m)									
Westerman 2020	Retrospective cohort	65	Accuracy 0.69 [0.58 to 1]	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[3]	LOW	CRITICAL
Accuracy of Revised Tokuhashi Score in patients with score 9-11: Palliative (survival 6-12m)									
Westerman 2020	Retrospective cohort	141	Accuracy 0.73 [0.66 to 1]	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[4]	MODERATE	CRITICAL
Accuracy of Revised Tokuhashi Score in patients with score 12-15: Excisional (survival ≥ 12m)									
Westerman 2020	Retrospective cohort	17	Accuracy 0.88 [0.73 to 1]	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[3]	LOW	CRITICAL

AUC: area under ROC curve; CI, confidence interval; LR+, positive likelihood ratio; LR-, negative likelihood ratio
1. Tan 2018, Westerman 2020
2. 95% CI crosses 1 MID (thresholds for AUC were 0.50,0.70,0.90)
3. Sample size < 300
4. Sample size < 100
5. Population is indirect in Tan 2018 due to the inclusion of lung cancer patients only

Table 17: Evidence profile for Tomita

No. of studies	Study design	Sample size	Effect size (95% CI)	Risk of bias	Inconsistency	Indirectness	Imprecision	Quality	Importance
AUC for prediction of survival									
7[1]	Retrospective cohort	1742	AUC range 0.38 to 0.77	no serious risk of bias	very serious[3]	no serious indirectness	very serious[4]	VERY LOW	CRITICAL
Accuracy of Tomita Score in patients with score 8-10: Supportive (survival < 3m)									
3[2]	Retrospective cohort	299	Accuracy 0.34 [0.17 to 0.56]	no serious risk of bias	serious[5]	no serious indirectness	serious[6]	LOW	CRITICAL
Accuracy of Tomita Score in patients with score 6-7: Palliative (survival 6-12m)									
3[2]	Retrospective cohort	349	Accuracy 0.13 [0.10 to 0.17]	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	HIGH	CRITICAL
Accuracy of Tomita Score in patients with score 4-5: Mid-term (survival 1-2yr)									
3[2]	Retrospective cohort	167	Accuracy 0.16 [0.07 to 0.30]	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[6]	MODERATE	CRITICAL
Accuracy of Tomita Score in patients with score 2-3: Long-term (survival >2yr))									
3[2]	Retrospective cohort	164	Accuracy range 0.16 to 0.63	no serious risk of bias	very serious[3]	no serious indirectness	serious[6]	VERY LOW	CRITICAL

AUC: area under ROC curve; CI, confidence interval
1. Ahmed 2018, Balain 2013, Denisov 2020, Kumar 2014,Tabourel 2021,Tan 2016a,Westerman 2020
2. Tabourel 2021, Ribas 2016, Westerman 2020
3. Very serious hetereogeneity unexplained by subgroup analysis
4. 95% CI crosses 2 MIDs (thresholds for AUC were 0.50,0.70,0.90)
5. Serious hetereogeneity unexplained by subgroup analysis
6. sample size < 300

Table 18: Evidence profile for Van der Linden

No. of studies	Study design	Sample size	Effect size (95% CI)	Risk of bias	Inconsistency	Indirectness	Imprecision	Quality	Importance
AUC for prediction of survival									
3[1]	Retrospective cohort	1138	AUC 0.68 [0.59 to 0.76]	no serious risk of bias	very serious[2]	no serious indirectness	serious[3]	VERY LOW	CRITICAL

AUC: area under ROC curve; CI, confidence interval
1. Ahmed 2018,Tabourel 2021,Westerman 2020
2. Very serious heterogeneity unexplained by subgroup analysis
3. 95% CI crosses 1 MID (thresholds for AUC were 0.50,0.70,0.90)

Appendix G Economic evidence study selection

Study selection for: What is the prognostic value of validated scoring systems for determining survival in people with spinal cord compression caused by spinal metastases or direct malignant infiltration of the spine?

No economic evidence was identified which was applicable to this review question.

Appendix H Economic evidence tables

Economic evidence tables for review question: What is the prognostic value of validated scoring systems for determining survival in people with spinal cord compression caused by spinal metastases or direct malignant infiltration of the spine?

No evidence was identified which was applicable to this review question.

Appendix I Economic model

Economic model for review question: What is the prognostic value of validated scoring systems for determining survival in people with spinal cord compression caused by spinal metastases or direct malignant infiltration of the spine?

No economic analysis was conducted for this review question.

Appendix J Excluded studies

Excluded studies for review question: What is the prognostic value of validated scoring systems for determining survival in people with spinal cord compression caused by spinal metastases or direct malignant infiltration of the spine?

Excluded prognostic studies

Table 19: Excluded studies and reasons for their exclusion

Study	Reason for exclusion
Abbouchie, Hussein, Chao, Michael, Tacey, Mark et al. (2020) Vertebral fractures following stereotactic body radiotherapy for spine metastases. Journal of medical imaging and radiation oncology 64(2): 293-302	Outcomes do not match protocol
Afsar, Afifa; Qadeer, Mohsin; Sharif, Salman (2017) Surgically treated spinal metastases: Do prognostic scores have a role?. Surgical neurology international 8: 158	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Aiba, Hisaki, Kimura, Tomoki, Yamagami, Takaya et al. (2016) Prediction of skeletal-related events in patients with non-small cell lung cancer. Supportive care in cancer: (8): 3361-7	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Amelot, A., Cristini, J., Salaud, C. et al. (2017) Overall survival in spine myeloma metastases: Difficulties in predicting with prognostic scores. Spine 42(6): 400-406	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Anonymous. (2022) Erratum to: Validation and simplification of a score predicting survival in patients irradiated for metastatic spinal cord compression (Cancer, 116, 15, (3670-3673), 10.1002/cncr.25223). Cancer 128(3): 633-634	Other protocol criteria - not a validated scoring system
Anzuategui, Pedro Reggiani, Cunha, Luiz Antonio Munhoz da, Mello, Glauco Jose Pauka et al. (2019) Spinal Metastasis Surgery: A Proposal for a Predictive Model of Morbidity and Mortality. Revista brasileira de ortopedia 54(6): 665-672	Other protocol criteria - not a validated scoring system
Aoude, A, Fortin, M, Aldebeyan, Sulta et al. (2018) The revised Tokuhashi score; analysis of parameters and assessment of its accuracy in determining survival in patients afflicted with spinal metastasis. European spine journal : official publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society 27(4): 835-840	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Aoude, Ahmed and Amiot, Louis-Philippe (2014) A comparison of the modified Tokuhashi and Tomita scores in determining prognosis for patients afflicted with spinal metastasis. Canadian journal of surgery. Journal canadien de chirurgie 57(3): 188-93	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Armstrong, Terri S, Gning, Ibrahima, Mendoza, Tito R et al. (2010) Reliability and validity of the M. D. Anderson Symptom Inventory-Spine Tumor Module. Journal of neurosurgery. Spine 12(4): 421-30	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Atkinson, R.A., Davies, B., Jones, A. et al. (2016) Survival of patients undergoing surgery for metastatic spinal tumours and the impact of	Outcomes do not match

Study	Reason for exclusion
surgical site infection. Journal of Hospital Infection 94(1): 80-85	protocol – does not report data relevant to prognostic value of a scoring system
Balagamwala, Ehsan H, Miller, Jacob A, Reddy, Chandana A et al. (2018) Recursive partitioning analysis is predictive of overall survival for patients undergoing spine stereotactic radiosurgery. Journal of neuro-oncology 137(2): 289-293	Publication type does not match protocol - conference abstract
Bartels, R.H.M.A., Feuth, T., Rades, D. et al. (2011) External validation of a model to predict the survival of patients presenting with a spinal epidural metastasis. Cancer and Metastasis Reviews 30(2): 153-159	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Bartels, Ronald H M A, de Ruiter, Godard, Feuth, Ton et al. (2016) Prediction of life expectancy in patients with spinal epidural metastasis. Neuro-oncology 18(1): 114-8	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Bollen L, Wibmer C, Van der Linden Y, et al. Predictive Value of Six Prognostic Scoring Systems for Spinal Bone Metastases: An Analysis Based on 1379 Patients. Spine, 41, e155-62, 2016	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Bollen, Laurens, Groenen, Karlijn, Pondaag, Willem et al. (2017) Clinical Evaluation of the Spinal Instability Neoplastic Score in Patients Treated With Radiotherapy for Symptomatic Spinal Bone Metastases. Spine 42(16): e956-e962	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Bongers, Michiel E R, Karhade, Aditya V, Villavieja, Jemma et al. (2020) Does the SORG algorithm generalize to a contemporary cohort of patients with spinal metastases on external validation?. The spine journal : official journal of the North American Spine Society 20(10): 1646-1652	Other protocol criteria - not a validated scoring system
Buergy, Daniel, Siedlitzki, Lena, Boda-Heggemann, Judit et al. (2016) Overall survival after reirradiation of spinal metastases - independent validation of predictive models. Radiation oncology (London, England) 11: 35	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Cai, Zhenyu, Tang, Xiaodong, Yang, Rongli et al. (2019) Modified score based on revised Tokuhashi score is needed for the determination of surgical intervention in patients with lung cancer metastases to the spine. World journal of surgical oncology 17(1): 194	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Carrwik, Christian; Olerud, Claes; Robinson, Yohan (2020) Predictive Scores Underestimate Survival of Patients With Metastatic Spine Disease: A Retrospective Study of 315 Patients in Sweden. Spine 45(6): 414-419	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Chang, Sam Yeol, Ha, Jae Hong, Seo, Sang Gyo et al. (2018) Prognosis of Single Spinal Metastatic Tumors: Predictive Value of the Spinal Instability Neoplastic Score System for Spinal Adverse Events. Asian spine journal 12(5): 919-926	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Chantharakhit, Chaichana and Sujaritvanichpong, Nantapa (2022) Prognostic Scoring System Development for Malignant Spinal Cord Compression. Asian Pacific journal of cancer prevention : APJCP 23(2): 623-630	Other protocol criteria - not a validated scoring system
Chao, Samuel T, Koyfman, Shlomo A, Woody, Neil et al. (2012) Recursive partitioning analysis index is predictive for overall survival in patients undergoing spine stereotactic body radiation therapy for spi-	Outcomes do not match protocol – does not report

Study	Reason for exclusion
nal metastases. International journal of radiation oncology, biology, physics 82(5): 1738-43	data relevant to prognostic value of a scoring system
Chen, Huajiang, Xiao, Jianru, Yang, Xinghai et al. (2010) Preoperative scoring systems and prognostic factors for patients with spinal metastases from hepatocellular carcinoma. Spine 35(23): e1339-46	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Chen, Qing, Chen, Xiaohui, Zhou, Lei et al. (2021) The emergence of new prognostic scores in lung cancer patients with spinal metastasis: A 12-year single-center retrospective study. Journal of Cancer 12(18): 5644-5653	Other protocol criteria - not a validated scoring system
Chen, S., Yang, M., Zhong, N. et al. (2021) Quantified CIN Score From Cell-free DNA as a Novel Noninvasive Predictor of Survival in Patients With Spinal Metastasis. Frontiers in Cell and Developmental Biology 9: 767340	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Choi, D., Ricciardi, F., Arts, M. et al. (2018) Prediction accuracy of common prognostic scoring systems for metastatic spine disease. Spine 43(23): 1678-1684	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Choi, David, Pavlou, Menelaos, Omar, Rumana et al. (2019) A novel risk calculator to predict outcome after surgery for symptomatic spinal metastases; use of a large prospective patient database to personalise surgical management. European journal of cancer (Oxford, England : 1990) 107: 28-36	Other protocol criteria - not a validated scoring system
Chow, Edward; Harris, Kristin; Fung, Kinwah (2006) Successful validation of a survival prediction model in patients with metastases in the spinal column. International journal of radiation oncology, biology, physics 65(5): 1522-7	Other protocol criteria - not a validated scoring system
Cook, William H and Baker, Joseph F (2020) Retrospective evaluation of prognostic factors in metastatic spine disease: serum albumin and primary tumour type are key. ANZ journal of surgery 90(6): 1070-1074	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Crnalic, Sead, Lofvenberg, Richard, Bergh, Anders et al. (2012) Predicting survival for surgery of metastatic spinal cord compression in prostate cancer: a new score. Spine 37(26): 2168-76	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Cui, Yunpeng, Lei, Mingxing, Pan, Yuanxing et al. (2020) Scoring Algorithms for Predicting Survival Prognosis in Patients With Metastatic Spinal Disease: The Current Status and Future Directions. Clinical spine surgery 33(8): 296-306	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Dakson, Ayoub, Leck, Erika, Brandman, David M et al. (2020) The clinical utility of the Spinal Instability Neoplastic Score (SINS) system in spinal epidural metastases: a retrospective study. Spinal cord 58(8): 892-899	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Dardic, M, Wibmer, Christine, Berghold, A et al. (2015) Evaluation of prognostic scoring systems for spinal metastases in 196 patients treated during 2005-2010. European spine journal : official publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society 24(10): 2133-41	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
De la Garza Ramos, R., Goodwin, C.R., Jain, A. et al. (2016) Development of a Metastatic Spinal Tumor Frailty Index (MSTFI) Using a Nationwide Database and Its Association with Inpatient Morbidity, Mortality, and Length of Stay After Spine Surgery. World Neurosur-	Outcomes do not match protocol – predicts peri operative outcomes

Study	Reason for exclusion
gery 95: 548-555	
De la Garza Ramos, Rafael, Benton, Joshua A, Gelfand, Yaroslav et al. (2021) A Novel Clinical Scoring System for Perioperative Morbidity in Metastatic Spinal Tumor Surgery: The Spine Oncology Morbidity Assessment Score. Spine 46(3): e161-e166	Outcomes do not match protocol - predicts post operative morbidity
De la Garza Ramos, Rafael, Naidu, Ishan, Choi, Jong Hyun et al. (2021) Comparison of three predictive scoring systems for morbidity in oncological spine surgery. Journal of clinical neuroscience : official journal of the Neurosurgical Society of Australasia 94: 13-17	Outcomes do not match protocol – surgical morbidity
Derincek, Alihan, Guler, Umit O, Uysal, Mustafa et al. (2020) Spinal Metastatic Disease: Survival Analysis of 146 Patients and Evaluation of 4 Different Preoperative Scoring Systems. Clinical spine surgery 33(2): e81-e86	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Donnellan, Christopher J, Roser, Sophia, Maharaj, Monish M et al. (2020) Outcomes for Vertebrectomy for Malignancy and Correlation to the Spine Instability Neoplastic Score (SINS): a 10-Year Single-Center Perspective. World neurosurgery 138: e151-e159	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Douglas, S; Schild, S E; Rades, D (2012) Metastatic spinal cord compression in patients with cancer of unknown primary. Estimating the survival prognosis with a validated score. Strahlentherapie und Onkologie : Organ der Deutschen Rontgengesellschaft ... [et al] 188(11): 1048-51	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Douglas, Sarah; Schild, Steven E; Rades, Dirk (2012) A new score predicting the survival of patients with spinal cord compression from myeloma. BMC cancer 12: 425	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Ehresman, J., Schilling, A., Pennington, Z. et al. (2020) A novel MRI-based score assessing trabecular bone quality to predict vertebral compression fractures in patients with spinal metastasis. Journal of Neurosurgery: Spine 32(4): 499-506	Other protocol criteria - not a validated scoring system
Ehresman, Jeff, Lubelski, Daniel, Pennington, Zach et al. (2021) Utility of prediction model score: a proposed tool to standardize the performance and generalizability of clinical predictive models based on systematic review. Journal of neurosurgery. Spine: 1-9	Other protocol criteria - not a validated scoring system
Enkaoua, E A, Doursounian, L, Chatellier, G et al. (1997) Vertebral metastases: a critical appreciation of the preoperative prognostic tokuhashi score in a series of 71 cases. Spine 22(19): 2293-8	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Feng, Jiang-Tao, Yang, Xiong-Gang, Wang, Feng et al. (2019) Prognostic Discrepancy on Overall Survival Between Ambulatory and Nonambulatory Patients with Metastatic Spinal Cord Compression. World neurosurgery 121: e322-e332	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Finnigan, Renee, Burmeister, Bryan, Barry, Tamara et al. (2015) Technique and early clinical outcomes for spinal and paraspinal tumours treated with stereotactic body radiotherapy. Journal of clinical neuroscience : official journal of the Neurosurgical Society of Australasia 22(8): 1258-63	Outcomes do not match protocol – predictive factors/association between SINS and incidence of VCFs

Study	Reason for exclusion
Fisher, CG, DiPaola, CP, Ryken, TC et al. (2010) A novel classification system for spinal instability in neoplastic disease: an evidence-based approach and expert consensus from the Spine Oncology Study Group. Spine 35(22): E1221-9	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Fisher, Charles G, Schouten, Rowan, Versteeg, Anne L et al. (2014) Reliability of the Spinal Instability Neoplastic Score (SINS) among radiation oncologists: an assessment of instability secondary to spinal metastases. Radiation oncology (London, England) 9: 69	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Foerster, Robert, Habermehl, Daniel, Bruckner, Thomas et al. (2014) Spinal bone metastases in gynecologic malignancies: a retrospective analysis of stability, prognostic factors and survival. Radiation oncology (London, England) 9: 194	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system – study of prognostic factors
Fox, S., Spiess, M., Hnenny, L. et al. (2017) Spinal Instability Neoplastic Score (SINS): Reliability Among Spine Fellows and Resident Physicians in Orthopedic Surgery and Neurosurgery. Global Spine Journal 7(8): 744-748	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system - evaluates spinal surgery trainees use of tool (inter and intra observer reliability)
Gallizia, E, Apicella, G, Cena, T et al. (2017) The spine instability neoplastic score (SINS) in the assessment of response to radiotherapy for bone metastases. Clinical & translational oncology : official publication of the Federation of Spanish Oncology Societies and of the National Cancer Institute of Mexico 19(11): 1382-1387	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Gao, Qing-Peng, Yang, Da-Zhi, Yuan, Zheng-Bin et al. (2021) Prognostic factors and its predictive value in patients with metastatic spinal cancer. World journal of clinical cases 9(20): 5470-5478	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Gao, Zhong-Yu, Zhang, Tao, Zhang, Hui et al. (2021) Establishment and validation of nomogram model for survival predicting in patients with spinal metastases secondary to lung cancer. Neurological research 43(4): 327-335	Other protocol criteria - not a validated scoring system
Ghori, Ahmer K, Leonard, Dana A, Schoenfeld, Andrew J et al. (2015) Modeling 1-year survival after surgery on the metastatic spine. The spine journal : official journal of the North American Spine Society 15(11): 2345-50	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Gjyshi, Olsi, Boyce-Fappiano, David, Pezzi, Todd A et al. (2020) Spine stereotactic radiosurgery for metastases from hepatobiliary malignancies: patient selection using PRISM scoring. Journal of neuro-oncology 148(2): 327-334	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Goodwin, C Rory, Schoenfeld, Andrew J, Abu-Bonsrah, Nancy A et al. (2016) Reliability of a spinal metastasis prognostic score to model 1-year survival. The spine journal : official journal of the North American Spine Society 16(9): 1102-8	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Hacking, H.G.A.; Van As, H.H.J.; Lankhorst, G.J. (1993) Factors related to the outcome of inpatient rehabilitation in patients with neoplastic epidural spinal cord compression. Paraplegia 31(6): 367-374	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Han, Shuai, Wang, Ting, Jiang, Dongjie et al. (2015) Surgery and survival outcomes of 30 patients with neurological deficit due to clear	Outcomes do not match

Study	Reason for exclusion
cell renal cell carcinoma spinal metastases. European spine journal: official publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society 24(8): 1786-91	protocol – does not report data relevant to prognostic value of a scoring system – evaluates scores on scales as prognostic factors
Hardisty, Michael, Wright, Trinette, Campbell, Mikki et al. (2020) CT based quantitative measures of the stability of fractured metastatically involved vertebrae treated with spine stereotactic body radiotherapy. Clinical & experimental metastasis 37(5): 575-584	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
He, Xin, Jiao, Yong-Qiang, Yang, Xiong-Gang et al. (2020) A Novel Prediction Tool for Overall Survival of Patients Living with Spinal Metastatic Disease. World neurosurgery 144: e824-e836	Other protocol criteria - not a validated scoring system
Hernandez-Fernandez, Alberto, Velez, Roberto, Lersundi-Artamendi, Ana et al. (2012) External validity of the Tokuhashi score in patients with vertebral metastasis. Journal of cancer research and clinical oncology 138(9): 1493-500	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Hersh, Andrew M, Pennington, Zach, Hung, Bethany et al. (2021) Comparison of frailty metrics and the Charlson Comorbidity Index for predicting adverse outcomes in patients undergoing surgery for spine metastases. Journal of neurosurgery. Spine: 1-9	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Hessler, Christian, Vettorazzi, Eik, Madert, Juergen et al. (2011) Actual and predicted survival time of patients with spinal metastases of lung cancer: evaluation of the robustness of the Tokuhashi score. Spine 36(12): 983-9	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Hu, Ming-Hsiao, Yen, Hung-Kuan, Chen, I-Hsin et al. (2022) Decreased psoas muscle area is a prognosticator for 90-day and 1-year survival in patients undergoing surgical treatment for spinal metastasis. Clinical nutrition (Edinburgh, Scotland) 41(3): 620-629	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system – evaluates impact of adding an individual prognostic factor to a range of prognostic tools
Hutton, Jonathon and Leung, John (2013) Treatment of spinal cord compression: are we overusing radiotherapy alone compared to surgery and radiotherapy?. Asia-Pacific journal of clinical oncology 9(2): 123-8	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system – prediction of treatment outcome
Jensen, Garrett, Tang, Chad, Hess, Kenneth R et al. (2017) Internal validation of the prognostic index for spine metastasis (PRISM) for stratifying survival in patients treated with spinal stereotactic radiosurgery. Journal of radiosurgery and SBRT 5(1): 25-34	Other protocol criteria - not a validated scoring system
Kanda, Yutaro, Kakutani, Kenichiro, Sakai, Yoshitada et al. (2021) Surgical outcomes and risk factors for poor outcomes in patients with cervical spine metastasis: a prospective study. Journal of orthopaedic surgery and research 16(1): 423	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Karhade, A.V., Thio, Q.C.B.S., Ogink, P.T. et al. (2019) Development of Machine Learning Algorithms for Prediction of 30-Day Mortality after Surgery for Spinal Metastasis. Clinical Neurosurgery 85(1): e83-e91	Other protocol criteria - not a validated scoring system
Karhade, Aditya V, Ahmed, Ali K, Pennington, Zach et al. (2020) External validation of the SORG 90-day and 1-year machine learning algorithms for survival in spinal metastatic disease. Spine Journal,	Other protocol criteria - not a validated scoring system

Study	Reason for exclusion
20(1): 14-21	
Karhade, Aditya V, Thio, Quirina C B S, Ogink, Paul T et al. (2019) Predicting 90-Day and 1-Year Mortality in Spinal Metastatic Disease: Development and Internal Validation. Neurosurgery 85(4): e671-e681	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system - compares performance of modelling techniques
Katagiri, H, Takahashi, M, Wakai, K et al. (2005) Prognostic factors and a scoring system for patients with skeletal metastasis. The Journal of bone and joint surgery. British volume 87(5): 698-703	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Kato, Satoshi, Murakami, Hideki, Demura, Satoru et al. (2019) Kidney and Thyroid Cancer-Specific Treatment Algorithm for Spinal Metastases: A Validation Study. World neurosurgery 122: e1305-e1311	Other protocol criteria - not a validated scoring system
Kerstens, Peter; Yi, Ma; James, Melissa (2019) Radiotherapy for metastatic spinal cord compression; can the Rades score predict survival?. Asia-Pacific journal of clinical oncology 15(6): 331-336	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Kim, Young Rak, Lee, Chang-Hyun, Yang, Seung Heon et al. (2021) Accuracy and precision of the spinal instability neoplastic score (SINS) for predicting vertebral compression fractures after radiotherapy in spinal metastases: a meta-analysis. Scientific reports 11(1): 5553	Other protocol criteria - not a validated scoring system
Kim, Junhyung, Lee, Sun-Ho, Park, Se-Jun et al. (2014) Analysis of the predictive role and new proposal for surgical strategies based on the modified Tomita and Tokuhashi scoring systems for spinal metastasis. World journal of surgical oncology 12: 245	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Kim, H., Chang, S.Y., Son, J. et al. (2021) The effect of adding biological factors to the decision-making process for spinal metastasis of non-small cell lung cancer. Journal of Clinical Medicine 10(5): 1-10	Other protocol criteria - not a validated scoring system - adds additional factors to an existing tool.
Kobayashi, Kazuyoshi, Ando, Kei, Nakashima, Hiroaki et al. (2020) Prognostic Factors in the New Katagiri Scoring System After Palliative Surgery for Spinal Metastasis. Spine 45(13): e813-e819	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Kowalchuk, R.O., Mullikin, T.C., Harmsen, W.S. et al. (2022) Development and Internal Validation of a Recursive Partitioning Analysis-Based Model Predictive of Pain Flare Incidence After Spine Stereotactic Body Radiation Therapy. Practical Radiation Oncology	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system - predicts pain flare after stereotactic body radiation therapy
Kowalchuk, Roman O, Johnson-Tesch, Benjamin A, Marion, Joseph T et al. (2022) Development and Assessment of a Predictive Score for Vertebral Compression Fracture After Stereotactic Body Radiation Therapy for Spinal Metastases. JAMA oncology 8(3): 412-419	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Kwan, Kenny Yat Hong, Lam, Tai Chung, Choi, Horace Cheuk Wai et al. (2018) Prediction of survival in patients with symptomatic spinal metastases: Comparison between the Tokuhashi score and expert oncologists. Surgical oncology 27(1): 7-10	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Lakomkin, Nikita, Zuckerman, Scott L, Stannard, Blaine et al. (2019) Preoperative Risk Stratification in Spine Tumor Surgery: A Compari-	Outcomes do not match

Study	Reason for exclusion
son of the Modified Charlson Index, Frailty Index, and ASA Score. Spine 44(13): e782-e787	protocol – does not report data relevant to prognostic value of a scoring system
Lee, Chang-Hyun, Chung, Chun Kee, Jahng, Tae-Ahn et al. (2015) Which one is a valuable surrogate for predicting survival between Tomita and Tokuhashi scores in patients with spinal metastases? A meta-analysis for diagnostic test accuracy and individual participant data analysis. Journal of neuro-oncology 123(2): 267-75	Study design - systematic review without pooled results/quantitative data, checked for relevant studies
Lee, Chang-Hyun, Hong, Jae Taek, Lee, Sun-Ho et al. (2021) Is the Spinal Instability Neoplastic Score Accurate and Reliable in Predicting Vertebral Compression Fractures for Spinal Metastasis? A Systematic Review and Qualitative Analysis. Journal of Korean Neurosurgical Society 64(1): 4-12	Study design - systematic review without pooled results/quantitative data, checked for relevant studies
Lee, Sun-Ho, Tatsui, Claudio E, Ghia, Amol J et al. (2016) Can the spinal instability neoplastic score prior to spinal radiosurgery predict compression fractures following stereotactic spinal radiosurgery for metastatic spinal tumor?: a post hoc analysis of prospective phase II single-institution trials. Journal of neuro-oncology 126(3): 509-17	Other protocol criteria - overlap with study population of Sahgal 2013 - which is reported in an included systematic review (Kim 2021)
Lei, M., Liu, S., Yang, S. et al. (2016) Validation of a model with which to predict the survival prognosis of patients with spinal cord compression resulted from metastatic cancers. European Journal of Surgical Oncology 42(12): 1924-1930	Other protocol criteria - not a validated scoring system
Lei, Mingxing, Liu, Yaosheng, Tang, Chuanghao et al. (2015) Prediction of survival prognosis after surgery in patients with symptomatic metastatic spinal cord compression from non-small cell lung cancer. BMC cancer 15: 853	Other protocol criteria - not a validated scoring system
Lei, Mingxing, Liu, Yaosheng, Yan, Liang et al. (2016) A validated preoperative score predicting survival and functional outcome in lung cancer patients operated with posterior decompression and stabilization for metastatic spinal cord compression. European spine journal : official publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society 25(12): 3971-3978	Other protocol criteria - not a validated scoring system
Leithner, Andreas, Radl, Roman, Gruber, Gerald et al. (2008) Predictive value of seven preoperative prognostic scoring systems for spinal metastases. European spine journal : official publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society 17(11): 1488-95	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Li, Zemin, Long, Houqing, Guo, Rui et al. (2018) Surgical treatment indications and outcomes in patients with spinal metastases in the cervicothoracic junction (CTJ). Journal of orthopaedic surgery and research 13(1): 20	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Liu, Shuzhong, Zhou, Xi, Song, An et al. (2020) Clinical Characteristics and Prognostic Analysis of Gynecologic Cancer with Spinal Metastases: A Single-Center Retrospective Study. Cancer management and research 12: 7515-7525	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Liu, Yujie, Li, Lin, Jiang, Dongjie et al. (2021) A Novel Nomogram for Survival Prediction of Patients with Spinal Metastasis From Prostate Cancer. Spine 46(6): e364-e373	Other protocol criteria - not a validated scoring system
Liu, Yujie, Yang, Minglei, Li, Bo et al. (2019) Development of a novel model for predicting survival of patients with spine metastasis from colorectal cancer. European spine journal : official publication of the	Other protocol criteria - not a validated scoring system

Study	Reason for exclusion
European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society 28(6): 1491-1501	
Majeed, H, Kumar, S, Bommireddy, R et al. (2012) Accuracy of prognostic scores in decision making and predicting outcomes in metastatic spine disease. Annals of the Royal College of Surgeons of England 94(1): 28-33	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system - compares survival of patients who underwent surgery with their expected survival (calculated before surgery)
Massaad, E., Hadzipasic, M., Alvarez-Breckenridge, C. et al. (2020) Predicting tumor-specific survival in patients with spinal metastatic renal cell carcinoma: Which scoring system is most accurate?. Journal of Neurosurgery: Spine 33(4): 529-539	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Masuda, Kenji, Ebata, Ko, Yasuhara, Yoshimasa et al. (2018) Outcomes and Prognosis of Neurological Decompression and Stabilization for Spinal Metastasis: Is Assessment with the Spinal Instability Neoplastic Score Useful for Predicting Surgical Results?. Asian spine journal 12(5): 846-853	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Matsumiya, H., Todo, Y., Okamoto, K. et al. (2016) A prediction model of survival for patients with bone metastasis from uterine cervical cancer. Journal of Gynecologic Oncology 27(6): e55	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Mezei, Tamas, Horvath, Anna, Pollner, Peter et al. (2020) Research on the predicting power of the revised Tokuhashi system: how much time can surgery give to patients with short life expectancy?. International journal of clinical oncology 25(4): 755-764	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Mikula, Anthony L, Pennington, Zach, Lakomkin, Nikita et al. (2022) Independent predictors of vertebral compression fracture following radiation for metastatic spine disease. Journal of neurosurgery. Spine: 1-7	Other protocol criteria - not available
Mizumoto, M., Harada, H., Asakura, H. et al. (2008) Prognostic factors and a scoring system for survival after radiotherapy for metastases to the spinal column: A review of 544 patients at Shizuoka Cancer Center Hospital. Cancer 113(10): 2816-2822	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Mohd Rothi, Illina; Deverall, Hamish H; Baker, Joseph F (2019) The modified Frailty Index does not correlate with survival in surgically-treated patients with metastatic spine disease. Journal of clinical neuroscience : official journal of the Neurosurgical Society of Australasia 66: 178-181	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Morgen, Soren Schmidt, Fruergaard, Sidsel, Gehrchen, Martin et al. (2018) A revision of the Tokuhashi revised score improves the prognostic ability in patients with metastatic spinal cord compression. Journal of cancer research and clinical oncology 144(1): 33-38	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Morgen, Soren Schmidt, Nielsen, Dennis Hallager, Larsen, Claus Falck et al. (2014) Moderate precision of prognostic scoring systems in a consecutive, prospective cohort of 544 patients with metastatic spinal cord compression. Journal of cancer research and clinical oncology 140(12): 2059-64	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Nater, Anick, Chuang, Junior, Liu, Kuan et al. (2020) A Personalized Medicine Approach for the Management of Spinal Metastases with	Other protocol criteria - not a validated scoring system

Study	Reason for exclusion
Cord Compression: Development of a Novel Clinical Prediction Model for Postoperative Survival and Quality of Life. World neurosurgery 140: 654-663e13	
Nater, Anick, Tetreault, Lindsay A, Kopjar, Branko et al. (2018) Predictive factors of survival in a surgical series of metastatic epidural spinal cord compression and complete external validation of 8 multivariate models of survival in a prospective North American multicenter study. Cancer 124(17): 3536-3550	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system - prognostic factor study
Nenclares, P, Guardado, S, Asiain, L et al. (2020) A new and simple scoring system to predict overall survival after irradiation for metastatic spinal cord compression. Clinical & translational oncology : official publication of the Federation of Spanish Oncology Societies and of the National Cancer Institute of Mexico 22(3): 440-444	Other protocol criteria - not a validated scoring system
Ogihara, Satoshi, Seichi, Atsushi, Hozumi, Takahiro et al. (2006) Prognostic factors for patients with spinal metastases from lung cancer. Spine 31(14): 1585-90	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Oh, I.-S.; Kim, S.-I.; Ha, K.-Y. (2011) Significant predictive values for the life expectancy in patients with spinal metastasis following surgical treatment. European Journal of Orthopaedic Surgery and Traumatology: 1-8	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Osong, B., Sanli, I., Willems, P.C. et al. (2021) Overall survival nomogram for patients with spinal bone metastases (SBM). Clinical and Translational Radiation Oncology 28: 48-53	Other protocol criteria - not a validated scoring system
Pahuta, Markian A, Werier, Joel, Wai, Eugene K et al. (2019) Back to Bayesian: A strategy to enhance prognostication of metastatic spine disease. International journal of clinical practice 73(4): e13322	Study design does not match review protocol
Papastefanou, Sotiris, Alpantaki, Kalliopi, Akra, Gabriel et al. (2012) Predictive value of Tokuhashi and Tomita scores in patients with metastatic spine disease. Acta orthopaedica et traumatologica turcica 46(1): 50-6	Study design does not match review protocol
Park, Hae Jin, Kim, Hee Jung, Won, Jong-Ho et al. (2015) Stereotactic Body Radiotherapy (SBRT) for Spinal Metastases: Who Will Benefit the Most from SBRT?. Technology in cancer research & treatment 14(2): 159-67	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system - prognostic factors study
Park, SeJun, Lee, ChongSuh, Chung, SungSoo et al. (2015) How accurately can tokuhashi score system predict survival in the current practice for spinal metastases?: prospective analysis of 145 consecutive patients between 2007 and 2013. Journal of spinal disorders & techniques 28(4): e219-24	Other protocol criteria - duplicate publication
Paulino Pereira, Nuno Rui, Janssen, Stein J, van Dijk, Eva et al. (2016) Development of a Prognostic Survival Algorithm for Patients with Metastatic Spine Disease. The Journal of bone and joint surgery. American volume 98(21): 1767-1776	Other protocol criteria - not a validated scoring system
Paulino Pereira, Nuno Rui, Mclaughlin, Lily, Janssen, Stein J et al. (2017) The SORG nomogram accurately predicts 3- and 12-months survival for operable spine metastatic disease: External validation. Journal of surgical oncology 115(8): 1019-1027	Other protocol criteria - not a validated scoring system
Pennington, Zach, Ahmed, A Karim, Westbroek, Erick M et al. (2019) SINS Score and Stability: Evaluating the Need for Stabilization Within	Outcomes do not match

Study	Reason for exclusion
the Uncertain Category. World neurosurgery 128: e1034-e1047	protocol – does not report data relevant to prognostic value of a scoring system
Phinyo, Phichayut, Boonyanaruthee, Chonmavadh, Paholpak, Permsak et al. (2020) Natural disease progression and novel survival prediction model for hepatocellular carcinoma with spinal metastases: a 10-year single-center study. World journal of surgical oncology 18(1): 135	Other protocol criteria - not a validated scoring system
Pollner, Peter, Horvath, Anna, Mezei, Tamas et al. (2018) Analysis of Four Scoring Systems for the Prognosis of Patients with Metastasis of the Vertebral Column. World neurosurgery 112: e675-e682	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Quraishi, Nasir A, Arealis, George, Salem, Khalid M I et al. (2015) The surgical management of metastatic spinal tumors based on an Epidural Spinal Cord Compression (ESCC) scale. The spine journal : official journal of the North American Spine Society 15(8): 1738-43	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Rades, D., Bartscht, T., Janssen, S. et al. (2016) Forecasting survival probabilities after radiotherapy of metastatic epidural spinal cord compression from colorectal cancer in the elderly. Anticancer Research 36(4): 1829-1833	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Rades, D., Douglas, S., Veninga, T. et al. (2012) A survival score for patients with metastatic spinal cord compression from prostate cancer. Strahlentherapie und Onkologie 188(9): 802-806	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Rades, D., Douglas, S., Veninga, T. et al. (2010) Validation and simplification of a score predicting survival in patients irradiated for metastatic spinal cord compression. Cancer 116(15): 3670-3673	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Rades, D., Evers, J.N., Bajrovic, A. et al. (2014) Metastatic spinal cord compression: A validated survival score for elderly patients. Strahlentherapie und Onkologie 190(10): 919-924	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Rades, D., Evers, J.N., Rudat, V. et al. (2014) A validated score estimating ambulatory status following radiotherapy of elderly patients for metastatic spinal cord compression. BMC Cancer 14(1): 589	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Rades, D.; Hueppe, M.; Schild, S.E. (2013) A score to identify patients with metastatic spinal cord compression who may be candidates for best supportive care. Cancer 119(4): 897-903	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Rades, D., Huttenlocher, S., Bajrovic, A. et al. (2015) A new instrument for estimating the survival of patients with metastatic epidural spinal cord compression from esophageal cancer. Radiology and Oncology 49(1): 86-90	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Rades, D., Veninga, T., Bajrovic, A. et al. (2013) A validated scoring system to identify long-term survivors after radiotherapy for metastatic spinal cord compression. Strahlentherapie und Onkologie 189(6): 462-466	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Rades, D, Douglas, S, Huttenlocher, S et al. (2012) Prognostic factors and a survival score for patients with metastatic spinal cord compression from colorectal cancer. Strahlentherapie und Onkologie :	Outcomes do not match protocol – does not report data relevant to prognostic

Study	Reason for exclusion
Organ der Deutschen Rontgengesellschaft ... [et al] 188(12): 1114-8	value of a scoring system
Rades, D; Douglas, S; Schild, S E (2013) A validated survival score for breast cancer patients with metastatic spinal cord compression. Strahlentherapie und Onkologie : Organ der Deutschen Rontgengesellschaft ... [et al] 189(1): 41-6	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Rades, Dirk; Bajrovic, Amira; Bartscht, Tobias (2017) Predictive Factors and a Survival Score for Patients Irradiated for Metastatic Spinal Cord Compression from Carcinoma of the Salivary Glands. Anticancer research 37(12): 7011-7015	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Rades, Dirk, Cacicedo, Jon, Lomidze, Darejan et al. (2022) A New and Easy-to-Use Survival Score for Patients Irradiated for Metastatic Epidural Spinal Cord Compression. Practical radiation oncology	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Rades, Dirk, Conde, Antonio J, Garcia, Raquel et al. (2015) A new instrument for estimation of survival in elderly patients irradiated for metastatic spinal cord compression from breast cancer. Radiation oncology (London, England) 10: 173	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Rades, Dirk, Conde-Moreno, Antonio J, Cacicedo, Jon et al. (2015) Metastatic Spinal Cord Compression: A Survival Score Particularly Developed for Elderly Prostate Cancer Patients. Anticancer research 35(11): 6189-92	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Rades, Dirk, Conde-Moreno, Antonio J, Cacicedo, Jon et al. (2016) Estimating the Survival of Elderly Patients with Renal Cell Carcinoma Presenting with Malignant Spinal Cord Compression. Anticancer research 36(1): 409-13	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Rades, Dirk, Conde-Moreno, Antonio J, Cacicedo, Jon et al. (2018) A scoring system to predict local progression-free survival in patients irradiated with 20 Gy in 5 fractions for malignant spinal cord compression. Radiation oncology (London, England) 13(1): 257	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Rades, Dirk, Conde-Moreno, Antonio J, Garcia, Raquel et al. (2015) A Tool to Estimate Survival of Elderly Patients Presenting with Metastatic Epidural Spinal Cord Compression (MESCC) from Cancer of Unknown Primary. Anticancer research 35(11): 6219-22	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Rades, Dirk, Conde-Moreno, Antonio J, Segedin, Barbara et al. (2016) A Prognostic Instrument to Estimate the Survival of Elderly Patients Irradiated for Metastatic Epidural Spinal Cord Compression From Lung Cancer. Clinical lung cancer 17(4): 279-84	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Rades, Dirk, Conde-Moreno, Antonio Jose, Cacicedo, Jon et al. (2016) A predictive tool particularly designed for elderly myeloma patients presenting with spinal cord compression. BMC cancer 16: 292	Other protocol criteria - not a validated scoring system
Rades, Dirk, Douglas, Sarah, Huttenlocher, Stefan et al. (2011) Validation of a score predicting post-treatment ambulatory status after radiotherapy for metastatic spinal cord compression. International journal of radiation oncology, biology, physics 79(5): 1503-6	Other protocol criteria - not a validated scoring system
Rades, Dirk, Douglas, Sarah, Veninga, Theo et al. (2012) A validated survival score for patients with metastatic spinal cord compression from non-small cell lung cancer. BMC cancer 12: 302	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Rades, Dirk; Dunst, Juergen; Schild, Steven E (2008) The first score predicting overall survival in patients with metastatic spinal cord compression. Cancer 112(1): 157-61	Outcomes do not match protocol – does not report

Study	Reason for exclusion
	data relevant to prognostic value of a scoring system
Rades, Dirk, Haus, Rapha, Schild, Steven E et al. (2019) Prognostic factors and a new scoring system for survival of patients irradiated for bone metastases. BMC cancer 19(1): 1156	Other protocol criteria - not a validated scoring system
Rades, Dirk, Huttenlocher, Stefan, Bartscht, Tobias et al. (2015) Predicting the survival probability of gastric cancer patients developing metastatic epidural spinal cord compression (MESCC). Gastric cancer : official journal of the International Gastric Cancer Association and the Japanese Gastric Cancer Association 18(4): 881-4	Other protocol criteria - not a validated scoring system
Rades, Dirk, Motisi, Laura, Veninga, Theo et al. (2019) Predictors of Outcomes and a Scoring System for Estimating Survival in Patients Treated With Radiotherapy for Metastatic Spinal Cord Compression From Small-Cell Lung Cancer. Clinical lung cancer 20(4): 322-329	Other protocol criteria - not a validated scoring system
Rades, Dirk, Schild, Steven E, Karstens, Johann H et al. (2015) Predicting survival of patients with metastatic epidural spinal cord compression from cancer of the head-and-neck. Anticancer research 35(1): 385-8	Other protocol criteria - not a validated scoring system
Ragel, Brian T, Mendez, Gustavo A, Reddington, Justin et al. (2017) Life Expectancy and Metastatic Spine Scoring Systems: An Academic Institutional Experience. Clinical spine surgery 30(8): 335-342	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Sanli, I, Osong, B, Dekker, A et al. (2022) Radiomics biopsy signature for predicting survival in patients with spinal bone metastases (SBMs). Clinical and translational radiation oncology 33: 57-65	Other protocol criteria - not a validated scoring system
Schoenfeld, A.J., Le, H.V., Marjoua, Y. et al. (2016) Assessing the utility of a clinical prediction score regarding 30-day morbidity and mortality following metastatic spinal surgery: the New England Spinal Metastasis Score (NESMS). Spine Journal 16(4): 482-490	Other protocol criteria - not a validated scoring system
Schoenfeld, Andrew J, Blucher, Justin A, Barton, Lauren B et al. (2020) Design of the prospective observational study of spinal metastasis treatment (POST). The spine journal : official journal of the North American Spine Society 20(4): 572-579	Other protocol criteria - not a validated scoring system
Schoenfeld, Andrew J, Ferrone, Marco L, Blucher, Justin A et al. (2022) Prospective comparison of the accuracy of the New England Spinal Metastasis Score (NESMS) to legacy scoring systems in prognosticating outcomes following treatment of spinal metastases. The spine journal : official journal of the North American Spine Society 22(1): 39-48	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Schoenfeld, Andrew J, Ferrone, Marco L, Schwab, Joseph H et al. (2021) Prospective validation of a clinical prediction score for survival in patients with spinal metastases: the New England Spinal Metastasis Score. The spine journal : official journal of the North American Spine Society 21(1): 28-36	Other protocol criteria - not a validated scoring system
Shah, Akash A, Karhade, Aditya V, Park, Howard Y et al. (2021) Updated external validation of the SORG machine learning algorithms for prediction of ninety-day and one-year mortality after surgery for spinal metastasis. The spine journal : official journal of the North American Spine Society 21(10): 1679-1686	Other protocol criteria - not a validated scoring system
Shi, Diana D, Chen, Yu-Hui, Lam, Tai Chung et al. (2018) Assessing the utility of a prognostication model to predict 1-year mortality in patients undergoing radiation therapy for spinal metastases. The spine journal : official journal of the North American Spine Society 18(6): 935-940	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Shi, Diana D, Hertan, Lauren M, Lam, Tai Chung et al. (2018) As-	Outcomes do not match

Study	Reason for exclusion
sessing the utility of the spinal instability neoplastic score (SINS) to predict fracture after conventional radiation therapy (RT) for spinal metastases. Practical radiation oncology 8(5): e285-e294	protocol – does not report data relevant to prognostic value of a scoring system
Smeijers, S and Depreitere, B (2021) Prognostic scores for survival as decisional support for surgery in spinal metastases: a performance assessment systematic review. European spine journal : official publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society 30(10): 2800-2824	Study design - systematic review without pooled results/quantitative data, checked for relevant studies
Sutcliffe, P, Connock, M, Shyangdan, D et al. (2013) A systematic review of evidence on malignant spinal metastases: natural history and technologies for identifying patients at high risk of vertebral fracture and spinal cord compression. Health technology assessment (Winchester, England) 17(42): 1-274	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system - prognostic factor study
Szoverfi, Zsolt, Lazary, Aron, Bozsodi, Arpad et al. (2014) Primary Spinal Tumor Mortality Score (PSTMS): a novel scoring system for predicting poor survival. The spine journal : official journal of the North American Spine Society 14(11): 2691-700	Other protocol criteria - not a validated scoring system
Tan, Jonathan, Tan, Kimberly Anne, Zaw, Aye Sandar et al. (2017) 43 - Evaluation of prognostic factors and a modification to the modified tokuhashi score in patients with spinal metastases from breast cancer. Spine Journal 17: 16-s16	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system - prognostic factor study
Tang, Chad, Hess, Kenneth, Bishop, Andrew J et al. (2015) Creation of a Prognostic Index for Spine Metastasis to Stratify Survival in Patients Treated With Spinal Stereotactic Radiosurgery: Secondary Analysis of Mature Prospective Trials. International journal of radiation oncology, biology, physics 93(1): 118-25	Other protocol criteria - not a validated scoring system
Tokuhashi, Y., Matsuzaki, H., Toriyama, S. et al. (1990) Scoring system for the preoperative evaluation of metastatic spine tumor prognosis. Spine 15(11): 1110-1113	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Tokuhashi, Y, Matsuzaki, H, Kawano, H et al. (1994) [The indication of operative procedure for a metastatic spine tumor: a scoring system for the preoperative evaluation of the prognosis]. Nihon Seikeigeka Gakkai zasshi 68(5): 379-89	Other protocol criteria – not available in English
Tokuhashi, Yasuaki, Matsuzaki, Hiromi, Oda, Hiroshi et al. (2005) A revised scoring system for preoperative evaluation of metastatic spine tumor prognosis. Spine 30(19): 2186-91	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system - describes development of the revised Tokuhashi Scoring System - no external validation reported
Tokuhashi, Yasuaki; Uei, Hiroshi; Oshima, Masashi (2017) Classification and scoring systems for metastatic spine tumors: a literature review. Spine surgery and related research 1(2): 44-55	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Tokuhashi, Yasuaki, Uei, Hiroshi, Oshima, Masashi et al. (2014) Scoring system for prediction of metastatic spine tumor prognosis. World journal of orthopedics 5(3): 262-71	Study design - systematic review without pooled re-

Study	Reason for exclusion
	sults/quantitative data, checked for relevant studies
Uei, Hiroshi and Tokuhashi, Yasuaki (2018) Prognostic factors in patients with metastatic spine tumors derived from lung cancer-a novel scoring system for predicting life expectancy. World journal of surgical oncology 16(1): 131	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system - prognostic factor study
Uei, Hiroshi and Tokuhashi, Yasuaki (2020) Prognostic scoring system for metastatic spine tumors derived from hepatocellular carcinoma. Journal of orthopaedic surgery (Hong Kong) 28(1): 2309499019899167	Other protocol criteria - not a validated scoring system
Ulmar, Benjamin, Naumann, Ulrike, Catalkaya, Sibel et al. (2007) Prognosis scores of Tokuhashi and Tomita for patients with spinal metastases of renal cancer. Annals of surgical oncology 14(2): 998-1004	- Exclude Patients included in Ulmar 2007
Ulmar, Benjamin, Reichel, Heiko, Catalkaya, Sibel et al. (2007) Evaluation and modification of the Tomita score in 217 patients with vertebral metastases. Onkologie 30(89): 414-8	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Ulmar, Benjamin, Richter, Marcus, Cakir, Balkan et al. (2005) The Tokuhashi score: significant predictive value for the life expectancy of patients with breast cancer with spinal metastases. Spine 30(19): 2222-6	- Exclude Patients included in Ulmar 2007
van der Linden, Yvette M, Dijkstra, Sander P D S, Vonk, Ernest J A et al. (2005) Prediction of survival in patients with metastases in the spinal column: results based on a randomized trial of radiotherapy. Cancer 103(2): 320-8	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Vanek, Petr, Bradac, Ondrej, Trebicky, Ferdinand et al. (2015) Influence of the Preoperative Neurological Status on Survival After the Surgical Treatment of Symptomatic Spinal Metastases With Spinal Cord Compression. Spine 40(23): 1824-30	Other protocol criteria - not a validated scoring system
Verlaan, J.-J., Choi, D., Versteeg, A. et al. (2016) Characteristics of patients who survived <, 3 months or >2 years after surgery for spinal metastases: Can we avoid inappropriate patient selection?. Journal of Clinical Oncology 34(25): 3054-3061	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system - prognostic factor study
Veronesi, Francesca, Borsari, Veronica, Martini, Lucia et al. (2021) The Impact of Frailty on Spine Surgery: Systematic Review on 10 years Clinical Studies. Aging and disease 12(2): 625-645	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Versteeg, Anne L, Verlaan, Jorrit-Jan, Sahgal, Arjun et al. (2016) The Spinal Instability Neoplastic Score: Impact on Oncologic Decision-Making. Spine 41suppl20: 231-s237	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Walker, Allison, Bassale, Solange, Shukla, Rakendu et al. (2022) A Prognostic Index for Predicting Survival of Patients Undergoing Radiation Therapy for Spine Metastasis Using Recursive Partitioning Analysis. Journal of palliative medicine 25(1): 21-27	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system -

Study	Reason for exclusion
	prognostic factor study
Wang, S., Liu, Q., Lei, M. et al. (2018) Validation of a scoring system predicting survival and function outcome in patients with metastatic epidural spinal cord compression (MESCC): A prospective and multicenter study. International Journal of Clinical and Experimental Medicine 11(3): 2465-2470	Other protocol criteria - not a validated scoring system
Wanman, Johan, Jernberg, Johannes, Gustafsson, Patrik et al. (2021) Predictive Value of the Spinal Instability Neoplastic Score for Survival and Ambulatory Function After Surgery for Metastatic Spinal Cord Compression in 110 Patients with Prostate Cancer. Spine 46(8): 550-558	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Wei, Daniel, Nistal, Dominic A, Sobotka, Stanislaw et al. (2019) New Predictive Index for Survival in Symptomatic Spinal Metastases. World neurosurgery 123: e133-e140	Other protocol criteria - not a validated scoring system
Whitehouse, S, Stephenson, J, Sinclair, V et al. (2016) A validation of the Oswestry Spinal Risk Index. European spine journal : official publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society 25(1): 247-251	Other protocol criteria - not a validated scoring system
Wibmer, Christine, Leithner, Andreas, Hofmann, Gunter et al. (2011) Survival analysis of 254 patients after manifestation of spinal metastases: evaluation of seven preoperative scoring systems. Spine 36(23): 1977-86	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Xing, D., Dong, Z., Zheng, X. et al. (2019) The protective effects of surgery according to the spinal instability neoplastic score for patients with the EGFR mutation, lung adenocarcinoma, and spinal metastatic instability. International Journal of Clinical and Experimental Medicine 12(11): 12764-12772	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system
Yamashita, Takayuki, Aota, Yoichi, Kushida, Kazuyoshi et al. (2008) Changes in physical function after palliative surgery for metastatic spinal tumor: association of the revised Tokuhashi score with neurologic recovery. Spine 33(21): 2341-6	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system - prognostic factor study
Yang, Minglei, Ma, Xiaoyu, Wang, Pengru et al. (2022) Prediction of Survival Prognosis for Spinal Metastasis From Cancer of Unknown Primary: Derivation and Validation of a Nomogram Model. Global spine journal: 21925682221103833	Other protocol criteria - not a validated scoring system
Yang, Minglei, Xu, Wei, Liu, Tielong et al. (2019) Development and Validation of a Novel Survival Prediction Model in Patients With Spinal Metastasis From Non-small Cell Lung Cancer. Spine 44(4): 246-257	Other protocol criteria - not a validated scoring system
Yang, Xiong-Gang, Feng, Jiang-Tao, Wang, Feng et al. (2019) Development and validation of a prognostic nomogram for the overall survival of patients living with spinal metastases. Journal of neuro-oncology 145(1): 167-176	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system - prognostic factor study
Yang, Xiong-Gang, Wang, Feng, Feng, Jiang-Tao et al. (2019) Recursive Partitioning Analysis (RPA) of Prognostic Factors for Overall Survival in Patients with Spinal Metastasis: A New System for Stratified Treatment. World neurosurgery 127: e124-e131	Other protocol criteria - not a validated scoring system
Yilmazlar, Selcuk, Dogan, Seref, Caner, Basak et al. (2008) Compar-	Outcomes do not match

Study	Reason for exclusion
ison of prognostic scores and surgical approaches to treat spinal metastatic tumors: a review of 57 cases. Journal of orthopaedic surgery and research 3: 37	protocol – does not report data relevant to prognostic value of a scoring system
Zakaria, Hesham Mostafa, Wilkinson, Brandon Michael, Pennington, Zach et al. (2020) Sarcopenia as a Prognostic Factor for 90-Day and Overall Mortality in Patients Undergoing Spine Surgery for Metastatic Tumors: A Multicenter Retrospective Cohort Study. Neurosurgery 87(5): 1025-1036	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system - prognostic factor study
Zang, Shizhao, He, Qin, Bao, Qiyuan et al. (2019) Establishment and validation of a novel survival prediction scoring algorithm for patients with non-small-cell lung cancer spinal metastasis. International journal of clinical oncology 24(9): 1049-1060	Other protocol criteria - not a validated scoring system
Zeng, JC, Song, YM, Liu, H et al. (2007) [The predictive value of the Tokuhashi revised scoring system for the survival time of patients with spinal metastases]. Sichuan da xue xue bao. Yi xue ban = Journal of Sichuan University. Medical science edition 38(3): 488-91	Other protocol criteria – not available in English
Zhang, Dan, Xu, Wei, Liu, Tielong et al. (2013) Surgery and prognostic factors of patients with epidural spinal cord compression caused by hepatocellular carcinoma metastases: retrospective study of 36 patients in a single center. Spine 38(17): e1090-5	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system - prognostic factor study
Zhao, C., Wang, Y., Cai, X. et al. (2020) Prognostic significance of a novel score model based on preoperative indicators in patients with breast cancer spine metastases (Bcsm). Cancer Management and Research 12: 11501-11513	Other protocol criteria - not a validated scoring system
Zhong, N., Leng, A., He, S. et al. (2019) Surgical outcomes and prognostic factors for patients with gastric cancer spinal metastasis. Cancer Management and Research 11: 6971-6979	Outcomes do not match protocol – does not report data relevant to prognostic value of a scoring system - prognostic factor study
Zoccali, C., Skoch, J., Walter, C.M. et al. (2016) The Tokuhashi score: effectiveness and pitfalls. European Spine Journal 25(3): 673-678	Study design - systematic review without pooled results/quantitative data, checked for relevant studies

Excluded economic studies

No economic evidence was identified for this review. See supplementary material 2 for further information.

Appendix K Research recommendations – full details

Research recommendations for review question: What is the prognostic value of validated scoring systems for determining survival in people with spinal cord compression caused by spinal metastases or direct malignant infiltration of the spine?

No research recommendations were made for this review question.

Appendix L Study data (AUC data and observed / predicted survival data)

Prognostic data extraction for the review questions: What is the prognostic value of validated scoring systems for determining survival in people with spinal cord compression caused by spinal metastases or direct malignant infiltration of the spine?

Key to variables

- **study**: study ID
- **testname**: clinical prediction tool
- **population**: patient population in the study
- **N**: number of participants in the study
- **auc**: area under the receiver operating characteristic curve
- **auc_ci_lower, auc_ci_upper**: lower and upper 95%CI of AUC

Table 20: AUC data

study	testname	Population	N	auc	auc_ci_lower	auc_ci_upper
Ahmed 2018	Katagiri	Any primary (surgery)	176	0.78	0.72	0.85
Ahmed 2018	Modified Bauer	Any primary (surgery)	176	0.71	0.64	0.79
Ahmed 2018	Revised Tokuhashi	Any primary (surgery)	176	0.77	0.70	0.84
Ahmed 2018	SORG Classic scoring algorithm	Any primary (surgery)	176	0.77	0.70	0.84
Ahmed 2018	SORG nomogram	Any primary (surgery)	176	0.78	0.71	0.85
Ahmed 2018	Tokuhashi	Any primary (surgery)	176	0.78	0.71	0.85
Ahmed 2018	Tomita	Any primary (surgery)	176	0.70	0.62	0.78
Ahmed 2018	Van der Linden	Any primary (surgery)	176	0.71	0.63	0.78
Balain 2013	Modified Bauer	Any primary (surgery or RT)	199	0.64	0.61	0.70
Balain 2013	Oswestry Spinal Metastasis Risk Index	Any primary (surgery or RT)	199	0.67	0.64	0.70
Balain 2013	Revised Tokuhashi	Any primary (surgery or RT)	199	0.67	0.65	0.73
Balain 2013	Tomita	Any primary (surgery or RT)	199	0.65	0.62	0.71

study	testname	Population	N	auc	auc_ci_lower	auc_ci_upper
Denisov 2020	Katagiri	Any primary (surgery)	138	0.65	0.51	0.79
Denisov 2020	Revised Tokuhashi	Any primary (surgery)	138	0.61	0.59	0.62
Denisov 2020	Tomita	Any primary (surgery)	138	0.71	0.57	0.84
Kumar 2014	Bauer	Nasophayngeal cancer	87	0.65	0.55	0.75
Kumar 2014	Oswestry Spinal Metastasis Risk Index	Nasophayngeal cancer	87	0.57	0.49	0.65
Kumar 2014	Revised Tokuhashi	Nasophayngeal cancer	87	0.64	0.54	0.74
Kumar 2014	Tomita	Nasophayngeal cancer	87	0.71	0.61	0.81
Tabourel 2021	Lei	Any primary	739	0.69	0.66	0.71
Tabourel 2021	Rades	Any primary	739	0.58	0.56	0.60
Tabourel 2021	Revised Tokuhashi	Any primary	739	0.83	0.79	0.86
Tabourel 2021	Tomita	Any primary	739	0.40	0.38	0.42
Tabourel 2021	Van der Linden	Any primary	739	0.73	0.71	0.75
Tan 2016b	Bauer	Nasophayngeal cancer	92	0.52	0.44	0.60
Tan 2016b	Katagiri	Nasophayngeal cancer	92	0.61	0.51	0.71
Tan 2016b	SSG	Nasophayngeal cancer	92	0.59	0.51	0.67
Tan 2016a	Modified Bauer	Lung cancer	180	0.50	0.46	0.54
Tan 2016a	Oswestry Spinal Metastasis Risk Index	Lung cancer	180	0.32	0.24	0.40
Tan 2016a	Revised Tokuhashi	Lung cancer	180	0.48	0.44	0.52
Tan 2016a	Tomita	Lung cancer	180	0.38	0.30	0.46
Tan 2018	Modified Tokuhashi revised	Breast cancer	185	0.68	0.58	0.78
Tan 2018	Revised Tokuhashi	Breast cancer	185	0.62	0.52	0.72
Westerman 2020	Modified Bauer	Any primary (surgery)	223	0.69	0.67	0.71
Westerman 2020	Modified Tokuhashi revised	Any primary (surgery)	223	0.71	0.64	0.78
Westerman 2020	Oswestry Spinal Metastasis Risk Index	Any primary (surgery)	223	0.67	0.60	0.74
Westerman 2020	Revised Tokuhashi	Any primary (surgery)	223	0.71	0.64	0.78
Westerman 2020	Tokuhashi	Any primary (surgery)	223	0.71	0.64	0.77

study	testname	Population	N	auc	auc_ci_lower	auc_ci_upper
Westerman 2020	Tomita	Any primary (surgery)	223	0.77	0.71	0.84
Westerman 2020	Van der Linden	Any primary (surgery)	223	0.59	0.52	0.67
Yang 2021	SORG-ML	Any primary (surgery)	427	0.74	0.69	0.79

Key to variables

- **study**: study ID
- **testname**: clinical prediction tool
- **thresholds**: upper and lower scores used to define the survival group
- **population**: patient population in the study
- **predicted**: number of patients in the study whose score on the prediction tool met the criteria in thresholds variable
- **observed:** number of patients in the study who survived as long the prediction tool predicted
- **N**: number of participants in the study

Table 21: observed and predicted survival data

study	testname	thresholds	population	predicted	observed	N
Eap 2015	Revised Tokuhashi	Score of 0 - 8	Any primary (surgery)	105	57	260
Eap 2015	Revised Tokuhashi	Score of 9 - 11	Any primary (surgery)	82	18	260
Eap 2015	Revised Tokuhashi	Score of 12 - 15	Any primary (surgery)	73	63	260
Gakhar 2012	Revised Tokuhashi	Score of 0 - 8	Any primary (surgery)	36	13	90
Gakhar 2012	Revised Tokuhashi	Score of 9 - 11	Any primary (surgery)	33	3	90
Gakhar 2012	Revised Tokuhashi	Score of 12 - 15	Any primary (surgery)	21	17	90
Gruenberg 2017	Revised Tokuhashi	Score of 0 - 8	Any primary (surgery)	50	40	105
Gruenberg 2017	Revised Tokuhashi	Score of 9 - 11	Any primary (surgery)	36	12	105
Gruenberg 2017	Revised Tokuhashi	Score of 12 - 15	Any primary (surgery)	19	19	105
Iinuma 2021	Revised Tokuhashi	Score of 0 - 8	Any primary (surgery)	57	15	85
Iinuma 2021	Revised Tokuhashi	Score of 9 - 11	Any primary (surgery)	22	2	85
Iinuma 2021	Revised Tokuhashi	Score of 12 - 15	Any primary (surgery)	6	3	85

study	testname	thresholds	population	predicted	observed	N
Mollahoseini 2011	Revised Tokuhashi	Score of 0 - 8	Any primary	38	28	109
Mollahoseini 2011	Revised Tokuhashi	Score of 9 - 11	Any primary	39	16	109
Mollahoseini 2011	Revised Tokuhashi	Score of 12 - 15	Any primary	32	23	109
Park 2015	Revised Tokuhashi	Score of 0 - 8	Any primary (surgery)	106	63	145
Park 2015	Revised Tokuhashi	Score of 9 - 11	Any primary (surgery)	30	11	145
Park 2015	Revised Tokuhashi	Score of 12 - 15	Any primary (surgery)	9	9	145
Pelegrini de Almeida 2018	Revised Tokuhashi	Score of 0 - 8	Any primary (surgery)	72	29	117
Pelegrini de Almeida 2018	Revised Tokuhashi	Score of 9 - 11	Any primary (surgery)	37	6	117
Pelegrini de Almeida 2018	Revised Tokuhashi	Score of 12 - 15	Any primary (surgery)	8	6	117
Petteys 2015	Revised Tokuhashi	Score of 0 - 8	Renal cell carcinoma (surgery)	8	4	30
Petteys 2015	Revised Tokuhashi	Score of 9 - 11	Renal cell carcinoma (surgery)	7	1	30
Petteys 2015	Revised Tokuhashi	Score of 12 - 15	Renal cell carcinoma (surgery)	15	10	30
Quraishi 2013	Revised Tokuhashi	Score of 0 - 8	Any primary - MSCC	84	54	201
Quraishi 2013	Revised Tokuhashi	Score of 9 - 11	Any primary - MSCC	83	53	201
Quraishi 2013	Revised Tokuhashi	Score of 12 - 15	Any primary - MSCC	34	23	201
Ribas 2016	Revised Tokuhashi	Score of 0 - 8	Any primary (surgery)	8	6	17
Ribas 2016	Revised Tokuhashi	Score of 9 - 11	Any primary (surgery)	7	1	17
Ribas 2016	Revised Tokuhashi	Score of 12 - 15	Any primary (surgery)	2	0	17
Ribas 2016	Tomita	Score of 8 to 10	Any primary (surgery)	2	2	17
Ribas 2016	Tomita	Score of 6 to 7	Any primary (surgery)	8	1	17
Ribas 2016	Tomita	Score of 4 to 5	Any primary (surgery)	6	2	17
Ribas 2016	Tomita	Score of 2 to 3	Any primary (surgery)	1	0	17
Ribas 2016	Modified Bauer	Score of 0 to 1	Any primary (surgery)	3	2	17

study	testname	thresholds	population	predicted	observed	N
Ribas 2016	Modified Bauer	Score of 2	Any primary (surgery)	9	1	17
Ribas 2016	Modified Bauer	Score of 3 to 4	Any primary (surgery)	5	1	17
Tabourel 2021	Revised Tokuhashi	Score of 0 - 8	Any primary	313	160	739
Tabourel 2021	Revised Tokuhashi	Score of 9 - 11	Any primary	261	31	739
Tabourel 2021	Revised Tokuhashi	Score of 12 - 15	Any primary	165	139	739
Tabourel 2021	Tomita	Score of 8 to 10	Any primary	247	56	739
Tabourel 2021	Tomita	Score of 6 to 7	Any primary	283	38	739
Tabourel 2021	Tomita	Score of 4 to 5	Any primary	117	21	739
Tabourel 2021	Tomita	Score of 2 to 3	Any primary	92	15	739
Tabouret 2015	Revised Tokuhashi	Score of 0 - 8	Any primary - MSCC	72	42	121
Tabouret 2015	Revised Tokuhashi	Score of 9 - 11	Any primary - MSCC	38	5	121
Tabouret 2015	Revised Tokuhashi	Score of 12 - 15	Any primary - MSCC	11	9	121
Ulmar 2007	Revised Tokuhashi	Score of 0 - 8	Any primary (surgery)	108	68	217
Ulmar 2007	Revised Tokuhashi	Score of 9 - 11	Any primary (surgery)	76	57	217
Ulmar 2007	Revised Tokuhashi	Score of 12 - 15	Any primary (surgery)	33	29	217
Ulmar 2007	Tokuhashi	Score of 0 to 5	Any primary (surgery)	67	27	217
Ulmar 2007	Tokuhashi	Score of 6 to 8	Any primary (surgery)	101	59	217
Ulmar 2007	Tokuhashi	Score of 9 to 12	Any primary (surgery)	49	41	217
Wang 2012	Revised Tokuhashi	Score of 0 - 8	Any primary (surgery)	297	173	448
Wang 2012	Revised Tokuhashi	Score of 9 - 11	Any primary (surgery)	114	89	448
Wang 2012	Revised Tokuhashi	Score of 12 - 15	Any primary (surgery)	37	28	448
Wang 2012	Tokuhashi	Score of 0 to 5	Any primary (surgery)	214	84	448
Wang 2012	Tokuhashi	Score of 6 to 8	Any primary (surgery)	174	91	448
Wang 2012	Tokuhashi	Score of 9 to 12	Any primary (surgery)	60	39	448
Westerman 2020	Modified Bauer	Score of 0 to 1	Any primary (surgery)	59	31	223
Westerman 2020	Modified Bauer	Score of 2	Any primary (surgery)	85	33	223

study	testname	thresholds	population	predicted	observed	N
Westerman 2020	Modified Bauer	Score of 3 to 4	Any primary (surgery)	79	57	223
Westerman 2020	Modified Tokuhashi revised	Score of 0 - 8	Any primary (surgery)	65	45	223
Westerman 2020	Modified Tokuhashi revised	Score of 9 - 11	Any primary (surgery)	141	103	223
Westerman 2020	Modified Tokuhashi revised	Score of 12 - 15	Any primary (surgery)	17	15	223
Westerman 2020	Oswestry Spinal Metastasis Risk Index	1m	Any primary (surgery)	10	5	223
Westerman 2020	Oswestry Spinal Metastasis Risk Index	2m	Any primary (surgery)	36	4	223
Westerman 2020	Oswestry Spinal Metastasis Risk Index	4m	Any primary (surgery)	52	7	223
Westerman 2020	Oswestry Spinal Metastasis Risk Index	6m	Any primary (surgery)	111	8	223
Westerman 2020	Oswestry Spinal Metastasis Risk Index	23m	Any primary (surgery)	14	11	223
Westerman 2020	Revised Tokuhashi	Score of 0 - 8	Any primary (surgery)	115	61	223
Westerman 2020	Revised Tokuhashi	Score of 9 - 11	Any primary (surgery)	83	63	223
Westerman 2020	Revised Tokuhashi	Score of 12 - 15	Any primary (surgery)	25	22	223
Westerman 2020	Tokuhashi	Score of 0 to 5	Any primary (surgery)	67	31	223
Westerman 2020	Tokuhashi	Score of 6 to 8	Any primary (surgery)	102	46	223
Westerman 2020	Tokuhashi	Score of 9 to 12	Any primary (surgery)	54	42	223
Westerman 2020	Tomita	Score of 8 to 10	Any primary (surgery)	50	20	223

study	testname	thresholds	population	predicted	observed	N
Westerman 2020	Tomita	Score of 6 to 7	Any primary (surgery)	58	8	223
Westerman 2020	Tomita	Score of 4 to 5	Any primary (surgery)	44	3	223
Westerman 2020	Tomita	Score of 2 to 3	Any primary (surgery)	71	45	223
Westerman 2020	Van der Linden	A (bad)	Any primary (surgery)	171	64	223
Westerman 2020	Van der Linden	B (middle)	Any primary (surgery)	50	4	223
Westerman 2020	Van der Linden	C (surgery)	Any primary (surgery)	2	2	223
Yeung 2014	Revised Tokuhashi	Score of 0 - 8	Any primary - MSCC	92	77	128
Yeung 2014	Revised Tokuhashi	Score of 9 - 11	Any primary - MSCC	28	19	128
Yeung 2014	Revised Tokuhashi	Score of 12 - 15	Any primary - MSCC	8	3	128
Yu 2015	Revised Tokuhashi	Score of 0 - 8	Lung cancer	146	12	151
Yu 2015	Revised Tokuhashi	Score of 9 - 11	Lung cancer	5	1	151