

Appendix 1 (as supplied by the authors): Tools for prediction of mortality amongst hospitalized patients

Original research articles describing the derivation or validation of a clinical prediction rule for all-cause mortality after hospital admission were identified through a search for articles in any language in MEDLINE and EMBASE from inception to July 2011 using search terms “prognostic tool”, “prognostic model”, “prognostic index”, “mortality”, “hospitalization”. We excluded studies which only examined patients with a specific disease (e.g., heart failure, COPD, etc.), since hospitalized patients often have co-existing chronic conditions; studies examining the prognostic value of a single risk factor (e.g., anemia, hypoglycemia, etc.); studies restricted to the intensive care unit population; and studies only reporting in-hospital mortality. We searched the references lists of relevant systematic reviews to identify any additional relevant articles. These clinical prediction rules are summarized in the table below.

Author (Year)	Study Population	Predictor Variables Included in Clinical Prediction Rule (Point scoring)	Risk Groups	Primary Outcome	Outcome Event Rates, Derivation Cohort, % (95% CI)	Outcome Event Rates, Validation Cohort, % (95% CI)	c-statistic, Derivation Cohort (95% CI)	c-statistic, Validation Cohort (95% CI)
Di Bari (2010) ¹	10,913 patients age 75 years and older admitted to the medical ward via the emergency department of 6 hospitals (1 teaching hospital; 5 community hospitals) in Florence, Italy	Age (years) 80-84 (3 points) 85+ (9 points) Male (2 points) Unmarried/widowed/divorced (1 point) Previous admission to a day hospital (5 points) Previous admission to a regular ward for: respiratory disease (6 points) cancer (11 points) other (2 points) 8 or more drugs in the previous 3 months (2 points)	0-3 points 4-6 points 7-10 points 11+ points	1 year mortality	Not reported	24.3 36.8 56.7 78.9	0.66	0.64
Drame (2008a) ²	1,306 medical inpatients age 75 years and older from 9 teaching hospitals in France	Age ≥ 85 y (1 point) Dependent for 1+ ADL (1 point) Delirium (2 points) Malnutrition risk (Mini Nutritional Assessment short form score < 12) (2 points) Charlson co-morbidity index, score 2 to 4 (2 points) Charlson co-morbidity index, score 5 or more (3 points)	Low risk (≤2 points) Medium risk (3 to 5 points) High risk (≥6 points)	2 year mortality	20.8 (15.1-26.1) 49.6 (45.1-54.1) 62.1 (59.1-70.8)	21.7 (14.2-29.3) 48.5 (42.0-54.9) 65.4 (55.1-75.9)	0.72 (0.68-0.75)	0.71 (0.66-0.76)

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Drame (2008b) ³	As above	Dependent for 2 to 4 ADLs (5 points) Dependent for 5 or 6 ADLs (10 points) Malnutrition risk (Mini Nutritional Assessment short form score < 12) (2 points) Delirium (2 points)	Group I (0 to 4 points) Group II (5 to 12 points) Group III (over 12 points)	6 week mortality	1.1 (0.5-1.7) 11.1 (9.4-12.9) 22.4 (20.1-24.7)	Validation not performed	0.71 (0.67-0.75)	Validation not performed
Fischer (2006) ⁴	895 medical ward or ICU patients at single U.S. Veterans' Administration Medical Center (98% male)	Cancer as primary diagnosis (10 points) Admissions (2+ in past year) to hospital for chronic illness (3 points) Residence in a nursing home (3 points) ICU admission for multiorgan failure (10 points) Noncancer hospice Guidelines (2 or more National Hospice Palliative Care Organization's guidelines) (12 points) Age < 55 y (0 points) 55-65 y (1 point) 66-75 (2 points) > 75 y (3 points)	Low (\leq 4 points) Medium (5 to 12 points) High (\geq 13 points)	1 year mortality	< 17.5 17.5 to 48 \geq 49	Not reported	0.82	Not reported
Inouye (1998) ⁵	525 general medical ward patients age 70 years or older without delirium at a single U.S. centre	Any IADL impairment (1 point) MMSE > 20 (1 point) Shortened Geriatric Depression Scale \geq 7 (1 point)	Low (0 points) Intermediate (1 point) High (2 or more points)	2 year mortality	20 32 60	24 45 60	0.69	0.66

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Inouye (2003) ⁶	Derivation cohort as above; validated in a quality improvement dataset of 1,246 pts age 65 years or over with a principal discharge diagnosis of pneumonia at 27 hospitals in Connecticut, U.S.	High risk diagnoses* Group A (0 points) Group B (1 point) Group C (2 points) Group D (3 points) Albumin \leq 3.5 mg/dL at admission (1 point) Creatinine > 1.5 mg/dL at admission (1 point) Dementia (1 point) Walking impairment (1 point)	Group I (0 to 1 points) Group II (2 points) Group III (3 points) Group IV (\geq 4 points)	1 year mortality	8.4 24.3 51.2 73.6	5.2 16.6 32.7 60.6	0.83	0.77
Knaus (1995) ⁷	9,105 seriously ill ward or ICU patients age 18 years or older (acute respiratory failure/MOSF; CHF/COPD/cirrhosis; coma; colon or lung cancer) from 5 U.S. hospitals	PaO ₂ /FiO ₂ , mean arterial pressure, WBC, albumin, APACHE III respiration score, temperature, heart rate, bilirubin, creatinine, sodium, coma score, age, disease class, days in hospital before study entry, cancer†	Regression model formula	180 day mortality	Range from 29% for CHF to 87% for coma	Not reported	Not reported	0.78
Levine (2007) ⁸	6,382 medical inpatients at single U.S. center age 65 years or older who survived to hospital discharge (81% African American)	Age (years) 70-74 (1 point) \geq 75 (2 points) Discharge to nursing home (1 point) Length of stay \geq 5 days (1 point) CHF (1 point) Peripheral vascular disease (1 point) Dementia (1 point) Renal disease (1 point) Malignancy (hematologic or solid) (1 point) Metastatic cancer (2 points)	0-1 points 2 points 3 points 4 or more points	1 year mortality	14 (11-16) 18 (15-21) 32 (28-36) 46 (42-50)	14 (12-16) 24 (22-27) 30 (26-33) 42 (38-45)	0.67	0.65

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Pilotto (2008) ⁹	Acutely ill patients age 65 years or older admitted to the geriatric unit of a single hospital in Italy	Complex table resulting in MPI score between 0 and 1, based on assessment across 8 domains: ADLs, IADLs, Short Portable Mental Status Questionnaire (SPMSQ), comorbidity index, Mini Nutritional Assessment (MNA), risk of developing pressure sores using Exton Smith Scale (ESS), number of medications, social support network.	Low (MPI \leq 0.33) Moderate (MPI 0.34-0.66) Severe (MPI > 0.66)	1 year mortality	8.1 21.3 43.4	5.7 23.2 45.1	Not reported	0.75 (0.71-0.80)
Teno (2000) ¹⁰	1,266 hospitalized patients age 80 years or older from 4 U.S. centres	Disease class (acute renal failure/multiple organ system failure/coma; CHF; Cancer; Orthopedic; all others) Age Glasgow Coma Score Acute Physiology Score of APACHEIII Activities of Daily Living scored from 0 to 7 dependencies Weight Loss	No point scoring system; uses nomogram to estimate survival	1 year mortality, 2 year mortality, and estimates of survival time	Requires use of nomogram	Requires use of nomogram	0.74	0.73
Walter (2001) ¹¹	2,922 medical inpatients aged 70 years or older at 2 U.S. hospitals	Male (1 point) Dependent in 1-4 ADLs at discharge (2 points) Dependent in all ADLs (bathing, dressing, using the toilet, transferring from bed to chair, eating) (5 points) CHF (2 points) Solitary cancer (includes hematologic malignancy) (3 points) Metastatic cancer (8 points) Creatinine > 3.0 mg/dL on admission (2 points) Albumin 3.0-3.4 g/dL on admission (1 point) Albumin < 3.0 g/dL on admission (2 points)	0-1 points 2-3 points 4-6 points > 6 points	1 year mortality	13 (10-16) 20 (16-24) 37 (33-41) 68 (63-73)	4 (2-6) 19 (15-23) 34 (23-39) 64 (58-70)	0.75	0.79

Abbreviations: 95% CI, 95% confidence interval; ICU, intensive care unit; ADL, activities of daily living; IADL, instrumental activities of daily living; MOSF, multi-organ system failure; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; APACHE III, Acute Physiology, Age, Chronic Health Evaluation III score; MPI, multidimensional prognostic index.

* Based on the presence of the following comorbidities (lymphoma/leukemia=6 pts; acute renal failure=5 pts; metastatic cancer=3 pts; localized cancer=3 pts; stroke=2 pts; CHF=2 pts; chronic lung disease=2 pts; chronic renal failure=2 pts; diabetes with end organ damage=1 pt; pneumonia=1 pt), patients are categorized as Group A (0 pts), Group B (1-2 pts), Group C (3-5 pts), or Group D (≥6 pts).

†SUPPORT study prognostic model:

$$\text{SPS} = 259.9\{\text{ARF/MOSF}\} + 263.4\{\text{COPD/CHF}\} + 241.4\{\text{Cirrhosis/Coma}\} + 281.5\{\text{Lung/Colon Cancer}\} - 0.06174 \min(\text{PaO}_2/\text{Fio}_2, 225) - 0.6316 \min(\text{Mean BP}, 60) + 1.0205 \text{WBC} - 0.3676(\text{WBC} - 8)_+ - 0.5631(\text{WBC} - 11)_+ + 0.2691 \min(\text{Alb}, 4.6) + 0.2312 \text{Aresp} - 2.362 \text{Temp} + 1.326(\text{Temp} - 36.6)_+ + 2.473(\text{Temp} - 38.3)_+ - 1.579 \times 10^{-1} \text{HR} + 9.770 \times 10^{-5} (\text{HR} - 55)^3_+ - 2.189 \times 10^{-4} (\text{HR} - 80)^3_+ + 1.518 \times 10^{-4} (\text{HR} - 110)^3_+ - 3.062 \times 10^{-5} (\text{HR} - 149)^3_+ + 0.9763 \text{Bil} - 0.7481(\text{Bil} - 7)_+ - 6.8761 \text{Cr} + 11.6058(\text{Cr} - 0.600)^3_+ - 21.8413(\text{Cr} - 1.000)^3_+ + 10.3574(\text{Cr} - 1.500)^3_+ - 0.1219(\text{Cr} - 5.399)^3_+ - 0.6167096 \text{Na} + 0.0021118(\text{Na} - 128)^3_+ - 0.0036730(\text{Na} - 135)^3_+ + 0.0006126(\text{Na} - 139)^3_+ + 0.0009486(\text{Na} - 148)^3_+ - 6.278\{\text{COPD/CHF}\} \times \min(\text{Alb}, 4.6) - 11.45 \{\text{Lung/Colon Cancer}\} \times \min(\text{Alb}, 4.6) + \{\text{ARF/MOSF}\}[-2.3549 \text{WBC} + 2.7494 (\text{WBC} - 8)_+ - 0.4638 (\text{WBC} - 11)_+]$$

where {disease group} = 1 if subject is in the disease group, 0 otherwise, $(x)_+ = x$ if $x > 0$, 0 otherwise. For example, the term $0.4638 (\text{WBC} - 11)_+$ is ignored if $\text{WBC} < 11$. These terms are components of cubic spline functions. All measurements are made at day 3 except albumin (day 1). Alb: albumin; Aresp: APACHE III respiration score; Bil: bilirubin; Cr: creatinine; Na: sodium; P_aO_2 : partial pressure oxygen in arterial blood; Mean BP: mean arterial blood pressure; WBC: white blood cell count in thousands; Temp: temperature (Celsius); HR: heart rate per minute. Set $\text{WBC} = 9$ in $\text{WBC} < 9$ and the disease class is not ARF/MOSF. Set $\text{WBC} = 40$ if $\text{WBC} > 40$. Set $\text{Cr} = 15$ if $\text{Cr} > 15$.

Probability $\{T > t \text{ given disease class} = i\} = S_i(t)$,

where T = survival time in days, t = an arbitrary time, e is the base of the natural logarithm, and $X_\beta = -3.652 + 0.8353 \{\text{CHF}\} + 0.9257 \{\text{Cirrhosis}\} + 0.6287 \{\text{Lung Cancer}\} \pm 1.1803 \{\text{MOSF w/Malig}\} + 0.01434 \text{Scoma} \pm 0.01935 \text{Age} + 0.2413 \text{Cancer} - 1.863 [\text{Hday} + 3.4]^{-1} + 0.08121 \text{SPS} + \text{Age}[0.015261 \{\text{COPD/CHF/Cirrhosis}\} + 0.009047 \{\text{Coma}\} - 0.008294 \{\text{Cancer}\}] + \text{Age}[-0.012498 \{\text{CHF}\} - 0.004578 \{\text{Cirrhosis}\} - 0.001435 \{\text{Lung Cancer}\} - 0.013891 \{\text{MOSF w/Malig}\}]$ and {disease group} = 1 if subject is in the disease group, 0 otherwise.

Scoma = SUPPORT Coma Score (0-100); cancer = cancer by comorbidity or primary disease category (0 = no; 1 = present; 2 = metastatic); Hday = day in hospital when qualified for study; CHF = congestive heart failure; MOSF w/Malig = multiple organ system failure with malignancy; COPD = chronic obstructive pulmonary disease.

References

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