Supplemental Online Content

Schneider C, Aubert CE, Del Giovane C, et al. Comparison of 6 mortality risk scores for prediction of 1-year mortality risk in older adults with multimorbidity. *JAMA Netw Open*. 2022;5(7):e2223911. doi:10.1001/jamanetworkopen.2022.23911

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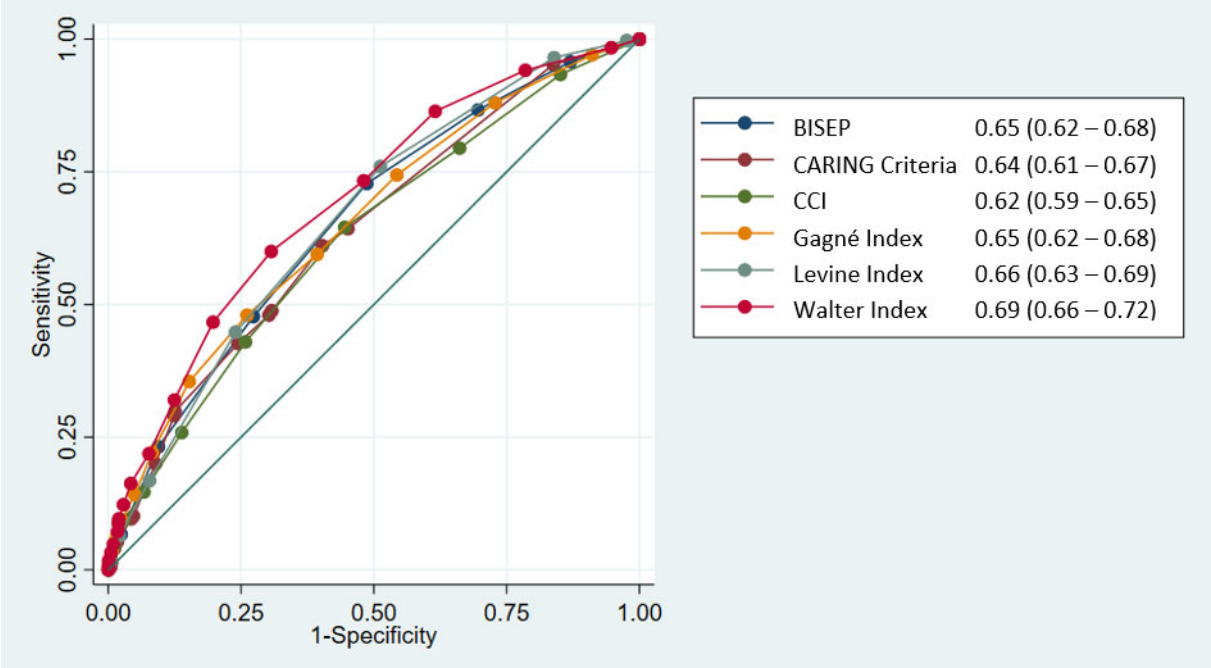
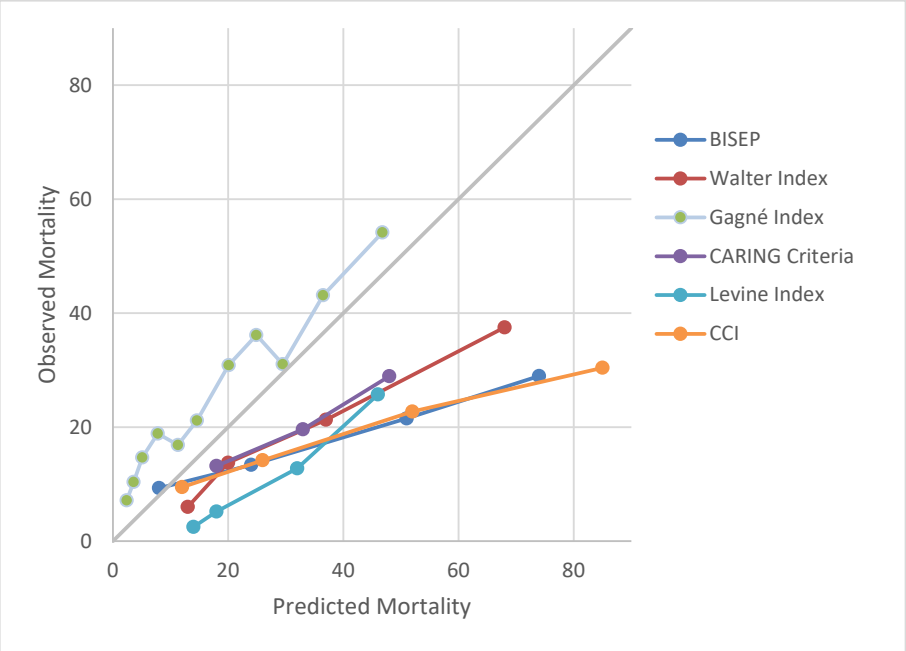
eFigure 1. Area Under the Receiver Operating Characteristic Curves for 1-Year Mortality.



C-Statistic for each 1-year mortality score calculated by score points, with 95% confidence in parenthesis. Values ≥ 0.9 indicate excellent, 0.8 – 0.89 very good, 0.7 – 0.79 good, 0.6 – 0.69 moderate and 0.5 – 0.59 poor discriminatory power.[21] The C-statistic significantly (p-value < 0.01) differ with the CCI performing worst and the Walter Index performing best.
Abbreviations: AUC, area under the receiver operating characteristic curve; BISEP, Burden of illness Score; CCI, Charlson Comorbidity Index.

eFigure 2. Score Calibration Plot for 1-Year Mortality



Calibration plot with predicted mortality on the x-axis and the observed mortality on the y-axis. If a model calibrates well, it is close to the 45° line of perfect fit.
Abbreviations: BISEP, Burden of illness Score for Elderly Persons; CCI, Charlson Comorbidity Index.

eTable 1. Characteristics of the Six Evaluated 1-Year Mortality Scores

Index	Cohort	Items	Points	Predicted mortality [%] (total points)
Burden of Illness Score for Elderly Persons (BISEP) Inouye et al. 2003[12]	Development: n = 525 Age ≥ 70 y Mean age 79 y Hospitalized patients External validation: n = 1246 Age ≥ 65 y Mean age 81 y Nursing home patients	Critical diagnosis (maximal 3 points in this section cumulative) - Lymphoma or leukemia - Acute renal failure - Metastatic cancer - Localized cancer - Stroke - Congestive heart failure - Chronic lung disease - Chronic renal failure - Diabetes mellitus (with end-organ damage) - Pneumonia Albumin ≤ 35 g/l Creatinine > 115 umol/l Dementia Need help / is unable to walk	 3 2 2 2 1 1 1 1 1 1 1 1 1	5 (0-1 point) 16 (2 points) 32 (3 points) 61 (> 3 points)
CARING Criteria Fischer et al. 2006[13]	Development: n = 435 Hospitalized patients Internal Validation: n = 438 Hospitalized patients Overall: Mean age 63 y	Age 55 - 65 66 - 75 ≥ 75 Cancer as primary diagnosis Admissions ≥ 2 Residence in a nursing home Intensive care unit with multiorgan failure Meet non-cancer hospice guidelines (≥2)	1 2 3 10 3 3 10 12	<18 (< 5 points) 18-48 (5-12 points) >48 (>12 points)
Charlson Comorbidity Index Charlson et al. 1987[14]	Development: n = 559 Hospitalized patients External validation: n = 685 Hospitalized patients with proven primary carcinoma of the breast	Metastatic solid tumor HIV/AIDS Moderate to severe liver disease Lymphoma Leukaemia Any tumor Diabetes with end organ damage Moderate to severe renal disease Hemiplegia Myocardial infarct Congestive heart failure Peripheral vascular disease Chronic pulmonary disease Cerebrovascular disease Dementia Connective tissue disease Ulcer disease Mild liver disease	6 6 3 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1	12 (0 points) 26 (1-2 point(s)) 52 (3-4 points) 85 (> 4 points)
Gagne Index Gagne et al. 2011[15]	Development: n = 120679 Age > 65 y Mean age 80 y Community dwelling External validation: n = 123855 Mean age 79 y Community dwelling	Metastatic cancer Congestive heart failure Dementia Renal failure Weight loss Hemiplegia Alcohol abuse Any tumour Cardiac arrhythmias Chronic pulmonary disease Coagulopathy Complicated diabetes Deficiency anaemias Fluid and electrolyte disorders Liver disease Peripheral vascular disorder Psychosis Pulmonary circulation disorders HIV/AIDS Hypertension	5 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	2.4 (<0 points) 3.6 (0 points) 5.1 (1 point) 7.8 (2 points) 11.3 (3 points) 14.6 (4 points) 20.1 (5 points) 24.9 (6 points) 29.5 (7 points) 36.5 (8-9 points) 46.8 (>9 points)

Levine Index	Development:	Age	70-74 y	1	14
	n = 2739		≥ 75 y	2	(0-1 point)
Levine et al.	Mean age 78 y				
2007[16]	Hospitalized	Discharge to nursing home		1	24
	patients	Length of stay	≥ 5 days	1	(2 points)
		Heart failure		1	
	Internal validation:	Peripheral Vascular Disease		1	30
	n = 3543	Dementia		1	(3 points)
	Mean age 78 y	Renal disease		1	
	Hospitalized	Hematologic and solid malignancy		1	42
	Patients	Metastatic cancer		2	(>3 points)
Walter Index	Development:	Gender	Male	1	13
	n = 1495		Female	2	(0-1 point)
Walter et al.	Age > 70 y				
2001[17]	Mean age 81 y	ADLs	Bath		20
	Hospitalized patients	on discharge	Dressing		(2-3 points)
			Transfer (if 1-4)	4	
	External validation:		Toilet (if 5)	5	37
	n = 1427		Eating		(4-6 points)
	Mean age 79 y				
	Hospitalized patients	Congestive heart failure		2	68
					(>6 points)
		Cancer	No metastasis	3	
			With metastasis	6	
		Creatinine on admission (> 265umol/l)		2	
		Albumin on admission	30-34 g/l	1	
			< 30 g/l	2	

Abbreviations: BISEP, Burden of illness Score for Elderly Persons; CCI, Charlson Comorbidity Index; n, Number of participants; y, years.

eTable 2. Participant Characteristics

	OPERAM	BISEP[12]	CARING[13]	CCI*[14]	Gagné[15]	Levine[16]	Walter[17]
N	**1879**	**525**	**873**	**559**	**120,679**	**2739**	**1495**
Characteristics, mean (range, % or SD)							
Age[y]	80 (70-100)	79 (70-98)	63 (13)		80 (7.3)	78 (8.3)	81 (7)
Female sex, [n] (%)	835 (44.4%)	294 (56.0%)	(2%)		(83.4%)	1733 (63%)	1004 (67%)
Length of stay [days]	11.8 (1-155)						
Charlson >= 2, [n] (%)		372 (71.0%)					
Number of diagnoses	13.0 (1-58)				18.0 (IQR 11-27)		
Number of medications	11.4 (1-36)				8.0 (IQR 5-12)		
Living in nursing home	96 (5.8%)	37 (7.1%)	26 (3%)		9.1%		
Discharge to nursing home	155 (8.4%)					415 (15%)	452 (30%)
Death, n (%)							
Death within one year	375 (20.0%)	154 (29.3%)	229 (26.2%)		10,769 (8.9%)	415 (15.2%)	492 (32.9%)

Abbreviations: BISEP, Burden of illness Score for Elderly Persons; CCI Charlson Comorbidity Index, IQR, interquartile range.

* None of the information could be found in the published literature.

eTable 3. Pairwise Comparison of the ROC Curves

	BISEP	CARING Criteria	Charlson Comorbidity Index	Gagné Index	Levine Index	Walter Index
BISEP	x	0.4395	**0.0178**	0.9472	0.6290	**0.0015**
CARING Criteria	0.4395	x	0.3267	0.5101	0.1932	**0.0003**
Charlson Comorbidity Index	**0.0178**	0.3267	x	**0.0076**	**0.0030**	**0.0000**
Gagné Index	0.9472	0.5101	**0.0076**	x	0.5042	**0.0039**
Levine Index	0.6290	0.1932	0.0030	0.5042	x	**0.0130**
Walter Index	**0.0015**	**0.0003**	**0.0000**	**0.0039**	**0.0130**	x

P-values of the pairwise comparison of the ROC curves calculated with roccomp of STATA.

Abbreviations: BISEP, Burden of illness Score for Elderly Persons; ROC, receiver operating characteristic

eTable 4. Calibration of the Six Scores Analyzed With the Brier Score and the Hosmer-Lemeshow Chi Square Test With the Hosmer-Lemeshow Chi Square Test Run on a Subsample

Score	Predicted mortality		Observed mortality		Brier	Hosmer-Lemeshow		HL subsample*	
	%	95% CI	%	95% CI		Chi^2	p-value	Chi^2	p-value
BISEP	8		10	(8-13)	0.24	767.5	< 0.01	39.3	< 0.001
	24		14	(11-18)					
	51		23	(19-27)					
	74		30	(26-34)					
CARING Criteria	<18		14	(12-16)	0.17	104.7	< 0.01	7.5	0.06
	18-48		21	(17-25)					
	≥49		30	(26-34)					
Charlson Comorbidity Index	12		10	(7-15)	0.23	938.4	< 0.01	37.4	< 0.01
	26		15	(13-18)					
	52		24	(20-27)					
	85		31	(26-37)					
Gagné Index	2.4	(2.2-2.6)	7.7	(3.9-13.4)	0.16	89.8	< 0.01	1.2	1.00
	3.6	(3.4-3.8)	11.2	(7.9-15.3)					
	5.1	(4.9-5.4)	15.4	(11.7-19.7)					
	7.8	(7.4-8.3)	20.1	(15.5-25.3)					
	11.3	(10.7-12.0)	18.1	(13.5-23.7					
	14.6	(13.8-15.5)	21.8	(16.0-27.9)					
	20.1	(18.9-21.4)	31.4	(24.3-39.3)					
	24.9	(23.3-26.5)	37.0	(26.6-48.5)					
	29.5	(24.4-31.6)	32.1	(20.3-46.0)					
	36.5	(34.4-38.7)	44.9	(30.7-59.8)					
	46.8	(43.4-50.1)	54.2	(32.8-74.4)					
Levine Index	14	(11-16)	3	(0-15)	0.19	271.7	< 0.01	21.6	< 0.01
	18	(15-21)	6	(3-10)					
	32	(28-36)	14	(11-17)					
	46	(42-50)	27	(24-30)					
Walter Index	13	(10-16)	6	(4-9)	0.17	206.8	< 0.01	12.2	0.02
	20	(16-24)	15	(12-18)					
	37	(33-41)	22	(19-25)					
	68	(63-73)	39	(34-45)					

Abbreviations: BISEP, Burden of illness Score for Elderly Persons; CI, confidence interval; HL Hosmer-Lemeshow.

* Calibration assessed in a random selected subsample of 100 participants.

eTable 5. Sensitivity Analysis. Overall performance, discriminatory ability and calibration of the six scores analyzed with the Brier score, C-statistics and Hosmer-Lemeshow goodness of fit test using multiple imputation for missing data in variables for albumin values and nursing home residence.

Score	Overall performance[1]	Discriminatory ability		Calibration	
	Brier score			Hosmer-Lemeshow[2]	
		C-Statistic	95% CI	Chi^2	p-value
BISEP	0.25	0.65	(0.62-0.68)	927.6	< 0.01
CARING Criteria	0.18	0.64	(0.61-0.67)	201.3	< 0.01
Charlson Index	0.23	0.62	(0.59-0.65)	938.4	< 0.01
Gagné Index	0.16	0.65	(0.62-0.68)	89.8	< 0.01
Levine Index	0.19	0.66	(0.63-0.69)	271.7	< 0.01
Walter Index	0.17	0.69	(0.66-0.72)	209.9	< 0.01

Abbreviations: AUC, area under the receiver operating characteristic curve; BISEP, Burden of illness Score for Elderly Persons; CI, confidence interval.

[1] The Brier score ranges from 0 (perfect overall performance) to 0.25 (non-informative model).

[2] The null hypothesis of the HL goodness of fit test is that the assessed score predicts death correctly. Thus a significant p-value indicates a poor calibration.

eTable 6: Sensitivity Analysis. Overall Performance, Discriminatory Ability and Calibration of the Six Scores Analyzed With the Brier Score, C-statistics and Hosmer-Lemeshow Goodness of Fit Test After Excluding All 71 Death During Hospitalization

Score	Overall performance[1]	Discriminatory ability		Calibration	
	Brier score			Hosmer-Lemeshow[2]	
		C-Statistic	95% CI	Chi^2	p-value
BISEP	0.24	0.64	(0.61-0.67)	894.3	< 0.01
CARING Criteria	0.16	0.65	(0.62-0.69)	161.9.7	< 0.01
Charlson Index	0.23	0.62	(0.59-0.66)	1066.2	< 0.01
Gagné Index	0.14	0.65	(0.62-0.69)	43.0	< 0.01
Levine Index	0.18	0.66	(0.63-0.69)	355.4	< 0.01
Walter Index	0.17	0.69	(0.66-0.72)	280.7	< 0.01

Abbreviations: AUC, area under the receiver operating characteristic curve; BISEP, Burden of illness Score for Elderly Persons; CI, confidence interval.

[1] The Brier score ranges from 0 (perfect overall performance) to 0.25 (non-informative model).

[2] The null hypothesis of the HL goodness of fit test is that the assessed score predicts death correctly. Thus a significant p-value indicates a poor calibration.

eTable 7. OPERAM Patient Characteristics at Baseline With Information About Missing Data

	Study population (N = 1879)	
		Number of participants with missing data, n (%)
Female, n (%)	835 (44.4)	0
Male, n (%)	1044 (55.6)	0
Age (years), median (IQR)	79 (74-84)	0
Length of hospital stay (days), median (IQR)	8.5 (6-14)	45 (2.4)
Number of diagnoses, median (IQR)	11 (8-16)	0
Number of drugs, median (IQR)	11 (8-14)	0
Current or experienced Cancer, n (%)	520 (27.7)	0
Living in nursing home, n (%)	96 (5.9)	226 (12.0)
Discharge to nursing home, n (%)	155 (8.4)	30 (1.6)
≥2 admissions in last year, n (%)	445 (23.8)	6 (0.3)
Laboratory, median (IQR)		
Albumin (g/l)	33 (28-37)	717 (38.2)
Creatinine (µmol/l)	95 (74-128)	22 (1.2)
Activity of daily living, n (%)		
Dependent for bathing	596 (32.0)	18 (1.0)
Dependent for feeding	150 (8.0)	9 (0.5)
Dependent for dressing	524 (28.0)	8 (0.4)
Dependent for toileting and hygiene	338 (18.1)	9 (0.5)
Dependent for transferring	329 (17.6)	8 (0.4)
Dependent for mobility	405 (21.7)	10 (0.5)
Study site, n (%)		
Switzerland	805 (42.8)	
Belgium	338 (18.0)	
The Netherlands	406 (21.6)	
Republic of Ireland	330 (17.6)	

Abbreviations: IQR, interquartile range; n, number.
Conversion factor to convert from International System of Units (SI) into conventional units: albumin 0.1, creatinine 0.0113.

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