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<td>Alba 2013</td>
<td>• SR • Funding/Col: Vanier Canada Graduate Scholarship, administered by the Canadian Institutes of Health Research, Ottawa, ON, Canada; no Col • Search date: May 2012 • Databases: Medline, Embase, Cinahl, references • Study designs: no restrictions</td>
<td>• Eligibility criteria: Eligible articles enrolled adults (&gt;19 years) who were ambulatory patients with heart failure; used multivariable analysis (≥2 independent variables) to predict mortality or a composite outcome including mortality; reported &gt;30 deaths; reported results as a score, a prediction rule, or as a set of regression coefficients sufficient to make predictions for individual patients; and reported a measure of discrimination or calibration. They also included 5 externally validated models (independent cohort): - Heart Failure Survival Score: • 7 variables: ischemic cardiomyopathy, presence of intraventricular conduction delay (QRS &gt;120 ms), LVEF, resting heart rate, mean blood pressure, peak oxygen consumption, and serum sodium • Composite outcome of death, urgent heart transplantation and ventricular assist device implantation • 3 risk scores: high, medium, low • Derived from single-centre cohort (N=268) • Validated in 8 independent single-centre cohorts (N=2240) • c-statistic at 1y: range 0.56-0.79 - Seattle Heart Failure Model: • 10 continuous variables: age, LVEF, NYHA class, systolic blood pressure, diuretic dose adjusted by weight, lymphocyte count, hemoglobin, serum sodium, total cholesterol, and uric acid; 10 categorical variables: sex, ischemic cardiomyopathy, QRS&gt;120 ms, use of β-blockers, angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, potassium-sparing diuretic, statins and allopurinol, and ICD/CRT status • Composite outcome of death, urgent heart transplantation, and ventricular assist device • Continuous risk score, expressed as predicted mean life expectancy or event-free survival at 1, 2, and 5 years • Derived from RCT (N=1125)</td>
<td>• High-quality review • Duplicate study selection, but unclear if duplicate data extraction</td>
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|          | • N included studies: 32 (20 models, of which 5 were validated) | studies evaluating the performance of an existing score in a different population to the one from which it was developed, and reported model discrimination and calibration | • Validated in 14 independent cohorts (N=16057)  
- Frankenstein et al’s model:  
  2 variables: brain natriuretic peptide and 6-minute walk test with different cutoffs depending on sex and use of β-blockers  
  Outcome: all-cause mortality  
  3 risk score: 0, 1 or 2  
  Derived from single cohort (N=636)  
  Validated in independent cohort (N=676)  
  c-statistic: range 0.66-0.68 | |
|          | • No restrictions on study design, left ventricular ejection fraction (LVEF), language, or date of publication | They excluded studies that enrolled patients during hospital admission or duplicate studies providing no new relevant data | - PACE Risk Score:  
  4 variables: presence of peripheral vascular disease, age >70 years, creatinine >2 mg/dL, and LVEF <20%  
  Outcome: all-cause mortality  
  Continuous risk score from 0-5  
  Derived from single ICD cohort (N=905)  
  Validated in independent ICD cohort (N=1812)  
  c-statistic: 0.69 at 1y | |
|          | • They excluded studies that enrolled patients during hospital admission or duplicate studies providing no new relevant data | | - SHOCKED Predictors:  
  7 variables: age >75 years, NYHA class >II, atrial fibrillation, chronic obstructive pulmonary disease, chronic kidney disease, LVEF <20%, and diabetes mellitus  
  Outcome: 1-, 2-, 3- and 4-year survival (nomogram)  
  Continuous risk score from 0-400  
  Derived and validated from Medicare ICD cohort (N=27893)  
  c-statistic: 0.74 at 1y | |
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| Scrutinio 2014 | • Design: cohort study  
• Funding/Col: no CoI  
• Setting: unclear  
• Sample size: N=445  
• Duration: unclear | • Eligibility criteria: current hospitalization for worsening of chronic established HF, history of heart failure for at least 1 year, receiving chronic treatment with standard therapies, NYHA Class III/IV symptoms and evidence of severe left ventricular systolic dysfunction (left ventricular ejection fraction <= 0.30 as measured by two-dimensional echocardiography) at admission, and need for intravenous diuretic and/or inotropic treatment  
• Exclusion criteria: acute coronary syndromes or angina pectoris, recent cardiac surgical or percutaneous procedures, planned coronary revascularization, congenital heart disease, and valvular heart disease regardless of whether surgically | ADHF/NT-proBNP score  
- 8 variables: chronic obstructive pulmonary disease, systolic blood pressure, estimated glomerular filtration rate, serum sodium, hemoglobin concentration, NT-proBNP concentration, LVEF, moderate-to-severe tricuspid regurgitation  
- Outcome: cumulative mortality, 1y-mortality | c-statistic:  
Cumulative mortality:  
- 0.738 in overall cohort  
- 0.771 in patients aged 70 or less  
Post-discharge mortality:  
- 0.741 in overall cohort  
- 0.751 in patients aged 70 or less  
Adding prior (<=6 months) hospitalizations for HF to the score increased the c-statistic for post-discharge mortality to 0.759 in the overall cohort and to 0.774 in patients aged 70 or less | Level of evidence: high risk of bias  
• 9 patients lost-to-follow-up from 454 eligible patients  
• 364 patients were included in original study (179 in derivation cohort, 185 in validation cohort) |
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| Scruino 2015 | Design: cohort study | • Eligibility criteria: patients admitted for acute decompensation of chronic, established HF with NYHA III/IV symptoms and evidence of severe LV systolic dysfunction (LVEF ≤0.30 on 2-D echocardiography) at admission  
• A priori patient characteristics:  
  o Mean age: 63  
  o Male: 83.7%  
  o NYHA IV: 46%  
  o LVEF <= 20%: 37.1% | Updated ADHF/NT-proBNP score  
- 8 variables: chronic obstructive pulmonary disease, systolic blood pressure, estimated glomerular filtration rate, serum sodium, hemoglobin concentration, NT-proBNP concentration, LVEF, moderate-to-severe | c-statistic:  
90-day mortality: 0.81  
in-hospital mortality: 0.815 | Level of evidence: high risk of bias  
• 33 patients incomplete follow-up |
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| Uszko - Lence r 2017 | • Design: cohort study  
• Funding/CoI: clearly reported in article, many grants from pharmaceutical companies  
• Setting: university centre, Germany | • Eligibility criteria: patients diagnosed with heart failure  
• *A priori* patient characteristics:  
  o Mean age: 63.3y  
  o Male: 72%  
  o NYHA III/IV: 51.3%  
  o LVEF <= 45%: 88.1% | tricuspid regurgitation,  
- Adjusted for age and hospitalization for HF within the 6 months preceding the index admission  
- Outcome: all-cause mortality within 90d of admission | Significant differences between BARDICHE-risk groups for mortality (HR 3.63 per BARDICHE-group, 95%CI 3.10-4.25)  
Almost identical AUCs were shown between the BARDICHE and the MAGGIC-score regarding 2-year mortality (0.736 vs 0.738, p>0.9) | Level of evidence: high risk of bias  
• Model theoretically developed  
• Validated in dataset of 1811 patients: 602 from the TIME-CHF study and 1209 from a local cohort |
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| Salah 2014 | • Design: 7 prospective cohort studies  
• Funding/Col: competing interests reported  
• Setting: 7 cohort studies  
• Sample size: N=1301 (derivation cohort)  
• Duration: unclear | • Eligibility criteria: (1) admitted because of clinically validated ADHF, (2) discharged alive and (3) NT-proBNP measurements available at admission and at discharge  
• *A priori* patient characteristics:  
  o Median age: 74y  
  o Male: 60%  
  o NYHA IV: 0.3%  
  o LVEF <25%: 28% | heart rate, and 6-min walk test  
- Outcome: 5y all-cause survival  
- 3 risk categories: low, medium, high | Derivation cohort: c-statistic 0.76  
Validation cohort (N=325): 1y all-cause mortality, low risk 7%, intermediate risk 13%, high risk 24%, very high risk 52% (p<0.001) | Level of evidence: high risk of bias |
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<td>Pocock 2013</td>
<td>• Design: 30 studies, individual patient data • Funding/CoI: grants from the New Zealand National Heart Foundation, the University of Auckland, and the</td>
<td>• Eligibility criteria: patients with heart failure • <em>A priori</em> patient characteristics: alive vs. died ○ Mean age: 64.3 vs. 71.9y ○ Male: 69% vs. 65.1% ○ NYHA IV: 4.1% vs. 13.4% ○ Mean LVEF: 36.6% vs. 33.6%</td>
<td>MAGGIC - 13 variables: age, lower EF, NYHA class, serum creatinine, diabetes, not prescribed beta-blocker, lower systolic</td>
<td>No c-statistic reported Model goodness-of-fit: only reported in figure, no data reported 3y-mortality probability for score 10, 20, 30 and 40: 0.101, 0.256, 0.525, and 0.842, respectively</td>
<td>Level of evidence: low risk of bias</td>
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| Sartipy 2014 | Design: cohort study  
Funding/Col: Swedish  
Heart Lung Foundation (grant nos 20080409 and) | • Eligibility criteria: patients with clinician-judged heart failure  
• *A priori* patient characteristics: alive vs. died  
  - Mean age: 71.3 vs. 80.0y  
  - Male: 62% vs. 58%  | MAGGIC  
- 13 variables: age, lower LVEF, NYHA class, serum creatinine,  | Overall 3y mortality: 39.4%  
Predicted mortality: 36.4%  
c-statistic: 0.741 | Level of evidence: low risk of bias |
| University of Glasgow; no CoI | Setting:  
Sample size: N=39372  
Duration: median follow-up 2.5y | BP, lower body mass, time since diagnosis, current smoker, chronic obstructive pulmonary disease, male gender, and not prescribed ACE-inhibitor or angiotensin-receptor blockers  
- Outcome: 3y mortality  
- Integer score |  |  |  |
<p>| University of Glasgow; no CoI |  |  |  |  |  |
| University of Glasgow; no CoI |  |  |  |  |  |</p>
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<td>20100419</td>
<td>20100419 to L.H.L.) and the Stockholm County Council (grant no. 00556-2009 to L.H.L.); no CoI</td>
<td>NYHA IV: 2% vs. 9% &lt;br&gt;LVEF &lt;30%: 28% vs. 29%</td>
<td>diabetes, not prescribed beta-blocker, lower systolic BP, lower body mass, time since diagnosis, current smoker, chronic obstructive pulmonary disease, male gender, and not prescribed ACE-inhibitor or angiotensin-receptor blockers</td>
<td>High risk scores were associated with both all-cause mortality</td>
<td>Level of evidence: high</td>
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<tr>
<td>Bjurm an</td>
<td>• Design: prospective &lt;br&gt;• Eligibility criteria: patients with heart failure and Multimarker score</td>
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| 2015     | cohort study  
• Funding/CoI: supported by the Heart and Lung Foundation; no CoI  
• Setting: single university centre, Sweden  
• Sample size: N=124  
• Duration: 2010; 3y follow-up | reduced LVEF <50%  
• A priori patient characteristics: survived vs. died  
  o Mean age: 72 vs. 78y  
  o Male: 72% vs. 73%  
  o Mean LVEF: 35% vs. 33% | - 3 variables: age, serum troponin T, and serum cystatin C  
- Outcome: all-cause mortality, cardiovascular mortality  
- 3 risk groups: low, medium, high | mortality (HR 4.2, 95%CI 2.2-8.1, p<0.001) and CV mortality (HR 3.6, 95%CI 1.7-8.0, p = 0.0015) | risk of bias  
• Validation cohort |
| Hussa in 2014 | Design: cohort study  
• Funding/CoI: not reported  
• Setting: single centre, Pakistan  
• Sample size: N=118  
• Duration: 1y follow-up | Eligibility criteria: patients with systolic heart failure, LVEF <40%  
• A priori patient characteristics: intervention vs. control  
  o Mean age: 41.6y  
  o Male: 73.7%  
  o NYHA III/IV: 97.5%  
  o Mean LVEF: 23% | Seattle Heart Failure Model  
- 10 continuous variables: age, LVEF, NYHA class, systolic blood pressure, diuretic dose adjusted by weight, | AUC for 1y mortality: 0.802 | Level of evidence: high risk of bias |
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<td>lymphocyte count, hemoglobin, serum sodium, total cholesterol, and uric acid; 10 categorical variables: sex, ischemic cardiomyopathy, QRS&gt;120 ms, use of β-blockers, angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, potassium-sparing diuretic, statins and allopurinol, and ICD/CRT</td>
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| Shirai shi 2016 | • Design: cohort study  
• Funding/CoI: supported by JPSS KAKENHI Grant Number 23591062; one author with links with Pfizer and Bayer Pharmaceutical Co.  
• Setting: single university centre, Japan  
• Sample size: N=504  
• Duration: Apr 2006 – Aug 2014; mean follow-up 763d | • Eligibility criteria: patients hospitalised because of acute heart failure  
• A priori patient characteristics:  
  o Mean age: 68y  
  o Male: 68%  
  o Mean NYHA class: 2.2  
  o Median LVEF: 35% | Seattle Heart Failure Model  
- 10 continuous variables: age, LVEF, NYHA class, systolic blood pressure, diuretic dose adjusted by weight, lymphocyte count, hemoglobin, serum sodium, total cholesterol, and uric acid; 10 categorical variables: sex, ischemic | c-statistic:  
- 1y post-discharge survival: 0.666  
- 2y post-discharge survival: 0.721 | Level of evidence: high risk of bias  
• 12 patients died during hospitalisation (excluded) |
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- **Model**: cardiomyopathy, QRS>120 ms, use of β-blockers, angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, potassium-sparing diuretic, statins and allopurinol, and ICD/CRT status.

- **Outcome**: 1y, 2y and 3y mortality.

**Abbreviations**: 95%CI: 95% confidence interval; AUC: area under the curve; CoI: conflicts of interest; CRT: cardiac resynchronization therapy; ICD: implantable cardioverter-defibrillator; LVEF: left ventricular ejection fraction; MA: meta-analysis; MD: mean difference; NS: not significant; NYHA: New York Heart Association; QOL: quality of life; RCT: randomized controlled trial; SR: systematic review.

**References**
