National Clinical Guideline Centre

Appendix O

Pressure ulcer prevention and management

Risk assessment

Commissioned by the National Institute for Health and Care Excellence

Disclaimer
Healthcare professionals are expected to take NICE clinical guidelines fully into account when exercising their clinical judgement. However, the guidance does not override the responsibility of healthcare professionals to make decisions appropriate to the circumstances of each patient, in consultation with the patient and/or their guardian or carer.

Contents

Appendix O: Risk assessment and skin assessment

O.1 Summary of risk assessment tools

Table 1: Summary of existing risk assessment tools

Risk assessment tool	Risk factors	Scores
Braden scale (Bergstrom 1987a[5])	Sensory perception (completely limited to no impairment) Moisture (constantly to rarely) Activity (bedfast to walks frequently) Mobility (completely immobile to no limitation) Nutrition (very poor to excellent) Friction and shear (problem to no apparent problem)	Score ranges from 6 to 23*
Norton scale (Norton 1962[29])	Physical condition (very bad to good) Mental condition (stupor to alert) Activity (bedfast to ambulant) Mobility (immobile – full) Incontinent (urinary and faecal to not)	Score ranges from 5 to 20*
Waterlow scale (Waterlow 1985[48]; revised Waterlow, 2005[49])	Build/weight for height (average to below average) Skin type visual risk area (healthy to broken/spots grade 2-4) Sex (male or female) Age (14 to 81+) Continence (complete/catheterised to urinary and faecal incontinence) Mobility (fully to chair bound) Malnutrition screening tool (MST) (nutrition score) Special risk: tissue malnutrition (terminal cachexia, multiple/single organ failure, peripheral vascular disease, anaemia, smoking); neurological deficit (diabetes, MS, CVA, motor/sensory, paraplegia); major surgery/trauma (orthopaedic/spinal, on table ≥2hrs/6hrs); medication (cytotoxic, long term/high dose steroids, anti-inflammatory)	Score ranges from 2 to 20+**
Cubbin-Jackson scale (Cubbin 1991[11]; revised Jackson 1999[19])	Age Weight Skin condition of the whole body Mental state Mobility Nutrition Respiration Incontinence Hygiene Hemodynamic state	Score ranges from 10 to 40*

Risk assessment tool	Risk factors	Scores
Braden-Q scale (Quigley 1996[34])	Mobility (completely immobile to no limitations) Activity (bedfast to all patients too young to ambulate or walks frequently) Sensory perception (completely limited to no impairment) Moisture (constantly to rarely) Friction and shear (problem to no apparent problem) Nutrition (very poor to excellent) Tissue perfusion and oxygenation (extremely compromised to excellent)	Scores ranges from 7 to 28*

O.2 Area under the ROC curve

O.2.1 Median AUC across studies for additional scales

Table 2: Modified Braden scale

Study	Risk of bias	Inconsistency	Indirectness	Imprecision	Number of patients	Number of events	AUC (%) (95%CI)	Acceptability of values*	Quality
General population									
Chan 2009[9]	Serious1	No serious inconsistency	No serious indirectness	Serious2	197	18	74.0 (95% CI: 63.0 to 84.0)	Fair discrimination	LOW

** 90.0-100.0: perfect discrimination; 80.0-89.0: good discrimination; 70.0-79.0: fair discrimination; 60.0-69.0: poor discrimination;50.0-59.0: fail to discriminate*
1 Study had high risks of bias (see quality table)
2 Confidence interval around the value is consistent with two decisions

Table 3: Braden-Q scale

Study	Risk of bias	Inconsistency	Indirectness	Imprecision	Number of patients	Number of events	AUC (%) (95%CI)	Acceptability of values*	Quality
General population									
Curley 2003[12]	Serious1	No serious inconsistency	No serious indirectness	Serious2	322	86	83.0 (95% CI: 76.0-91.0)	Good discrimination	LOW

** 90.0-100.0: perfect discrimination; 80.0-89.0: good discrimination; 70.0-79.0: fair discrimination; 60.0-69.0: poor discrimination;50.0-59.0: fail to discriminate*
1 Study had high risks of bias (see quality table)
2 Confidence interval around the median is consistent with two decisions

Table 4: Waterlow scale – subgroups

Study	Risk of bias	Inconsistency	Indirectness	Imprecision	Number of patients (range)	Number of events (range)	Median AUC (%) (95%CI) range	Acceptability of values*	Quality
General population									
Schoonhoven 2002[37]; Anthony 2003[2]; Serpa 2009[39]	Very serious1	Serious2	No serious indirectness	Serious imprecision	98-45735	7-203	61 (56 to 66), range54– 90)	Poor discrimination	VERY LOW
Intensive care patients									
Compton 2008[10]	Very serious1	No serious inconsistency	No serious indirectness	No serious imprecision	698	121	59.0 (95% CI: 54.0 to 65.0)	Fail discrimination	LOW

** 90.0-100.0: perfect discrimination; 80.0-89.0: good discrimination; 70.0-79.0: fair discrimination; 60.0-69.0: poor discrimination;50.0-59.0: fail to discriminate*
1 The studies had high to very high risks of bias (see quality table)
2 Wide variation in AUC across the studies
3 Confidence interval around the median is consistent with two decisions
4 Confidence interval around the median is consistent with three decisions

Table 5: Douglas scale

Study	Risk of bias	Inconsistency	Indirectness	Imprecision	Number of patients	Number of events	AUC (%)	Acceptability of values*	Quality
Intensive care patients									
Seongsook 2004[38]**	Serious1	No serious inconsistency	No serious indirectness	Serious2	112	170	79	Fair discrimination	LOW

** 90.0-100.0: perfect discrimination; 80.0-89.0: good discrimination; 70.0-79.0: fair discrimination; 60.0-69.0: poor discrimination;50.0-59.0: fail to discriminate*
*** Unclear if patients with a PU at start of the study were included.*
1 Study had high risks of bias (see quality table)
2 Low event rates (< 100); no confidence interval

Table 6: Fragmment scale

Study	Risk of bias	Inconsistency	Indirectness	Imprecision	Number of patients	Number of events	AUC (95% CI)	Acceptability of values*	Quality
General population and intensive care patients									
Perneger 2002[33]	Serious1	No serious inconsistency	No serious indirectness	No serious imprecision	1190	170	79 (95% CI: 75.0 to 82.0)	Fair discrimination	MODERATE

** 90.0-100.0: perfect discrimination; 80.0-89.0: good discrimination; 70.0-79.0: fair discrimination; 60.0-69.0: poor discrimination;50.0-59.0: fail to discriminate*
1 Study had high risks of bias (see quality table)

Table 7: Song and Choi scale

Study	Risk of bias	Inconsistency	Indirectness	Imprecision	Number of patients	Number of events	AUC (%)	Acceptability of values*	Quality
Intensive care patients									
Kim 2009[21]	Serious1	No serious inconsistency	No serious indirectness	Serious2	219	40	89	Good discrimination	LOW

** 90.0-100.0: perfect discrimination; 80.0-89.0: good discrimination; 70.0-79.0: fair discrimination; 60.0-69.0: poor discrimination;50.0-59.0: fail to discriminate*
1 Study had high risks of bias (see quality table)
2 Low event rates (< 100); no confidence interval

Table 8: The Northern Hospital Pressure Ulcer Prevention Plan (TNH-PUPP)

Study	Risk of bias	Inconsistency	Indirectness	Imprecision	Number of patients	Number of events	AUC (95% CI) (range)	Acceptability of values*	Quality
Intensive care patients									
Page 2011[31]	Very serious1	No serious inconsistency	No serious indirectness	Serious2	165	7	90.0 (95% CI: 82 to 99)	Perfect discrimination	VERY LOW

** 90.0-100.0: perfect discrimination; 80.0-89.0: good discrimination; 70.0-79.0: fair discrimination; 60.0-69.0: poor discrimination;50.0-59.0: fail to discriminate*

1 Study had very high risks of bias (see quality table)
2 Very low events rates (< 100)

O.2.2 AUC within study comparisons

Table 9: Schoonhoven 2002[37]

Scale	Risk of bias	Inconsistency	Indirectness	Imprecision	Number of patients	Number of events	AUC (%) (95% CI)	Acceptability of values*	Quality
General population									
Braden scale Norton scale Waterlow scale	Serious1	No serious inconsistency	No serious indirectness	No serious imprecision	1129	135	55 (95% CI 49 to-60) 56 (95% CI 51 to 61) 61 (95% CI 56 to 66)	Fail Fail Poor	MODERATE

** 90.0-100.0: perfect discrimination; 80.0-89.0: good discrimination; 70.0-79.0: fair discrimination; 60.0-69.0: poor discrimination;50.0-59.0: fail to discriminate*
1 The study had high risks of bias (see quality table)

Table 10: Perneger 2002[33]

Scale	Risk of bias	Inconsistency	Indirectness	Imprecision	Number of patients	Number of events	AUC (%) (95% CI)	Acceptability of values*	Quality
General population and intensive care patients									
Braden scale Norton scale Fragmment scale	Serious1	No serious inconsistency	No serious indirectness	No serious imprecision	1190	170	74 (95% CI 70 to 78) 74 (95% CI 70 to 78) 79 (95% CI 75 to 82)	Fair Fair Fair	MODERATE

** 90.0-100.0: perfect discrimination; 80.0-89.0: good discrimination; 70.0-79.0: fair discrimination; 60.0-69.0: poor discrimination;50.0-59.0: fail to discriminate*
1 The study had high risks of bias (see quality table)

Table 11: Seongsook 2004[38]**

Scale	Risk of bias	Inconsistency	Indirectness	Imprecision	Number of patients	Number of events	AUC (%)	Acceptability of values*	Quality
Intensive care patients									
Braden scale Cubbin-Jackson scale Douglas scale	Serious 1	No serious inconsistency	No serious indirectness	Serious2	112	35	71 83 79	Fair Good Fair	LOW

** 90.0-100.0: perfect discrimination; 80.0-89.0: good discrimination; 70.0-79.0: fair discrimination; 60.0-69.0: poor discrimination;50.0-59.0: fail to discriminate*
*** Unclear if patients with a PU at start of the study were included.*
1 The study had high risks of bias (see quality table)
2 Low event rates (< 100); no confidence interval

Table 12: Chan 2009[9]

Scale	Risk of bias	Inconsistency	Indirectness	Imprecision	Number of patients	Number of events	AUC (%) (95% CI)	Acceptability of values*	Quality
General population									
Braden scale Modified Braden scale	Serious 1	No serious inconsistency	No serious indirectness	Very serious2	197	18	73 (95% CI 63 to 84) 68 (95% CI 51 to 79)	Fair Poor	VERY LOW

** 90.0-100.0: perfect discrimination; 80.0-89.0: good discrimination; 70.0-79.0: fair discrimination; 60.0-69.0: poor discrimination;50.0-59.0: fail to discriminate*
1 The study had high risks of bias (see quality table)
2 Low event rates (< 100); wide confidence interval

Table 13: Kim 2009[21]

Scale	Risk of bias	Inconsistency	Indirectness	Imprecision	Number of patients	Number of events	AUC (%)	Acceptability of values*	Quality
Intensive care patients									
Braden scale	Serious 1	No serious inconsistency	No serious indirectness	Serious2	219	40	88	Good	LOW

Scale	Risk of bias	Inconsistency	Indirectness	Imprecision	Number of patients	Number of events	AUC (%)	Acceptability of values*	Quality
Cubbin-Jackson							91	Excellent	
Song and Choi							89	Good	

** 90.0-100.0: perfect discrimination; 80.0-89.0: good discrimination; 70.0-79.0: fair discrimination; 60.0-69.0: poor discrimination;50.0-59.0: fail to discriminate*
1 The study had high risks of bias (see quality table)
2 Low event rates (< 100); no confidence interval

Table 14: Serpa 2009[39]

Scale	Risk of bias	Inconsistency	Indirectness	Imprecision	Number of patients	Number of events	AUC (%) (95% CI)	Acceptability of values*	Quality
General population									
Waterlow scale (48 hours)	Very serious1	No serious inconsistency	Serious indirectness3	Very serious2	98	7	64 (95% CI 35 to 93)	Poor	VERY LOW
Waterlow scale (4 days)							59 (95% CI 34 to 83)	Fail Poor	
Waterlow scale (6 days)							54 (95% CI 35 to 74)		

** 90.0-100.0: perfect discrimination; 80.0-89.0: good discrimination; 70.0-79.0: fair discrimination; 60.0-69.0: poor discrimination;50.0-59.0: fail to discriminate*
1 The study had very high risks of bias (see quality table)
2 Very low event rates (< 100); very wide confidence intervals
3 Low risk patients excluded

Table 15: Serpa 2011[40]

Scale	Risk of bias	Inconsistency	Indirectness	Imprecision	Number of patients	Number of events	AUC (%) (95% CI)	Acceptability of values*	Quality
Intensive care patients									
Braden scale (48 hours)	Very serious1	No serious inconsistency	Serious indirectness3	Very serious2	72	8	79 (95% CI 29 to 100)	Fair	VERY LOW
Braden scale							79(95% CI 27 to 100)	Fair Good	

Scale	Risk of bias	Inconsistency	Indirectness	Imprecision	Number of patients	Number of events	AUC (%) (95% CI)	Acceptability of values*	Quality
(4 days) Braden scale (6 days)							80 (95% CI 28 to 100)		

** 90-100: perfect discrimination; 80-89: good discrimination; 70-79: fair discrimination; 60-69: poor discrimination;50-59: fail to discriminate*
1 The study had very high risks of bias (see quality table)
2 Very low event rates (< 100); very wide confidence intervals
3 Low risk patients excluded

O.3 Predictive ability (sensitivity and specificity)

Table 16: Braden scale

Study	Cut-off score*	Median sensitivity** (range)	Specificity**‡ (range)
Follow-up < 1 week – all stages – general population			
Bergstrom 1998a; Braden 1994a	≤ 17	59 (range 50-78)	80 (range 76-85)
Bergstrom 1998[4]a; Braden 1994a	≤ 18	75 (range 60-88)	68 (range 68-81)
Bergstrom 1998a; Braden 1994a	≤ 19	86.5 (range 67-100)	62.5 (range 40-73)
Follow-up < 1 week – all stages – ICU			
Serpa 2011[40] (48 hours)	≤ 12	88 (95%CI 47 to 100)	64 (95%CI 51 to 76)
Serpa 2011 (6 days)	≤ 13	75 (95%CI 35to 97)	81 (95%CI 70 to 90)
Feuchtinger 2007[15]	≤ 16	77 (95%CI 56 to 91)	30 (95%CI 14 to 50)
Follow-up > 1 week – all stages – general population			
Bergstrom 1987a; Bergstrom 1998[4]a; Braden 1994a; Capobianco 1996; Chan	≤ 18	80 (95%CI 68 to 89b	73 (95%CI 66 to 79 b

Study	Cut-off score*	Median sensitivity** (range)	Specificity**‡ (range)
2009; Goodridge 1998; Langemo 1991[23]; Lyder 1999; Pang 1998; Salvadalena 1992		(range 46.2-100)	(range 14-100)
Bergstrom 1987a; Bergstrom 1998a; Braden 1994a; Capobianco 1996[8]; Salvadalena 1992	≤ 19	86 (95%CI 57 to 98) (range 71.4-100)	78 (95%CI 61 to 90) c (range 42.9-77.8)
Bergstrom 1987a; Bergstrom 1998a; Braden 1994a; Capobianco 1996; Salvadalena 1992	≤ 20	93.2 (95%CI 76 to 99) d (range 65-100)	43 (95%CI 32 to 55) d (range 31.6-66.7)
Follow-up > 1 week – all stages – ICU			
Braden 1994[7]	≤ 15	32 (95%CI 16 to 52)	95 (95%CI 87 to 99)
Braden 1994[7]a; Seongsook 2004[38]a***	≤ 16	50 (95%CI 31 to 69) and 97 (95%CI 85 to 100)	89 (95%CI 80 to 95) 26 (95%CI 17 to 37)
Braden 1994[7]	≤ 17	87.5	50.0
Follow-up > 1 week – stage 2+ – general population			
Ramundo 1995[35] e	≤ 17	42.9 (95%CI 10 to 82)	63.4 (95%CI 47 to 78)
Ramundo 1995[35] e	≤ 18	100.0 (95%CI 59 to 100)	34.1 (95%CI 20 to 51)
Ramundo 1995[35] e	≤ 19	100.0 (95%CI 59 to 100)	22.0 (95%CI 11 to 38)

** The reported thresholds are these with the highest values for median sensitivity and specificity*
*** Percentage*
**** Unclear if patients with a PU at start of the study were included.*
‡ Specificity corresponding to the median sensitivity
a Study of which sensitivity and specificity are presented.
b Sensitivity analysis without studies with < 10 events (Bergstrom 1987a and Langemo 1991) revealed a median sensitivity of 78.6 (range: 46.2-90.5) and a corresponding specificity of 74.3 (range: 14.0-100.0)
c Sensitivity analysis without study with < 10 events (Bergstrom 1987a) revealed a median sensitivity of 85.7 (range: 71.4-100.0) and a corresponding specificity of 59.1 (range: 43.0-77.8)
d Sensitivity analysis without study with < 10 events (Bergstrom 1987a) revealed a median sensitivity of 91.7 (range: 43.2-100.0) and a corresponding specificity of 40.1 (range: 31.6-66.7)
e The study of Ramundo 1995 had 7 events

Table 17: Braden-Q scale

Study	Cut-off score*	Sensitivity	Specificity
Follow-up > 1 week – all stages – paediatric ICU patients			
Curley 2003[12]	≤ 15	75.6	67.8
Curley 2003[12]	≤ 16	88.4	58.1
Curley 2003[12]	≤ 17	91.9	44.1

Table 18: Norton scale

Study	Cut-off score*	Median sensitivity**	Specificity**‡
Follow-up > 1 week – all stages – general population			
Kwong 2005[22]; Lincoln 1986[25]; Stotts 1998[42]a***; Wai-Han 1997[47]a	≤ 14	16 (95%CI 8 to 27) b range 0.0-88.9	94 (95%CI 91 to 97) b Range 61.0-94.4
Schoonhoven 2002[37] c	≤ 15	45.9 (95%CI 37 to 55)	60.3 (95%CI 57 to 63)
Pang 1998[32]a; Smith 1989[41]a	≤ 16	60 (95%CI 41 to 77) and 81 (95%CI 58 to 95)	31 (95%CI 21 to 43) and 59 (95%CI 48 to 69)

** The reported thresholds are these with the highest values for median sensitivity and specificity*
*** Percentage*
**** Unclear if patients with a PU at start of the study were included.*
‡ Specificity corresponding to the median sensitivity
a Study of which sensitivity and specificity are presented.
b Sensitivity analysis without studies with < 10 events (Kwong 2005 and Lincoln 1986) revealed a median sensitivity of 45.7 (range: 16.4-75.0) and a corresponding specificity of 80.6 (range: 66.7-94.4)
c The study of Schoonhoven 2002 had 135 events

Table 19: Waterlow scale

Study	Cut-off score*	Median sensitivity**	Specificity**‡
Follow-up < 1 week – all stages – general population			
Serpa 2009[39] (48 hours) b	≥17	71.4 (95%CI 29 to 96)	67.0 (95%CI 56 to 77)
Serpa 2009[40] (4 days) b	≥ 20	85.7 (95%CI 42 to 100)	41.0 (95%CI 30 to 51)
Follow-up > 1 week – all stages – general population			

Study	Cut-off score*	Median sensitivity**	Specificity**‡
Anthony 2003[2]a; Schoonhoven 2002[37]; Wai-Han 1997[47]	≥ 10	87.5 (95%CI 47 to 100)c range 82.3-89.6	28.2 (95%CI 22 to 35) c range 22.4-85.2
Anthony 2003[2] d	≥ 15	48.8 (95%CI 42 to 56)	94.4 (95%CI 94 to 95)
Pang 1998[32]a; Smith 1989[41]a***	≥ 16	95 (95%CI 76 to 100) and 73 (95%CI 54 to 88)	44 (95%CI 33 to 55) and 38 (95%CI 27 to 50)
Follow-up < 1 week – stage 2+ – ICU			
Weststrate 1998[50]	≥ 15	80.9 (95%CI 67 to 91)	28.5 (95%CI 25 to 33)

** The reported thresholds are these with the highest values for median sensitivity and specificity*
*** Percentage*
**** Unclear if patients with a PU at start of the study were included.*
‡ Specificity corresponding to the median sensitivity
a Study of which sensitivity and specificity are presented.
b The study of Serpa 2009 had 7 events and low risk patients were excluded
c Sensitivity analysis with only studies with > 100 events (Antony 2003 and Schoonhoven 2002) revealed a median sensitivity of 86.0 (range: 82.3-89.6) and a corresponding 53.8 (range: 22.4-85.2)
d The study of Antony 2003 had 203 events

Table 20: Cubbin-Jackson scale

Study	Cut-off score*	Sensitivity	Specificity*
Follow-up > 1 week – all stages – ICU			
Seongsook 2004[38]***	≤ 24	88.6 (95%CI 73 to 97)	61.0 (95%CI 49 to 72)
Kim 2009[21]	≤ 28	95.0 (95%CI 83 to 99)	81.6 (95%CI 75 to 87)

*** Percentage*
**** Unclear if patients with a PU at start of the study were included.*

Table 21: Fragmment scale

Study	Cut-off score*	Sensitivity	Specificity
Follow-up > 1 week – all stages – general population			
Perneger 2002[33] a	≤ 1	78.7	53.5
Perneger 2002[33] a	≤ 2	76.7	71.9

Study	Cut-off score*	Sensitivity	Specificity
Perneger 2002[33] a	≤ 3	62.1	85.0

*** Percentage*
a The study of Perneger 2002 had 170 events

Table 26: Douglas scale

Study	Cut-off score*	Sensitivity	Specificity*
Follow-up > 1 week – all stages – ICU			
Seongsook 2004[38]***	≤ 18	100.0	18.2

*** Percentage*
**** Unclear if patients with a PU at start of the study were included.*

Table 27: The Northern Hospital Pressure Ulcer Prevention Plan

Study	Cut-off score*	Sensitivity	Specificity
Follow-up > 1 week – all stages – general population			
Page 2011[31] a	≥ 2	85.7	62.0
Page 2011[31] a	≥ 3	71.4	81.0
Page 2011[31] a	≥ 4	71.4	88.0

a The study of Page 2011 had a 7 events

Table 22: Song and Choi scale

Study	Cut-off score*	Sensitivity	Specificity
Follow-up > 1 week – all stages – ICU			
Kim 2009[21]	≤ 21	95.0	69.3

*

Table 23: Suriadi and Sanada scale

Study	Cut-off score*	Sensitivity	Specificity
Follow-up > 1 week – all stages – ICU			
Suriadi 2008[43]	≥ 3	97.2	53.0
Suriadi 2008[43]	≥ 4	80.6	82.9
Suriadi 2008[43]	≥ 5	72.2	86.7

‡ Specificity corresponding to the median sensitivity

Table 24: Clinical judgement

Study	Cut-off score	Sensitivity**	Specificity**‡
Follow-up > 1 week – all stages – ICU			
Salvadalena 1992[36]a; VandenBosch 1996[46]a	Yes/no	50 (95%CI 27 to 73) and 52 (95%CI 33 to 70)	80 (95%CI 69 to 88) and 59 (95%CI 47 to 70)

*** Percentage*
a Study of which sensitivity and specificity are presented.

O.4 Quality of the studies

Table 25: Quality of the studies

Study	Selection bias*	Risk tool bias**	Outcome bias***	Analysis bias****
Andersen 1982[1]	Low	High	Low	High
Anthony 2003[2]	High	High	Low	High
Barnes 1993[3]	High	High	Low	High
Bergstrom 1987a[5]	Low	High	Low	Very high
Bergstrom 1987b[6]	Low	High	Low	Very High
Bergstrom 1998[4]	Low	High	Low	High
Braden 1994[7]	Low	High	Low	High
Capobianco 1996[8]	Low	High	Low	High
Chan 2009[9]	High	High	Low	High
Compton 2008[10]	Very high	High	Low	High
Curley 2003[12]	Low	High	Low	High
de Souza 2010[13]	Very high	High	Low	High
Edwards 1995[14]	Low	High	Low	Very high
Feuchtinger 2007[15]	Low	High	Low	High
Goodridge 1998[16]	High	High	Low	High
Halfens 2000[17]	High	High	Low	High
Hatanaka 2008[18]	High	High	High	High
Jalali 2005[20]	High	Very high	Low	High
Kim 2009[21]	High	High	Low	High
Kwong 2005[22]	High	High	Low	Very high
Langemo 1991[23]	High	High	Low	Very high
Lewicki 2000[24]	High	High	Low	Very high
Lincoln 1986[25]	High	High	Low	Very high

Study	Selection bias*	Risk tool bias**	Outcome bias***	Analysis bias****
Lindgren 2002[26]	High	High	Low	High
Lothian 1989[27]	Very high	Very high	Very high	High
Lyder 1999[28]	High	High	High	High
Ongoma 2006[30]	High	Very high	Very high	High
Page 2011[31]	Very high	High	High	Very high
Pang 1998[32]	High	High	Low	High
Perneger 2002[33]	High	High	Low	High
Ramundo 1995[35]	High	High	Low	Very high
Salvadalena 1992[36]	High	High	Low	High
Schoonhoven 2002[37]	High	High	Low	Low
Seongsook 2004[38]	Very high	High	Low	High
Serpa 2009[39]	High	High	High	Very high
Serpa 2011[40]	High	High	High	Very high
Smith 1989[41]	Very high	High	High	High
Stotts 1988[42]	Very high	High	Low	High
Suriadi 2006[44]	High	High	Low	High
Suriadi 2008[43]	High	High	Low	High
Towey 1988[45]	Low	High	High	High
VandenBosch 1996[46]	High	High	Low	High
Wai-Han 1997[47]	High	High	High	Very high
Weststrate 1998[50]	High	High	High	High

** inappropriate patient enrolment, inappropriate study design, not representative population*

*** unclear definition and measurement of predictive test, absence of imputation technique or unclear description of exclusion, inadequate threshold*

**** unclear definition and measurement of reference test, inappropriate duration*

***** no use of time to event analysis, number of events < 100, reason for missing data not reported*

O.5 Incidence and predictive ability of risk assessment scales - all thresholds

Table 26: Braden scale

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Barnes 1993[3]	2 weeks	6.1	≤ 16	72.7	90.6
Braden 1994[7]	48-72 hours‡	NR	≤ 14	29.0	97.0
			≤ 15	43.0	95.0
			≤ 16	46.0	84.0
			≤ 17	61.0	78.0
			≤ 18	79.0	68.0
			≤ 19	93.0	51.0
			≤ 20	96.0	35.0
	4 weeks	27.5	≤ 14	21.4	95.9
			≤ 15	32.1	94.6
			≤ 16	50.0	89.2
			≤ 17	57.1	85.1
			≤ 18	78.6	74.3
			≤ 19	85.7	59.3
			≤ 20	92.9	43.2
Bergstrom 1987a[5] (a)	6 weeks	7.1	≤ 9	14.3	100.0
			≤ 10	14.3	98.9
			≤ 13	28.6	98.9
			≤ 14	42.9	98.9
			≤ 15	71.4	94.6
			≤ 16	100.0	90.2
			≤ 17	100.0	88.0
			≤ 18	100.0	82.6
			≤ 19	100.0	73.9
			≤ 20	100.0	65.2
			≤ 21	100.0	50.0

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
			≤ 22	100.0	35.9
			≤ 23	100.0	0.0
(b)	12 weeks	9.0	≤ 8	11.1	95.6
			≤ 9	11.1	91.2
			≤ 11	22.2	89.0
			≤ 12	44.4	86.8
			≤ 13	55.6	83.5
			≤ 14	66.7	78.0
			≤ 15	77.8	73.
			≤ 16	100.0	63.7
			≤ 17	100.0	60.4
			≤ 18	100.0	50.5
			≤ 19	100.0	42.9
			≤ 20	100.0	31.9
			≤ 21	100.0	26.4
			≤ 22	100.0	9.9
			≤ 23	100.0	0.0
Bergstrom 1987b[6]	2 weeks	40.0	≤ 9	8.3	100.0
			≤ 10	8.3	97.2
			≤ 11	16.7	91.7
			≤ 12	33.3	88.9
			≤ 13	58.3	77.8
			≤ 14	70.8	75.0
			≤ 15	75.0	66.7
			≤ 16	83.3	63.9
			≤ 17	87.5	50.0
			≤ 18	91.7	38.9
			≤ 19	91.7	25.0
			≤ 20	95.8	13.9
			≤ 21	95.8	5.6

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
			≤ 22	100.0	0.0
Bergstrom 1998[4] (c)	48-72 hours‡	NR	≤ 9	4.0	100.0
			≤ 10	12.0	100.0
			≤ 11	19.0	99.0
			≤ 12	31.0	99.0
			≤ 13	38.0	98.0
			≤ 14	38.0	95.0
			≤ 15	46.0	90.0
			≤ 16	58.0	84.0
			≤ 17	62.0	76.0
			≤ 18	88.0	68.0
			≤ 19	100.0	59.0
			≤ 20	100.0	40.0
			≤ 21	100.0	23.0
	11 days	8.5	≤ 9	7.7	100.0
			≤ 10	11.5	100.0
			≤ 11	11.5	98.9
			≤ 12	15.4	98.9
			≤ 13	15.4	97.9
			≤ 14	15.4	97.1
			≤ 15	23.1	92.9
			≤ 16	30.8	88.9
			≤ 17	38.5	83.9
			≤ 18	46.2	68.9
			≤ 19	100.0	58.9
			≤ 20	100.0	40.0
			≤ 21	100.0	22.9
(d)	48-72 hours‡	NR	≤ 9	0.0	99.0
			≤ 10	10.0	99.0
			≤ 11	10.0	98.0

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
			≤ 12	10.0	98.0
			≤ 13	10.0	97.0
			≤ 14	20.0	96.0
			≤ 15	20.0	94.0
			≤ 16	30.0	90.0
			≤ 17	50.0	85.0
			≤ 18	60.0	81.0
			≤ 19	80.0	73.0
			≤ 20	80.0	69.0
			≤ 21	90.0	41.0
	11 days	7.4	≤ 9	0.0	99.2
			≤ 10	0.0	99.2
			≤ 11	0.0	99.2
			≤ 12	0.0	98.1
			≤ 13	28.6	98.1
			≤ 14	28.6	96.9
			≤ 15	52.4	93.9
			≤ 16	52.4	92.0
			≤ 17	61.9	87.0
			≤ 18	71.4	78.9
			≤ 19	71.4	70.9
			≤ 20	90.5	50.2
			≤ 21	90.5	32.2
(e)	48-72 hours‡	NR	≤ 9	0.0	99.0
			≤ 10	2.0	99.0
			≤ 11	2.0	99.0
			≤ 12	5.0	99.0
			≤ 13	13.0	99.0
			≤ 14	23.0	97.0
			≤ 15	33.0	93.0

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
			≤ 16	41.0	88.0
			≤ 17	56.0	81.0
			≤ 18	72.0	68.0
			≤ 19	67.0	48.0
			≤ 20	83.0	34.0
			≤ 21	97.0	17.0
	11 days	23.9	≤ 9	0.0	99.0
			≤ 10	19.7	99.0
			≤ 11	29.5	97.9
			≤ 12	8.2	97.9
			≤ 13	13.1	97.9
			≤ 14	19.7	95.9
			≤ 15	31.1	94.8
			≤ 16	49.2	90.2
			≤ 17	60.7	86.1
			≤ 18	80.3	73.2
			≤ 19	86.9	57.2
			≤ 20	93.4	40.2
			≤ 21	98.4	25.3
Capobianco 1996[8]	2 weeks	28.0	≤ 12	28.6	97.2
			≤ 13	28.6	97.2
			≤ 14	28.6	97.2
			≤ 15	35.7	94.4
			≤ 16	42.9	91.7
			≤ 17	57.1	91.7
			≤ 18	71.4	83.3
			≤ 19	85.7	77.8
			≤ 20	92.9	66.7
Chan 2009[9]	9 days	9.1	≤ 16	66.7	64.2
			≤ 17	72.2	40.8

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
			≤ 18	88.9	21.2
de Souza 2010[13] (f)	3 months	3.9	≤ 13	56.8	71.9
(g)	3 months	3.9	≤ 17	71.4	75.8
Feuchtinger 2007[15]	4 days	62.3	≤ 9	19.2	100.0
			≤ 10	23.1	100.0
			≤ 11	30.8	100.0
			≤ 16	76.9	29.6
			≤ 20	96.2	3.7
Goodridge 1998[16]	3 months	9.7	≤ 11	12.5	97.3
			≤ 16	25.0	85.6
			≤ 18	50.0	52.3
Halfens 2000[17]	NR	58.1	≤ 10	1.1	100.0
			≤ 11	3.2	100.0
			≤ 12	5.4	99.3
			≤ 13	11.8	97.8
			≤ 14	17.7	97.0
			≤ 15	22.0	94.8
			≤ 16	32.3	91.8
			≤ 17	40.9	90.3
			≤ 18	51.1	85.8
			≤ 19	61.3	79.9
			≤ 20	73.7	70.1
			≤ 21	78.5	56.7
			≤ 22	88.2	42.5
			≤ 23	100.0	29.9
Jalali 2005[20]	14 days	9.1	NR	52.7	100.0
Kim 2009[21]	90 days	18.3	≤ 14	92.5	69.8
Kwong 2005[22]	21 days	2.1	≤ 14	88.9	71.9
Langemo 1991[23] (h)	16 days	14.9	≤ 15	54.5	93.7

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
			≤ 16	63.6	87.3
(i)	31 days	28.0	≤ 18	57.1	61.1
Pang 1998[32]	2 weeks	19.8	≤ 18	90.5	62.4
Lyder 1999[28] (j)	NR‡	NR	≤ 18	81.0	100.0
(k)	NR‡	NR	≤ 16	77.0	50.0
(l)	NR‡	NR	≤ 18	90.0	14.0
Ramundo 1995[35]	4 weeks	14.6	≤ 11	14.3	97.6
			≤ 12	14.3	95.1
			≤ 13	14.3	95.1
			≤ 14	14.3	90.2
			≤ 15	14.3	82.9
			≤ 16	28.6	80.5
			≤ 17	42.9	63.4
			≤ 18	100.0	34.1
			≤ 19	100.0	22.0
			≤ 20	100.0	12.2
			≤ 21	100.0	4.9
			≤ 22	100.0	0.0
Salavadalena 1992[36]	6 months	20.2	≤ 9	0.0	98.7
			≤ 10	5.0	97.5
			≤ 11	5.0	91.1
			≤ 12	15.0	89.9
			≤ 13	20.0	86.1
			≤ 14	30.0	79.
			≤ 15	30.0	77.2
			≤ 16	40.0	69.6
			≤ 17	45.0	63.3
			≤ 18	60.0	54.4
			≤ 19	80.0	43.0

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
			≤ 20	85.0	31.6
			≤ 21	95.0	13.9
			≤ 22	100.0	1.3
			≤ 23	100.0	0.0
Schoonhoven 2002[37]	12 weeks	11.0	≤ 17	43.7	67.8
Seongsook 2004[38]	NR	31.3	≤ 16	97.1	26.0
Serpa 2011[40]	48 hours	11.1	≤ 12	87.5	64.1
	4 days	11.1	≤ 13	75.0	81.3
	6 days	11.1	≤ 13	75.0	82.8
Suriadi 2006[44]	21 days	33.3	≤ 14	80.0	54.3
VandenBosch 1996[46]	2 weeks	28.8	≤ 17	59.0	NR
			≤ 18	NR	79.0

** Percentage*
‡ No raw data was available to recalculate the sensitivity and specificity
NR: not reported
(a) ward one in Bergstrom 1987a study
(b) ward two in Bergstrom 1987a study
(c) tertiary care hospitals
(d) veteran medical centres
(e) skilled nursing facilities
(f) group of patients with a Braden score < 18 on admission
(g) group of patients with a Braden score < 19 on admission
(h) hospitalized patients
(i) long-term care patients
(j) black elders ≥ 75 yrs
(k) black elders < 75 yrs

(l) Latino/Hispanic < 75 yrs

Table 27: Extended Braden scale

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Halfens 2000[17]	NR	58.1	≤ 11	0.5	100.0
			≤ 12	1.6	100.0
			≤ 13	2.2	100.0
			≤ 14	3.8	99.3
			≤ 15	6.5	98.5
			≤ 16	12.4	97.9
			≤ 17	17.7	96.3
			≤ 18	24.2	94.8
			≤ 19	32.8	91.0
			≤ 20	40.9	88.8
			≤ 21	51.1	85.1
			≤ 22	62.9	79.1
			≤ 23	73.7	69.4
			≤ 24	78.5	55.2
			≤ 25	88.2	42.5
			≤ 26	100.0	29.1

** Percentage*
NR: not reported

Table 28: Modified Braden scale

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Chan 2009[9]	9 days	9.1	≤ 17	38.9	79.9
			≤ 18	55.6	72.6
			≤ 19	88.9	62.0
Kwong 2005[22]	21 days	2.1	≤ 16	88.9	75.0

** Percentage*

Table 29: Braden-Q scale

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Curley 2003[12]	10 days	26.7	≤ 10	3.5	100.0
			≤ 11	16.3	97.0
			≤ 12	47.7	92.8
			≤ 13	67.4	89.0
			≤ 14	72.1	78.8
			≤ 15	75.6	67.8
			≤ 16	88.4	58.1
			≤ 17	91.9	44.1
			≤ 18	100.0	30.1
			≤ 19	100.0	19.9
			≤ 20	100.0	8.1

** Percentage*

Table 30: Norton scale

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Kwong 2005[22]	21 days	2.1	≤ 14	88.9	61.0
Lincoln 1986[25]	26 days	13.9	≤ 14	0.0	93.5
Pang 1998[32]	2 weeks	19.8	≤ 16	81.0	58.8
Schoonhoven 2002[37]	12 weeks	11.0	≤ 15	45.9	60.3
Smith 1989[41]	NR	29.7	≤ 16	60.0	31.0
Stotts 1988[42]	3 weeks	17.3	≤ 14	16.4	94.4
Wai-Hang 1997[47]	4 weeks	4.3	≤ 14	75.0	66.7

** Percentage*
NR: Not reported

Table 31: Modified Norton scale (ICU)

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Feuchtinger 2007[15]	4 days	62.3	≤ 19	26.9	100.0
			≤ 21	34.6	92.6
			≤ 23	42.3	88.9
			≤ 25	57.7	48.1

** Percentage*

Table 32: Modified Norton scale (South African Hospital)

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Ongoma 2005[30]	1 week	37.9	≤ 20	92.0	29.3

** Percentage*

Table 33: Waterlow scale

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Anthony 2003[2]	NR	0.4	≥ 10	82.3	85.2
			≥ 15	48.8	94.5
			≥ 20	16.7	98.1
Compton 2008[10]	13 days	17.3	NR	37.2	94.6
Edwards 1995[14]	8 weeks	6.5	NR	100.0	10.3
Jalali 2005[20]	14 days	9.1	NR	63.5	83.3
Pang 1998[32]	2 weeks	19.8	≥ 16	95.2	43.5
Serpa 2009[39]	48 hours	7.1	≥ 17	71.4	67.0
	4 days	7.1	≥ 20	85.7	40.7
	6 days	7.1	≥ 20	85.7	33.0
Schoonhoven 2002[37]	12 weeks	11.0	≥ 10	89.6	22.4
Smith 1989[41]	NR	29.7	≥ 16	73.3	38.0
Wai-Han 1997[47]	4 weeks	4.3	≥ 10	87.5	28.2
Weststrate 1998[50]	183 days	7.9	≥ 15	80.9	28.5

** Percentage*

NR: not reported

Table 34: Andersen scale

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Andersen 1982[1]	3 months	1.2	≥ 2	87.5	86.7

** Percentage*

Table 35: Pressure Sore Prediction Score scale (PSPS)

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Lothian 1989[27]	3 weeks	4.3	> 6	88.7	76.0

** Percentage*

Table 36: Knoll scale

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Towey 1988[45]	28 days	46.7	≥ 12	85.7	56.3

** Percentage*

Table 37: <Insert Table Title here>

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Kim 2009[21]	90 days	18.3	≤ 28	95.0	81.6
Seongsook 2004[38]	NR	31.3	≤ 24	88.6	61.0

** Percentage*
NR: not reported

Table 38: Sunderland Pressure Sore Risk Calculator (modified Cubbin-Jackson)

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Ongoma 2005[30]	1 week	37.9	≤ 34	80.0	70.7

Table 39: Risk Assessment Pressure Sore scale (RAPS)

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Lindgren 2002[26]	12 weeks	11.7	≤ 31	31.5	84.6
			≤ 32	33.3	80.2
			≤ 33	38.9	75.3
			≤ 34	46.3	69.4
			≤ 35	50.0	64.3
			≤ 36	57.4	57.6
			≤ 37	70.4	46.5
			≤ 38	77.8	34.8

** Percentage*

Table 40: Fragmment scale

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Perneger 2002[33]	3 weeks	29.9	= 0	91.6	34.2
			≤ 1	78.7	53.5
			≤ 2	76.7	71.9
			≤ 3	62.1	85.0
			≤ 4	49.7	91.0
			≤ 5	40.2	94.2
			≤ 6	27.0	97.6
			≤ 7	17.7	98.9
			≤ 8	2.2	99.5

** Percentage*

Table 41: Douglas scale

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Seongsook 2004[38]	NR	31.3	≤ 18	100.0	18.2

** Percentage*
NR: Not reported

Table 42: Grosnell scale

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Jalali 2005[20]	2 weeks	9.1	NR	85.1	83.3

** Percentage*
NR: not reported

Table 43: Song and Choi scale

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Kim 2009[21]	90 days	18.3	≤ 21	95.0	69.3

** Percentage*

Table 44: 4-factor model

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Feuchtinger 2007[15]	4 days	62.3	≥ 2	84.6	29.6

** Percentage*

Table 45: Suriadi and Sanada scale (SS)

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Suriadi 2008[43]	NR	28.5	≥ 0	100.0	0.0
			≥ 2	97.2	42.0
			≥ 3	97.2	53.0
			≥ 4	80.6	82.9
			≥ 5	72.2	86.7
			≥ 6	61.1	92.3
			≥ 7	58.3	95.0
			≥ 9	6.9	100.0

** Percentage*
NR: not reported

Table 46: The Northern Hospital Pressure Ulcer Prevention Plan (TNH-PUPP)

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Page 2011[31]	NR	4.2	≥ 1	100.0	34.2
			≥ 2	85.7	62.0
			≥ 3	71.4	81.0
			≥ 4	71.4	88.0
			≥ 5	42.9	96.2
			≥ 6	57.1	99.4

** Percentage*
NR: not reported

Table 47: Clinical judgement

Study	Time point	Incidence*	Cut-off score	Sensitivity*	Specificity*
Salvadalena 1992[36]	6 months	20.2	Yes/no	50.0	79.7
VandenBosch 1996[46]	2 weeks	28.2	Yes/no	51.7	58.1

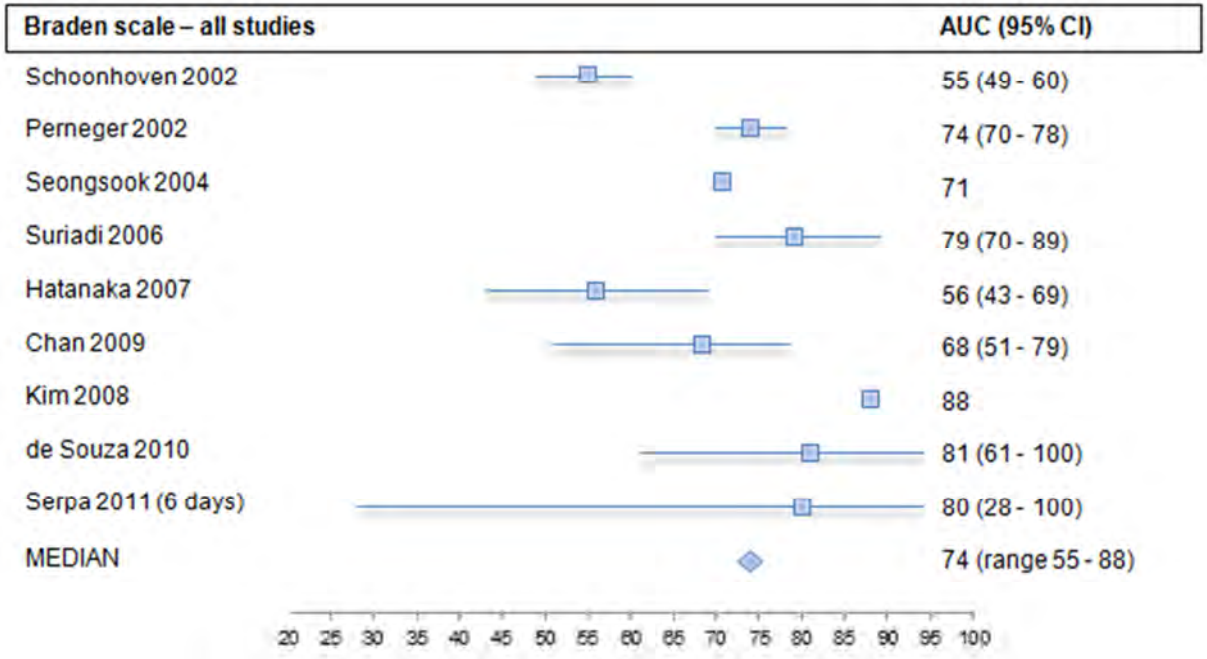
O.6 Forest plots area under the receiver operating characteristics curve (AUC)

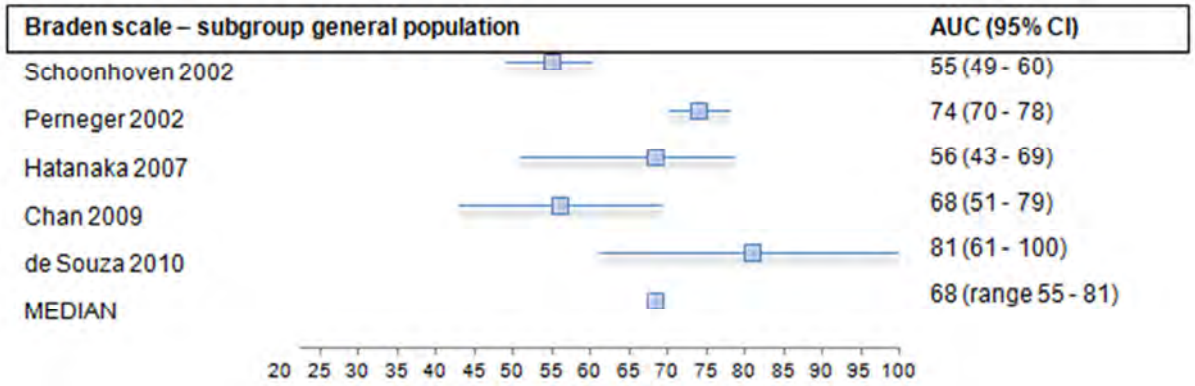
- Perneger 2002 and Schoonhoven 2002 were the only studies with more than 100 events; Serpa 2011 had fewer than 10 events.
- The proportion of pressure ulcers was less than 10% for Chan 2009;10-20% for de Souza 2010, Kim 2009, Perneger 2002, Schoonhoven 2002, Serpa 2011; 20-50% for Hatanaka 2008, Seongsook 2004, Suriadi 2006
- De Souza 2010 and Suriadi 2006 did not give preventative treatment; Schoonhoven 2002 and Perneger 2002 both gave less than half the patients preventative treatment; Hatanaka 2007, Kim 2009 and Seongsook 2004 gave preventative treatment to all patients.
- Suriadi 2006, Seongsook 2004 and Serpa 2011 were conducted in intensive care; Hatanaka 2007 had bedridden hospitalised patients and the patients in de Souza 2010 were in long term care.
- Serpa 2011 included a selected risk group (low risk patients missing)

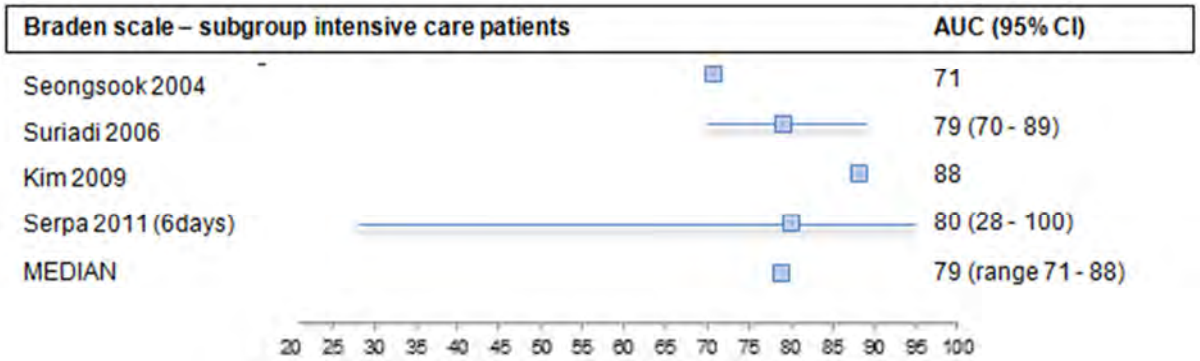
- Kim 2009 and Suriadi 2006 had a mean age of between 50 and 60 years; Schoonhoven 2002, Seongsook 2004, Serpa 2011, had a mean patient age of 60-70 years; Chan 2009, de Souza 2010 and Hatanake 2007 had a mean age of 70-80 years;

Table 48: Braden scale

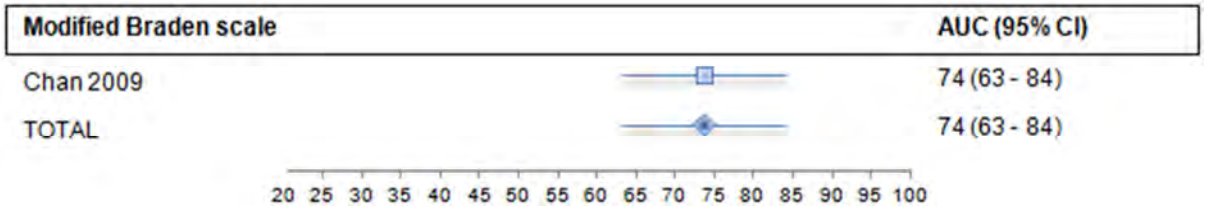
Sample sizes: Chan 2009 (n=197); de Souza 2010 (n=233); Hatanaka 2007 (n=149); Kim 2008 (219); Perneger 2002 (n=1190); Schoonhoven 2002 (n=1229); Seongsook 2004 (n=112); Serpa 2011 (n=72); Suriadi 2006 (n=105)



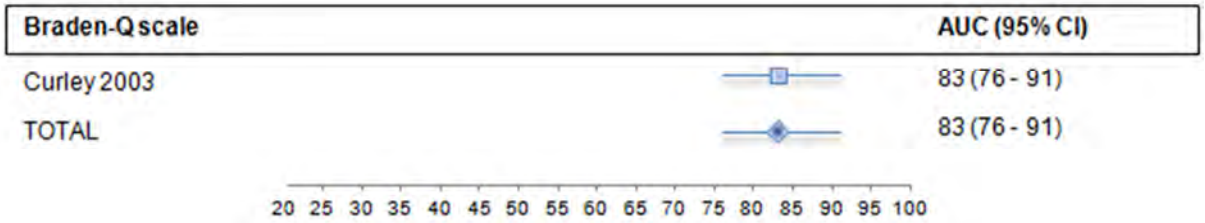




O.6.1 Modified Braden scale

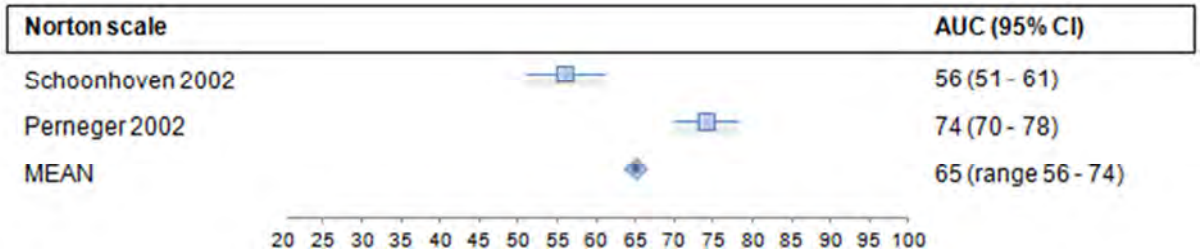


O.6.2 Braden-Q scale

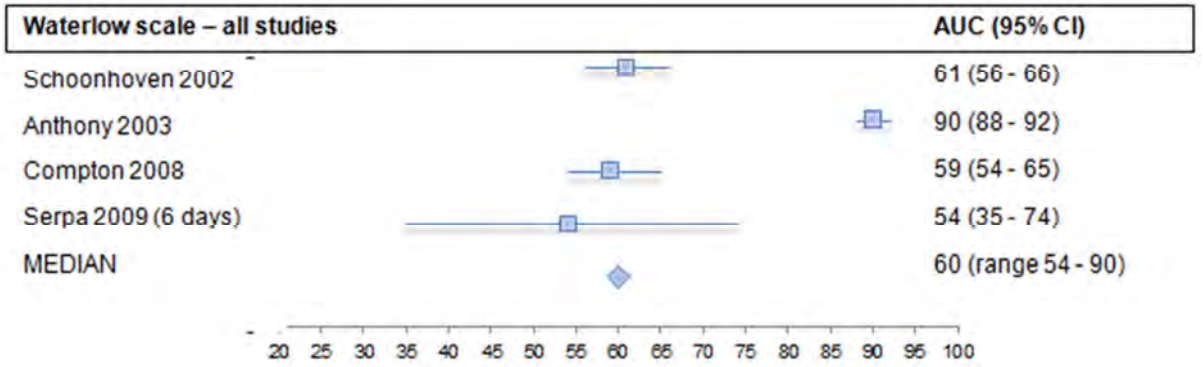


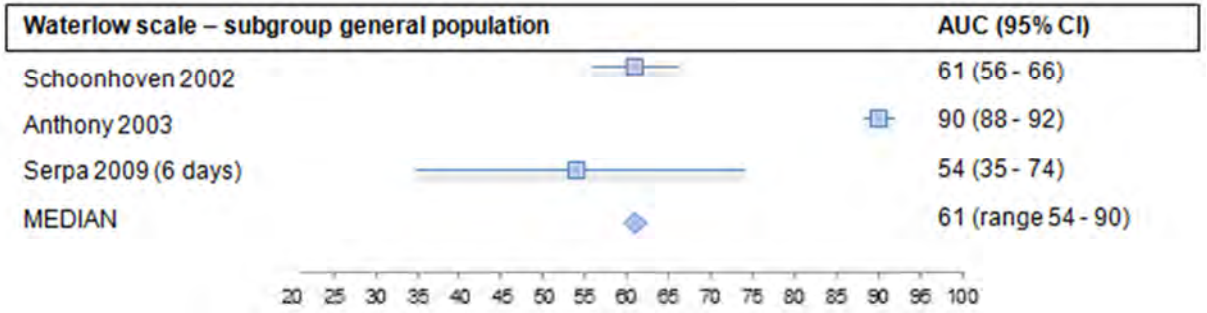
O.6.3 Norton scale

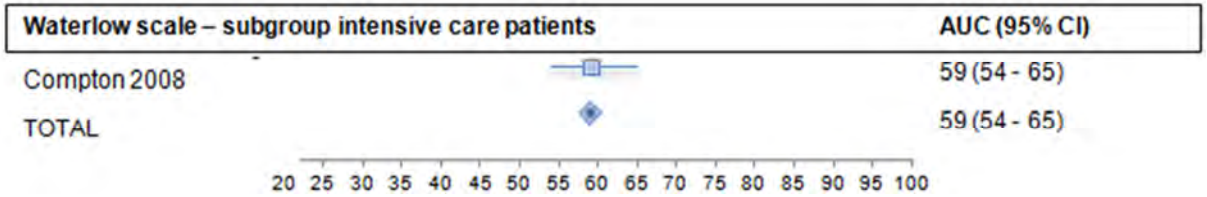
Sample sizes: Perneger 2002 (n=1190); Schoonhoven 2002 (n=1229);



O.6.4 Waterlow scale

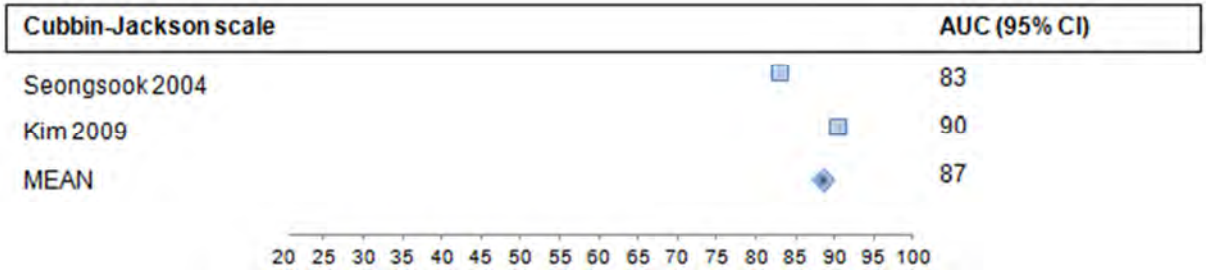




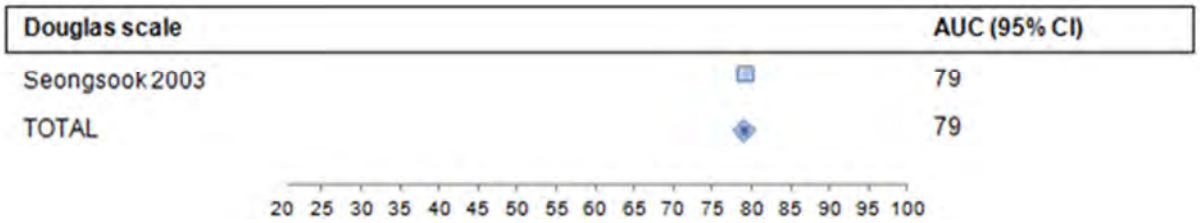


O.6.5 Cubbin-Jackson scale

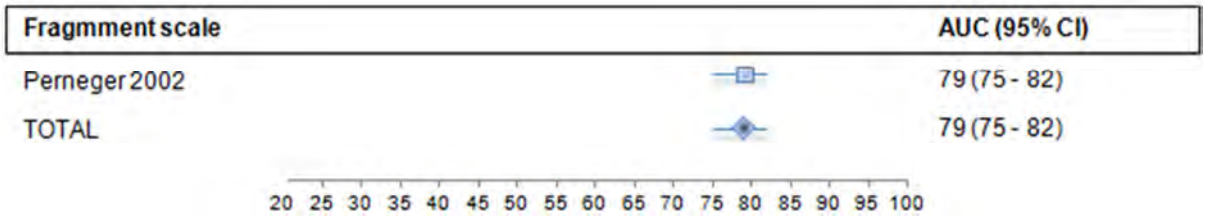
Both studies reported that all patients received preventative treatment. Confidence intervals were not reported in either study, but were estimated (using the number of patients) to be: Seongsook 2004 AUC 83% (95%CI 75 to 89) and Kim 2009 AUC 90% (95%CI 85 to 94).



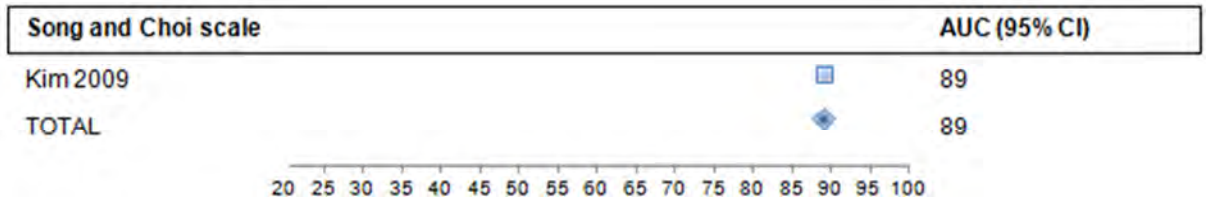
O.6.6 Douglas scale



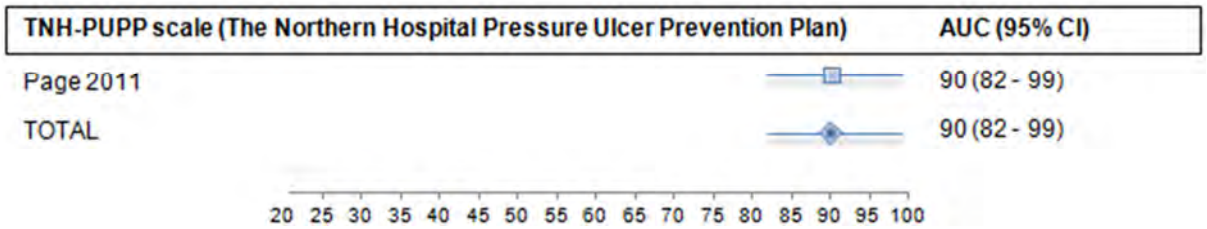
O.6.7 Fragmment scale



O.6.8 Song and choi scale

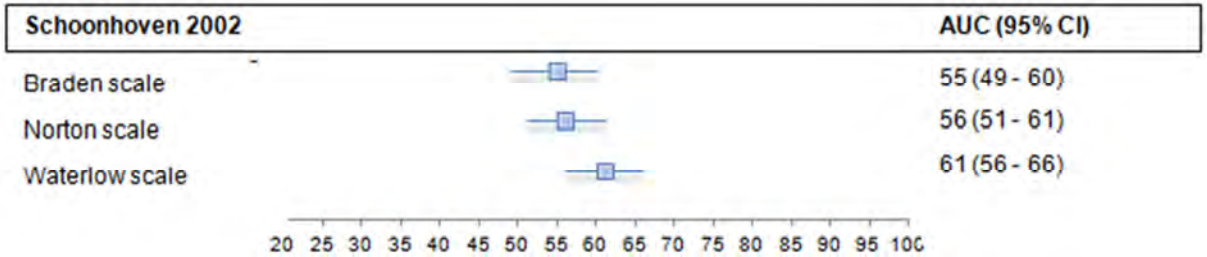


O.6.9 The Northern Hospital Pressure Ulcer Prevention Plan

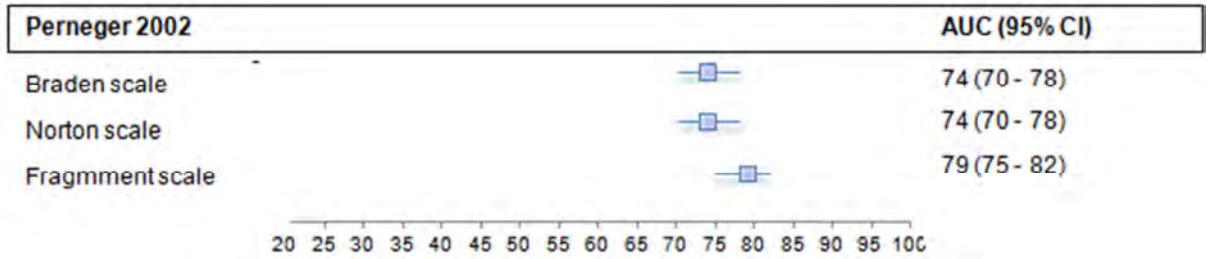


Comparison of scales in the same study

O.6.10 Schoonhoven 2002 (general patient group, mean age 60.1 years, 1229 patients, 135 events (11%), 5% received preventative treatment)

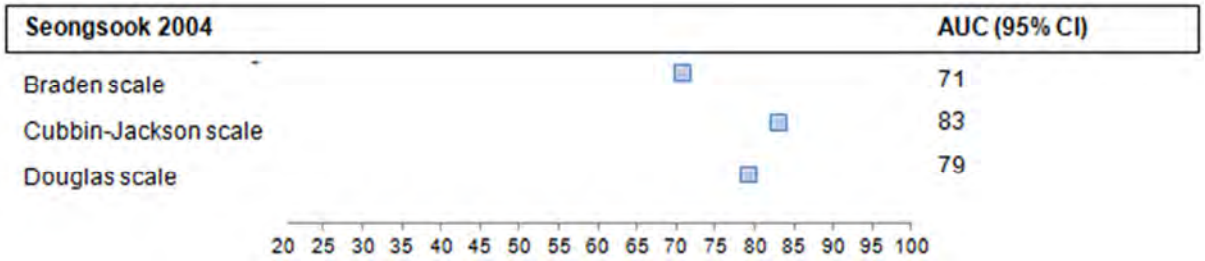


O.6.11 Perneger 2002 (general patient group, 1190 patients, 170 events (14%), 24% received preventative interventions)

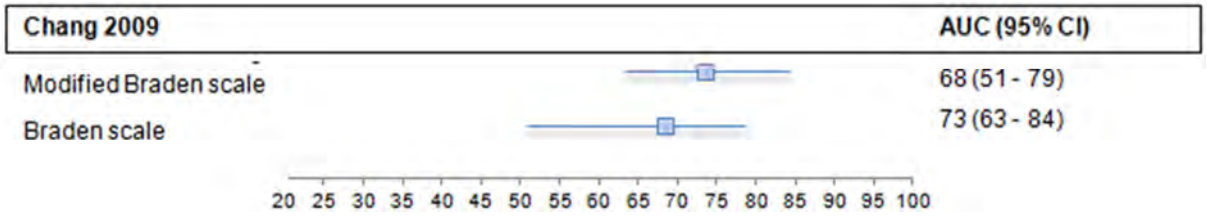


O.6.12 Seongsook 2004 (ICU, mean age 62 years, 112 patients, 35 events (31%), all patients received preventative measures)

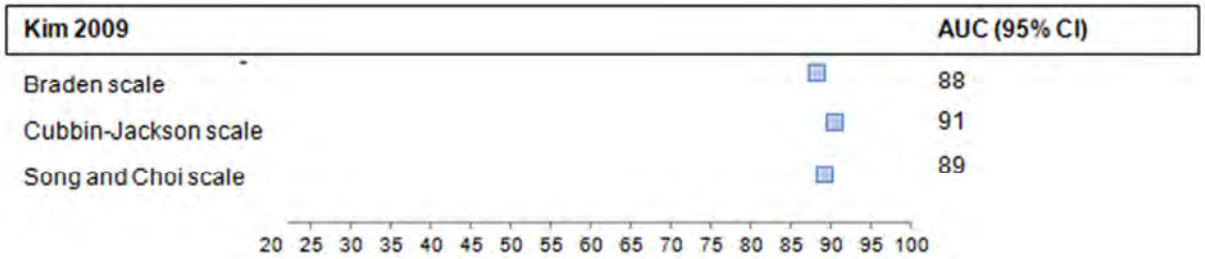
Confidence intervals were not reported, but were estimated (using the number of patients) to be: Braden AUC 71% (95%CI 62 to 79); Cubbin Jackson AUC 83% (95%CI 75 to 89) and Douglas scale AUC 79% (95%CI 70 to 86%).



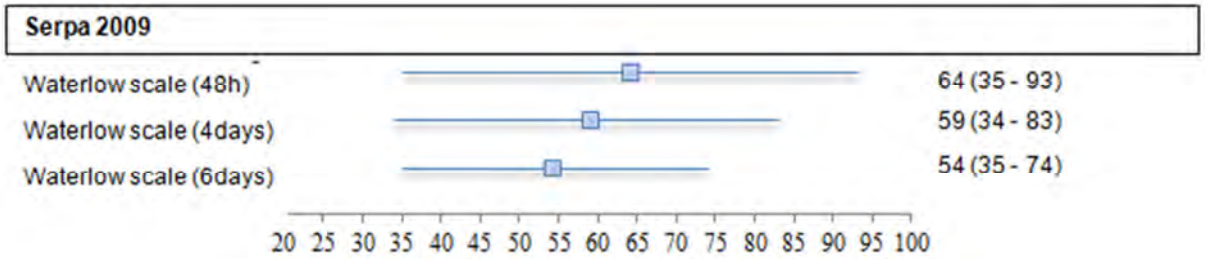
O.6.13 Chan 2009 (Orthopaedic patients, mean age 79 years, 197 patients, 18 events (9%), preventative measures applied 'as normal practice')



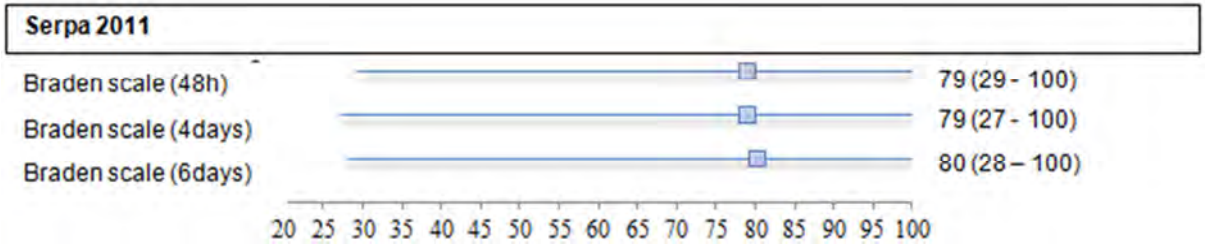
O.6.14 Kim 2009 (Surgical ICU patients, mean age 58 years, 219 patients, 40 events (18%), all patients received preventative measures)



O.6.15 Serpa 2009 (ICU patients, 98 patients, 7 events (7%), selected group (no low risk patients), mean age 71 years, preventative measures not mentioned)



O.6.16 Serpa 2011 (ICU patients, 72 patients, 8 events (11%), selected group (no low risk patients), mean age 61 years, preventative measures according to the institution)

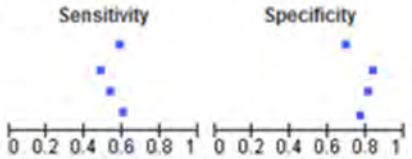


O.7 Forest plots and sensitivity

O.7.1 Braden scale cut-off score 17 – follow-up < 1 week – general population – all grades

Sample sizes: Bergstrom 1998 (1): 306; Bergstrom 1998 (2): 282; Bergstrom 1998 (3): 61; Braden 1994: 102

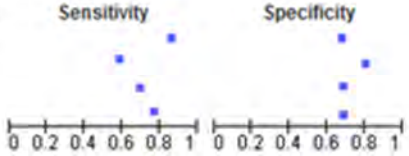
Study	TP	FP	FN	TN	Sensitivity	Specificity
Bergstrom 1998 (1)	0	0	0	0	0.62	0.76
Bergstrom 1998 (2)	0	0	0	0	0.50	0.85
Bergstrom 1998 (3)	0	0	0	0	0.56	0.81
Braden 1994	0	0	0	0	0.61	0.78



No raw data available
Bergstrom 1998 (1): tertiary hospital; Bergstrom 1998 (2): veteran medical centre; Bergstrom 1998 (3): skilled nursing facility

O.7.2 Braden scale cut-off score 18 – follow-up < 1 week – general population – all grades

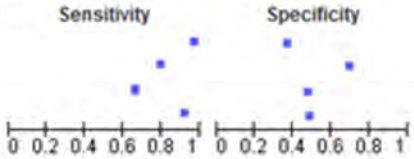
Study	TP	FP	FN	TN	Sensitivity	Specificity
Bergstrom 1998 (1)	0	0	0	0	0.88	0.68
Bergstrom 1998 (2)	0	0	0	0	0.60	0.81
Bergstrom 1998 (3)	0	0	0	0	0.72	0.68
Braden 1994	0	0	0	0	0.79	0.68



No raw data available
Bergstrom 1998 (1): tertiary hospital; Bergstrom 1998 (2): veteran medical centre; Bergstrom 1998 (3): skilled nursing facility

O.7.3 : Braden scale cut-off score 19 – follow-up < 1 week – general population – all grades

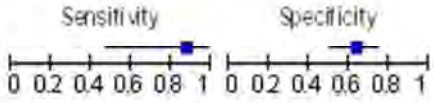
Study	TP	FP	FN	TN	Sensitivity	Specificity
Bergstrom 1998 (1)	0	0	0	0	1.00	0.40
Bergstrom 1998 (2)	0	0	0	0	0.80	0.73
Bergstrom 1998 (3)	0	0	0	0	0.67	0.48
Braden 1994	0	0	0	0	0.93	0.51



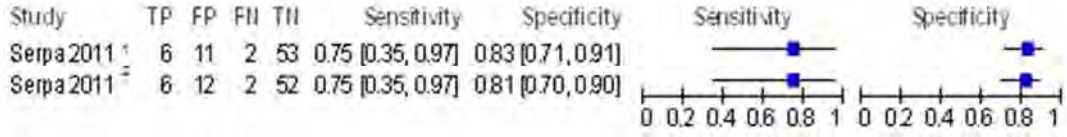
No raw data available
Bergstrom 1998 (1): tertiary hospital; Bergstrom 1998 (2): veteran medical centre; Bergstrom 1998 (3): skilled nursing facility

O.7.4 Braden scale cut-off score 12 – follow-up 48 hours – ICU – all grades

Study	TP	FP	FN	TN	Sensitivity	Specificity
Serpa 2011	7	23	1	41	0.88 [0.47, 1.00]	0.64 [0.51, 0.76]

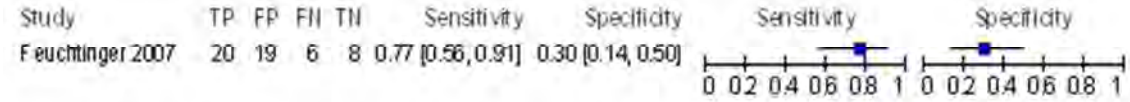


O.7.5 Braden scale cut-off score 13 – follow-up 4 and 6 days – ICU – all grades

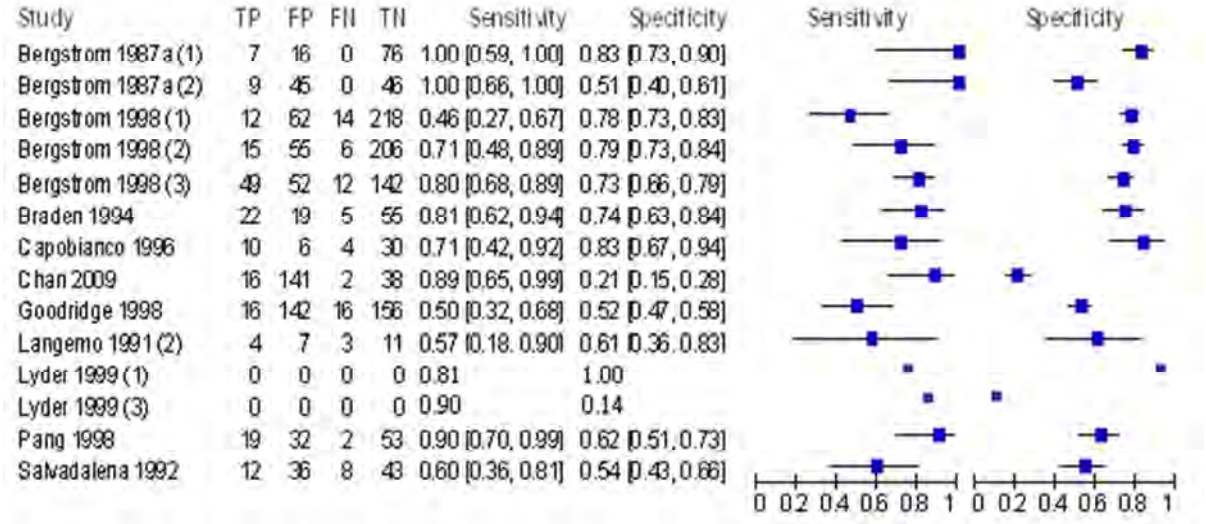


Serpa 2011 1: 4 days; Serpa 2011 2: 6 days

O.7.6 Braden scale cut-off score 16 – follow-up < 1 week – ICU – all grades



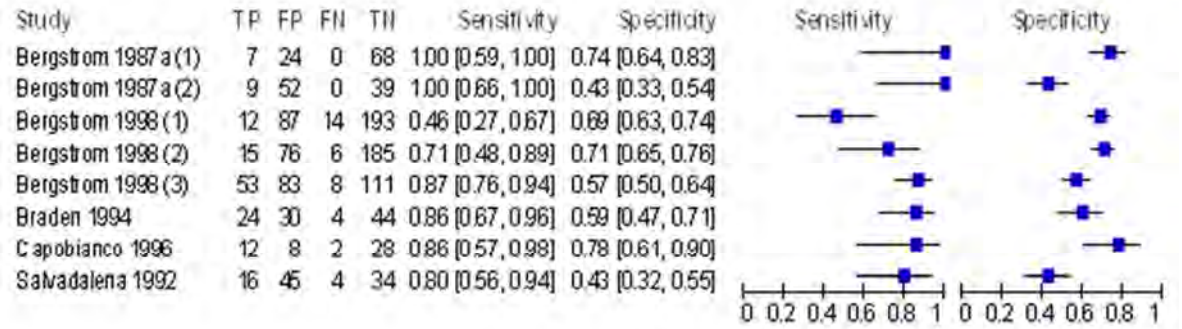
O.7.7 Braden scale cut-off score 18 – follow-up > 1 week – general population – all grades



No raw data for Lyder 1991
Bergstrom 1987a (1): ward one; Bergstrom 1987a (2): ward two; Bergstrom 1998 (1): tertiary hospital; Bergstrom 1998 (2):

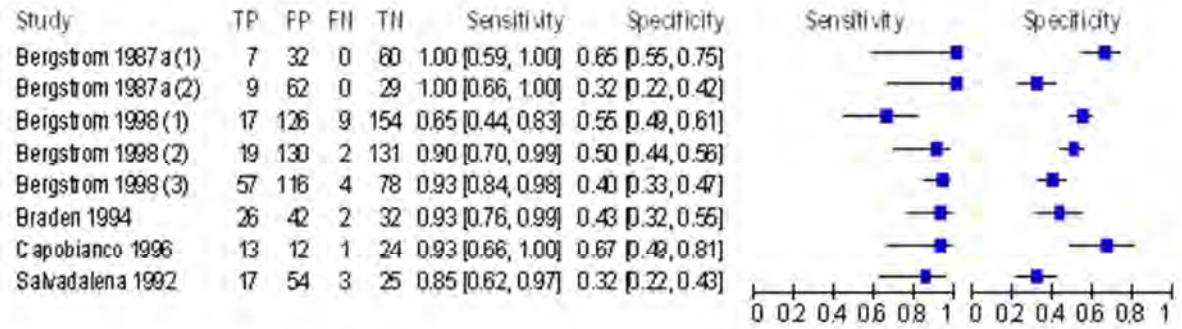
veteran medical centre; Bergstrom 1998 (3): skilled nursing facility; Langemo 1991 (2): skilled nursing facility; Lyder 1999 (1): black elders ≥ 75 yrs; Lyder 1999 (2): Latino/Hispanic < 75 yrs

O.7.8 Braden scale cut-off score 19 – follow-up > 1 week – general population – all grades



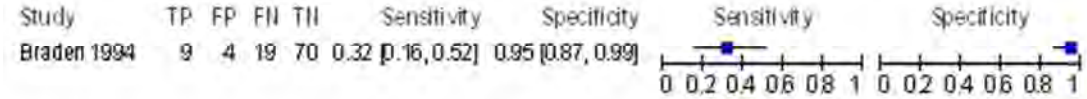
Bergstrom 1987a (1): ward one; Bergstrom 1987a (2): ward two; Bergstrom 1998 (1): tertiary hospital; Bergstrom 1998 (2): veteran medical centre; Bergstrom 1998 (3): skilled nursing facility

O.7.9 Braden scale cut-off score 20 – follow-up > 1 week – general population – all grades

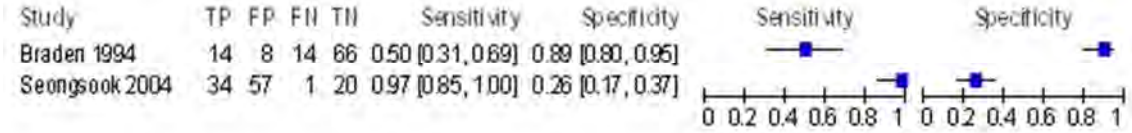


Bergstrom 1987a (1): ward one; Bergstrom 1987a (2): ward two; Bergstrom 1998 (1): tertiary hospital; Bergstrom 1998 (2): veteran medical centre; Bergstrom 1998 (3): skilled nursing facility

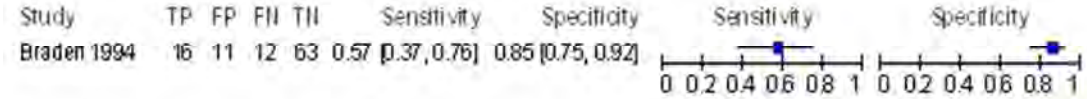
O.7.10 Braden scale cut-off score 15 – follow-up > 1 week – ICU – all grades



O.7.11 Figure 29: Braden scale cut-off score 16 – follow-up > 1 week – ICU – all grades

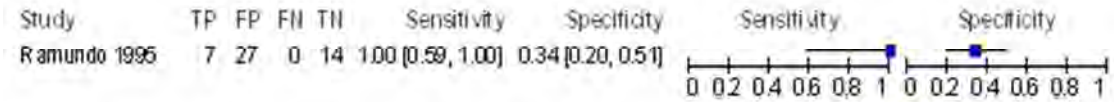


O.7.12 Braden scale cut-off score 17 – follow-up > 1 week – ICU – all grades

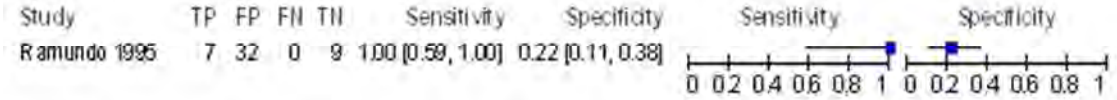


O.7.13 Braden scale cut-off score 17 – follow-up > 1 week – general population – stage 2+

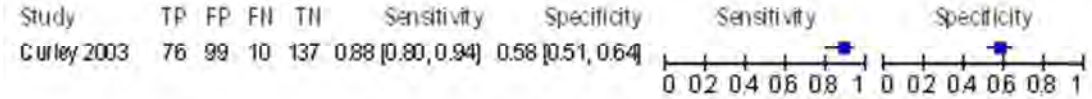
O.7.14 Braden scale cut-off score 18 – follow-up > 1 week – general population – stage 2+



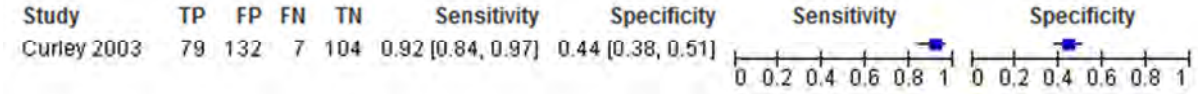
O.7.15 Braden scale cut-off score 19 – follow-up > 1 week – general population – stage 2+



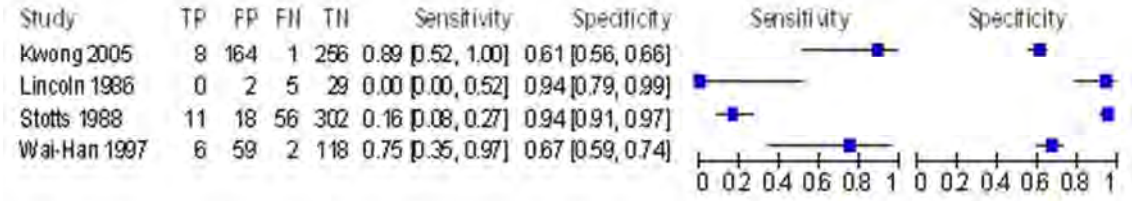
O.7.16 Braden-Q scale cut-off score 16 – follow-up > 1 week – paediatric ICU – all stages



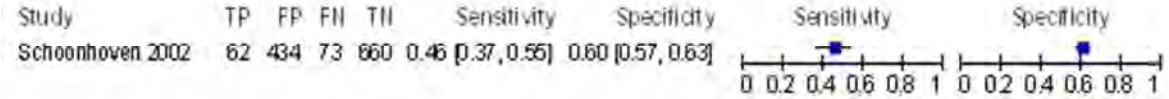
O.7.17 Braden-Q scale cut-off score 17 – follow-up > 1 week – paediatric ICU – all stages



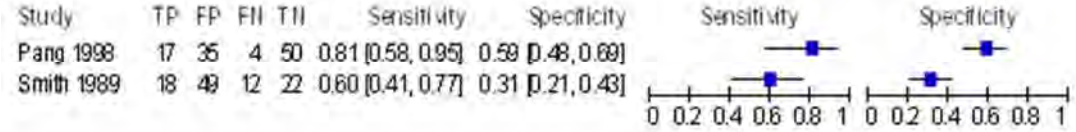
O.7.18 Norton scale cut-off score 14 – follow-up > 1 week – general population – all stages



O.7.19 Norton scale cut-off score 15 – follow-up > 1 week – general population – all stages

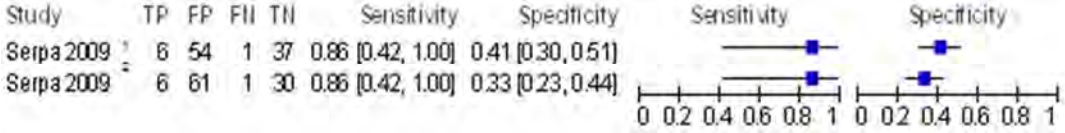


O.7.20 Norton scale cut-off score 16 – follow-up > 1 week – general population – all stages



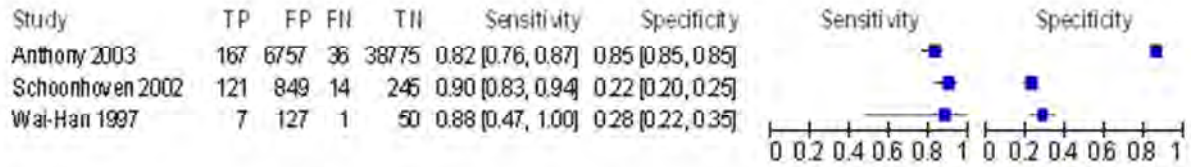
O.7.21 Waterlow scale cut-off score 17 – follow-up 48 hours – general population – all stages

O.7.22 Waterlow scale cut-off score 20 – follow-up 4 days and 6 days – general population – all stages

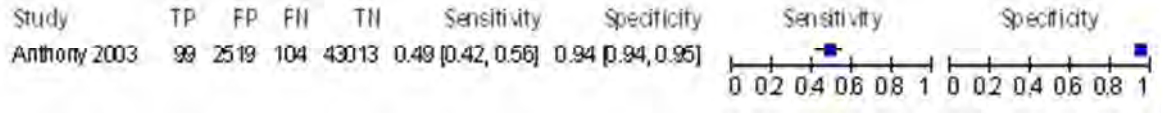


Serpa 2009 1: 4 days; Serpa 2009 2: 6 days

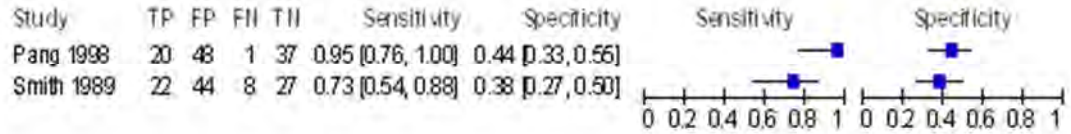
O.7.23 Waterlow scale cut-off score 10 – follow-up > 1 week – general population – all stages



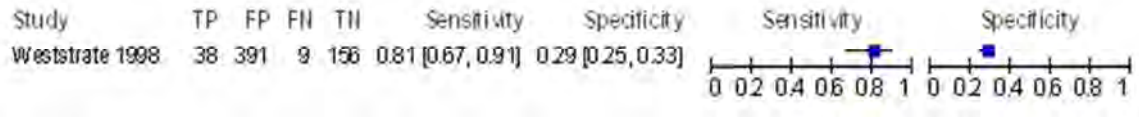
O.7.24 Waterlow scale cut-off score 15 – follow-up > 1 week – general population – all stages



O.7.25 Waterlow scale cut-off score 16 – follow-up > 1 week – general population – all stages

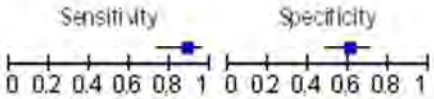


O.7.26 Waterlow scale cut-off score 15 – follow-up > 1 week – ICU – stage 2+



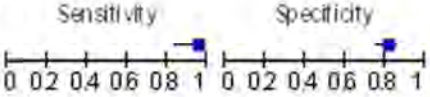
O.7.27 Cubbin-Jackson scale cut-off score 24 – follow-up > 1 week – ICU – all stages

Study	TP	FP	FN	TN	Sensitivity	Specificity
Seongsook 2004	31	30	4	47	0.89 [0.73, 0.97]	0.61 [0.49, 0.72]



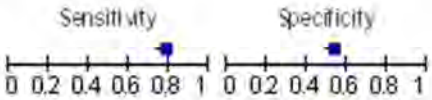
O.7.28 Cubbin-Jackson scale cut-off score 28 – follow-up > 1 week – ICU – all stages

Study	TP	FP	FN	TN	Sensitivity	Specificity
Kim 2009	38	33	2	146	0.95 [0.83, 0.99]	0.82 [0.75, 0.87]



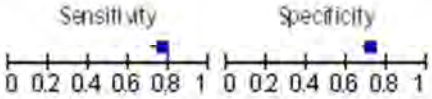
O.7.29 Fragmment scale cut-off score 1 – follow-up > 1 week – general population– all stages

Study	TP	FP	FN	TN	Sensitivity	Specificity
Perneger 2002	280	388	76	446	0.79 [0.74, 0.83]	0.53 [0.50, 0.57]



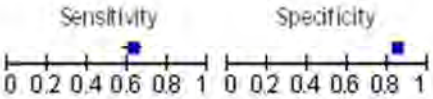
O.7.30 Fragmment scale cut-off score 2 – follow-up > 1 week – general population– all stages

Study	TP	FP	FN	TN	Sensitivity	Specificity
Perneger 2002	273	234	83	600	0.77 [0.72, 0.81]	0.72 [0.69, 0.75]

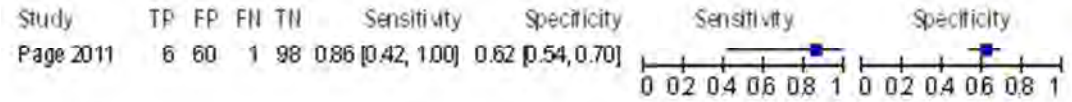


O.7.31 Fragmment scale cut-off score 3 – follow-up > 1 week – general population– all stages

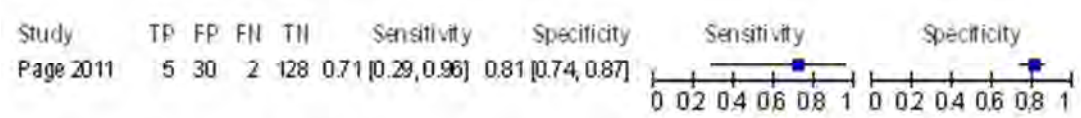
Study	TP	FP	FN	TN	Sensitivity	Specificity
Perneger 2002	221	125	135	709	0.62 [0.57, 0.67]	0.85 [0.82, 0.87]



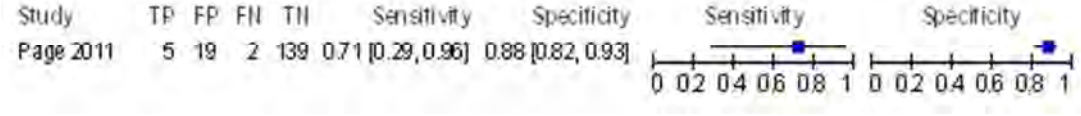
O.7.32 The Northern Hospital Pressure Ulcer Prevention plan cut-off score 2 – follow-up > 1 week – general population– all stages



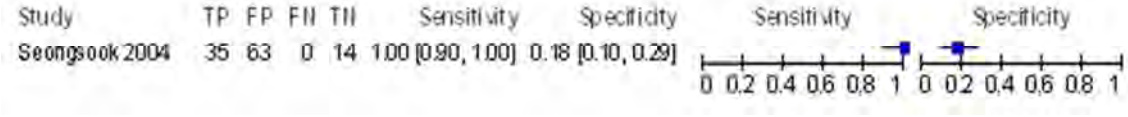
O.7.33 The Northern Hospital Pressure Ulcer Prevention plan cut-off score 3 – follow-up > 1 week – general population– all stages



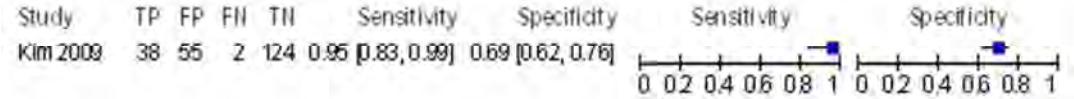
O.7.34 The Northern Hospital Pressure Ulcer Prevention plan cut-off score 4 – follow-up > 1 week – general population– all stages



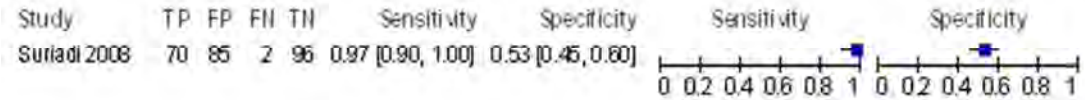
O.7.35 Douglas scale cut-off score 18 – follow-up > 1 week – ICU – all stages



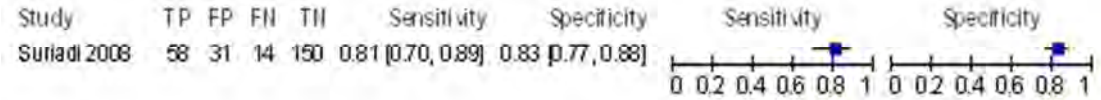
O.7.36 Song and Choi scale cut-off score 2 – follow-up > 1 week – ICU – all stages



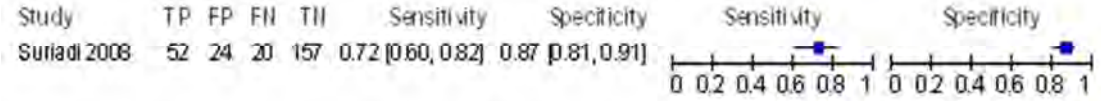
O.7.37 Suriadi and Sanada scale cut-off score 3 – follow-up > 1 week – ICU – all stages



O.7.38 Suriadi and Sanada scale cut-off score 4 – follow-up > 1 week – ICU – all stages



O.7.39 Suriadi and Sanada scale cut-off score 5 – follow-up > 1 week – ICU – all stages



O.7.40 Clinical judgement – follow-up > 1 week – general population – all stages

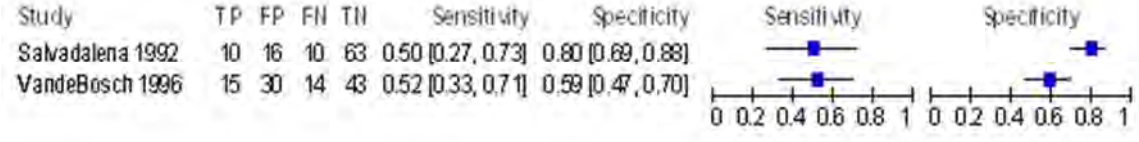


Figure 1: Norton, Waterlow, Braden scales and clinical judgement – all stages, general population – for studies reporting more than one scale

Norton

Study	TP	FP	FN	TN	Threshold	Sensitivity	Specificity
Jalali 2005_Norton	36	0	38	156	16.0	0.49 [0.37, 0.61]	1.00 [0.98, 1.00]
Pang 1998_Norton	17	35	4	50	16.0	0.81 [0.58, 0.95]	0.59 [0.48, 0.69]
Schoonhoven 2002_Norton	62	434	73	660	15.0	0.46 [0.37, 0.55]	0.60 [0.57, 0.63]
Waihan 1997_Norton	6	59	2	118	14.0	0.75 [0.35, 0.97]	0.67 [0.59, 0.74]

Waterlow

Study	TP	FP	FN	TN	Threshold	Sensitivity	Specificity
Jalali 2005_Waterlow	47	27	27	129	16.0	0.64 [0.52, 0.74]	0.83 [0.76, 0.88]
Pang 1998_Waterlow	20	48	1	37	16.0	0.95 [0.76, 1.00]	0.44 [0.33, 0.55]
Schoonhoven 2002_Waterlow	121	849	14	245	10.0	0.90 [0.83, 0.94]	0.22 [0.20, 0.25]
Waihan 1997_Waterlow	7	127	1	50	10.0	0.88 [0.47, 1.00]	0.28 [0.22, 0.35]

Clinical judgement

Study	TP	FP	FN	TN	Threshold	Sensitivity	Specificity
Salvadalena 1992_clinjudg	10	16	10	63	100.0	0.50 [0.27, 0.73]	0.80 [0.69, 0.88]
Vandenbosch 1996_clinjudg	15	30	14	43	100.0	0.52 [0.33, 0.71]	0.59 [0.47, 0.70]

Braden

Study	TP	FP	FN	TN	Threshold	Sensitivity	Specificity
Jalali 2005_Braden	39	0	35	156	18.0	0.53 [0.41, 0.64]	1.00 [0.98, 1.00]
Pang 1998_Braden	19	32	2	53	18.0	0.90 [0.70, 0.99]	0.62 [0.51, 0.73]
Salvadalena 1992_braden	12	36	8	43	18.0	0.60 [0.36, 0.81]	0.54 [0.43, 0.66]
Schoonhoven 2002_Braden	59	353	76	741	17.0	0.44 [0.35, 0.53]	0.68 [0.65, 0.70]
Vandenbosch 1996_Braden	17	30	12	44	17.0	0.59 [0.39, 0.76]	0.59 [0.47, 0.71]

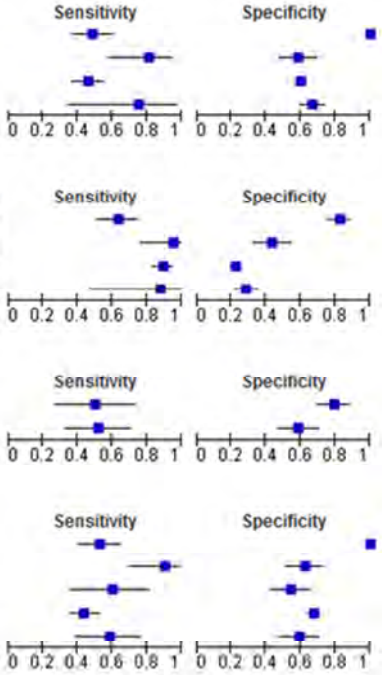
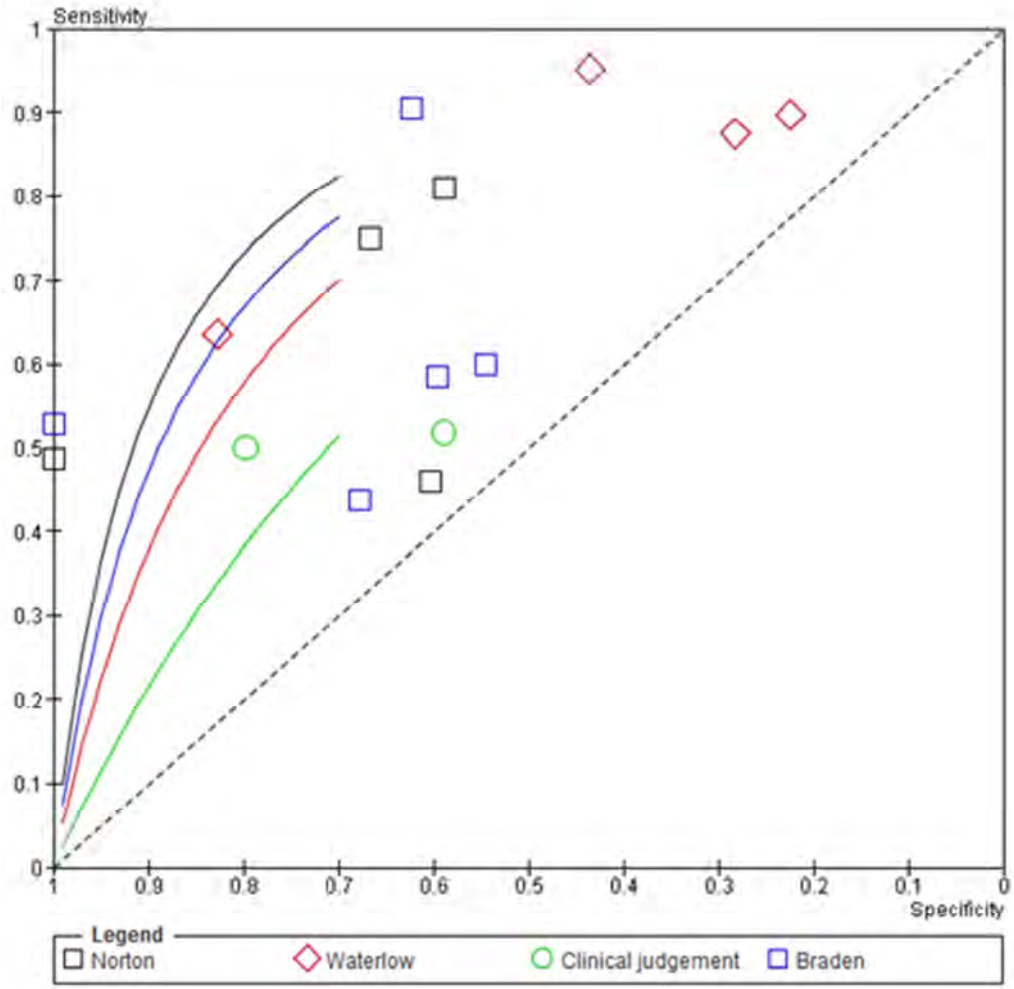


Figure 2: ROC curve for scales Norton, Waterlow, Braden and clinical judgement – all stages, general population – for studies reporting more than one scale



O.8 Skin assessment

O.8.1 Forest plots and sensitivity

Figure 3: Erythema / redness - grades 2-4 – from multivariable analyses (unless otherwise stated)

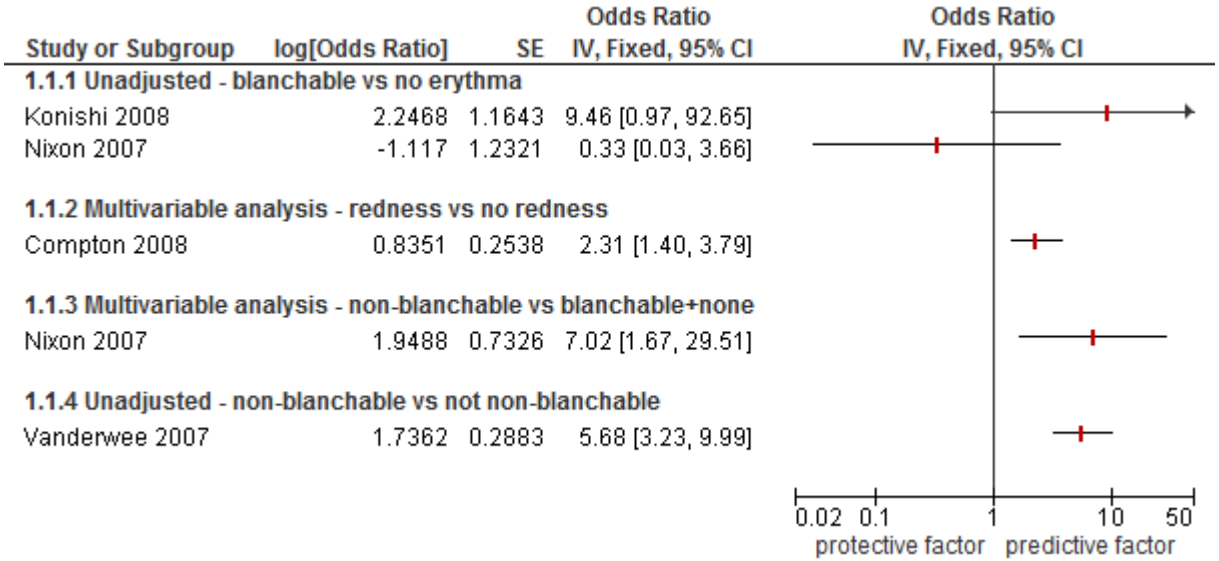


Figure 4: Subjective nursing assessment of skin assessment features - grades 2-4 – from multivariable analyses

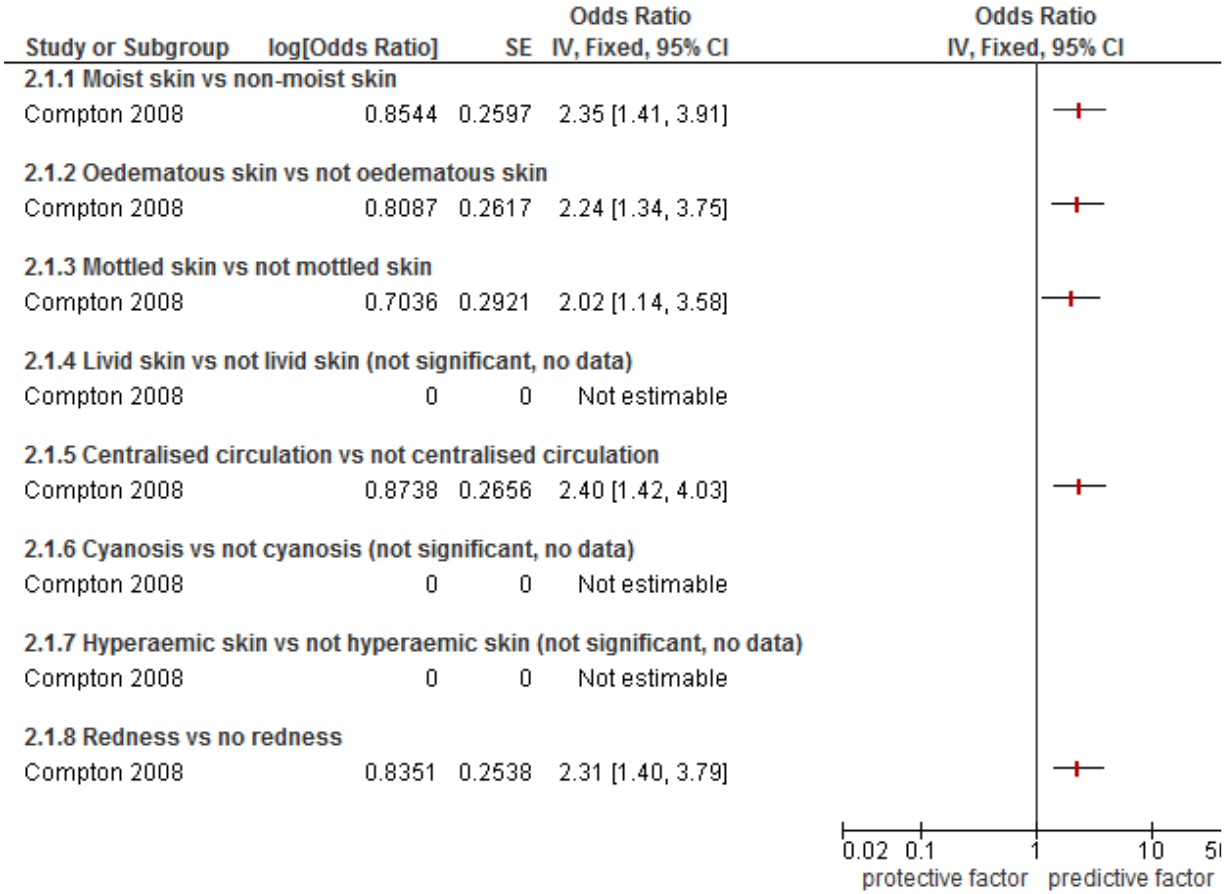


Figure 5: Subjective nursing assessment of moist skin – ICU- grades 2-4

Study	TP	FP	FN	TN	Sensitivity	Specificity
Compton 2008	92	202	29	375	0.76 [0.67, 0.83]	0.65 [0.61, 0.69]

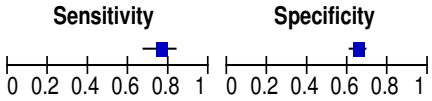


Figure 6: Subjective nursing assessment of oedematous skin – ICU- grades 2-4

Study	TP	FP	FN	TN	Sensitivity	Specificity
Compton 2008	77	135	44	442	0.64 [0.54, 0.72]	0.77 [0.73, 0.80]

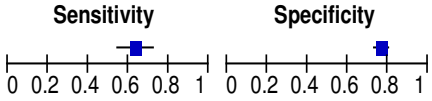


Figure 7: Subjective nursing assessment of mottled skin – ICU- grades 2-4

Study	TP	FP	FN	TN	Sensitivity	Specificity
Compton 2008	40	48	81	529	0.33 [0.25, 0.42]	0.92 [0.89, 0.94]

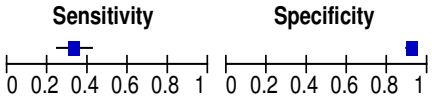


Figure 8: Subjective nursing assessment of centralised circulation – ICU- grades 2-4

Study	TP	FP	FN	TN	Sensitivity	Specificity
Compton 2008	86	171	35	406	0.71 [0.62, 0.79]	0.70 [0.66, 0.74]

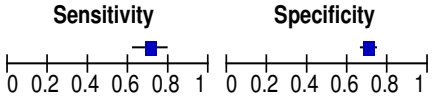


Figure 9: Subjective nursing assessment of livid skin – ICU- grades 2-4

Study	TP	FP	FN	TN	Sensitivity	Specificity
Compton 2008	38	48	83	529	0.31 [0.23, 0.40]	0.92 [0.89, 0.94]

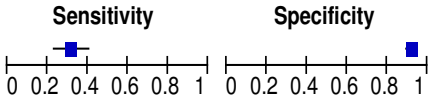


Figure 10: Subjective nursing assessment of cyanosis – ICU- grades 2-4

Study	TP	FP	FN	TN	Sensitivity	Specificity
Compton 2008	77	135	44	442	0.64 [0.54, 0.72]	0.77 [0.73, 0.80]

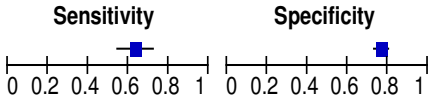


Figure 11: Subjective nursing assessment of reddened skin – ICU- grades 2-4

Study	TP	FP	FN	TN	Sensitivity	Specificity
Compton 2008	83	172	38	405	0.69 [0.60, 0.77]	0.70 [0.66, 0.74]

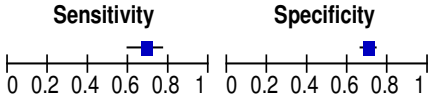


Figure 12: Subjective nursing assessment of hyperaemic skin – ICU- grades 2-4

Study	TP	FP	FN	TN	Sensitivity	Specificity
Compton 2008	26	50	95	527	0.21 [0.15, 0.30]	0.91 [0.89, 0.93]

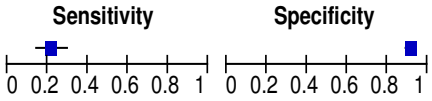


Figure 13: Presence of blanchable erythema assessed by finger test – hospitalized patients- all grades

Study	TP	FP	FN	TN	Sensitivity	Specificity
Konishi 2008	6	56	2	185	0.75 [0.35, 0.97]	0.77 [0.71, 0.82]

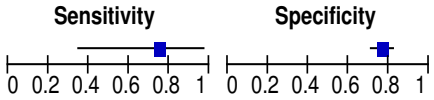


Figure 14: Presence of thermal anomaly (an area of the skin at least 1°C warmer than the surrounding skin) – follow-up 10 days- geriatric inpatients- all grades

Study	TP	FP	FN	TN	Sensitivity	Specificity
Newman 1981	6	22	0	63	1.00 [0.54, 1.00]	0.74 [0.63, 0.83]

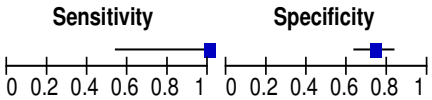


Figure 15: Presence of blanchable erythema assessed by finger test – hospitalized patients – grades 2-4

Study	TP	FP	FN	TN	Sensitivity	Specificity
Konishi 2008	3	59	1	186	0.75 [0.19, 0.99]	0.76 [0.70, 0.81]
Nixon 2006	3	55	1	6	0.75 [0.19, 0.99]	0.10 [0.04, 0.20]

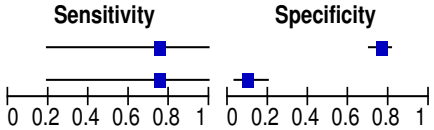


Figure 16: Presence of non-blanchable erythema assessed by finger test – surgical inpatients – grades 2-4

Study	TP	FP	FN	TN	Sensitivity	Specificity
Nixon 2007	11	21	4	61	0.73 [0.45, 0.92]	0.74 [0.64, 0.83]
Vanderwee 2007	26	102	30	668	0.46 [0.33, 0.60]	0.87 [0.84, 0.89]

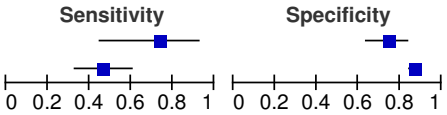


Figure 17: Presence of non-blanchable erythema assessed by transparent disk and Braden score then non-blanchable erythema (in comparison with non-blanchable erythema alone)

NBE

Study	TP	FP	FN	TN	Sensitivity	Specificity
Vanderwee 2007	26	102	30	668	0.46 [0.33, 0.60]	0.87 [0.84, 0.89]

Braden then NBE

Study	TP	FP	FN	TN	Sensitivity	Specificity
Vanderwee 2007	43	208	10	530	0.81 [0.68, 0.91]	0.72 [0.68, 0.75]

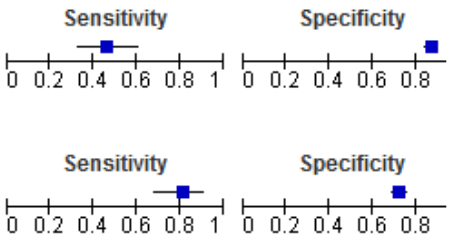
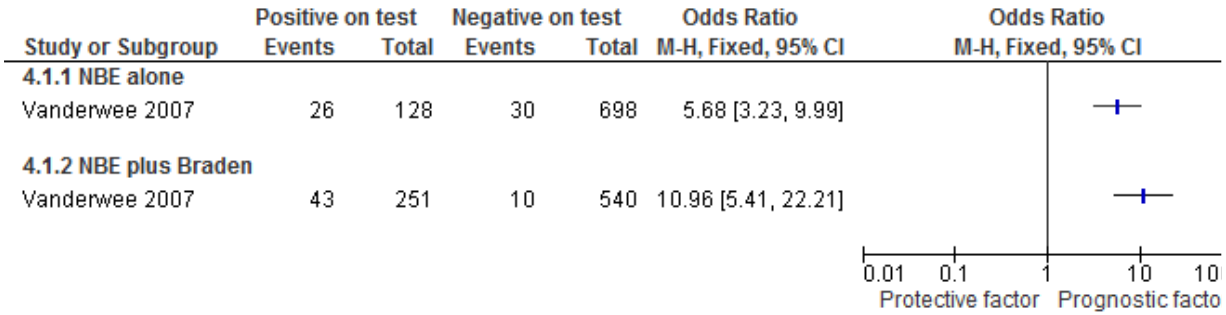


Figure 18: Unadjusted odds ratios for presence of non-blanchable erythema assessed by transparent disk and Braden score then non-blanchable erythema



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