Readmissions in patients with heart failure: predictors, patterns and controversies

Alex Bottle

Senior Lecturer in Medical Statistics
Dr Foster Unit at Imperial College London
robert.bottle@imperial.ac.uk
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Failures
Talk outline

• The context: HF and multimorbidity
• The issues: how should readmission be measured? What drives readmission rates?
• Research questions for our 3 studies
• Methods and Results for each
• Summary so far and further questions
Background: heart failure

- Heart muscle too stiff or weak
- Various causes: CHD, HT, heart valve disease, AF, alc/drug abuse…
- 900,000 pts in UK, mostly elderly
- Accounts for 2% of direct NHS costs
- A GP has mean of 30 HF pts and suspects a new dx of HF in perhaps 10 annually [NICE 2010]
- Chronic, with high mortality
- National Audit: care quality and outcomes v variable by ward, centre. Many readms thought “unnecessary”, but prevention hard!
Background: readmissions in heart failure patients

- HF admissions rising due to ageing
- Evidence suggests that many readms are “avoidable” as due to poor discharge planning, meds reconciliation, primary care
- CMS now penalise >2000 hospitals with high all-cause readm30 rates for AMI, HF, pneum
- Why 30 days? No biological reason; no neat cut-off can separate “preventable” from not — and some readms are necessary. Shorter times relate more to hospital than GP etc
- Why all causes? Power, pt focused, but could be a mixed bag for hospitals to use as QI
Background: are unplanned readmissions avoidable?

- CMAJ (2011) looked at 6-month readms in 11 hospitals for various types of AE: 16% of readms thereby classified as “preventable”
- All-cause and “preventable” readm rates at hospital level correlated (rho=0.29) but NSS (p=0.38)
- Limitations: reviewer diffs; cut-off for “preventable”; v few hosps in study
Are readmissions in HF patients preventable?

- CMS thinks so!
- Various studies show link between IP and OP processes and readm
- Syst rev & meta-analysis of 47 RCTs of transitional care: home-visiting programmes and multidisciplinary HF clinics reduced all-cause readmission (RR=0.75) and mort; struc phone support but not telemonitoring reduced HF-specific readmission and mort
Questions for the three studies

• What are the patient-level predictors of readms in HF patients?
• Same for 7d as for 365d?
• Same for HF and non-HF readms?
• Do post-discharge deaths invalidate readm measures (competing risks)?
• Do audit process figures correlate with readm rates? If so, which?
• Do count models tell us anything else?
Study 1 definition of patient cohorts and outcomes

- Patients whose first-ever HF adm occurred in 2008/9 or 2009/10 ended in live discharge
- Track forwards in time to get NEXT unplanned adm and ONS date of death if any. Follow up for 365 days then stop
- Define readm7, readm30, ..., readm365 for i) diag1=I50 on readm and ii) any other diag1
Analysis for study 1

• Find predictors of readmT by diag1 of readm
• Compare results for each T and diag1
• Compare logistic regression with survival analysis (two types)
Covariates considered

• Age, sex, deprivation, various comorbs
• Index adm LOS
• # OPD appts missed in previous yr
• # OPD appts attended in previous yr
• Ops: CABG, PTCA, defib imp, CRT, pacing
STUDY 1: PATIENT-LEVEL RESULTS
Results: basic numbers

• 84,212 pts, of which 14,104 (16%) died during the index admission and were excluded -> 70,108
• Of these, 29% died during the one year of follow-up, giving overall mortality rate of 40% within one year of first HF adm
• Half readmitted within that year
• Pts had an average of 3 comorbidities
• Only 31% (7d) and 21% (365d) readms had HF as primary dx for the readm
### Selected demographics of each cohort

<table>
<thead>
<tr>
<th>Factor</th>
<th>Value</th>
<th>Pts</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group</td>
<td>65-84</td>
<td>39302</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>85+</td>
<td>21919</td>
<td>31</td>
</tr>
<tr>
<td>Sex</td>
<td>Female</td>
<td>34691</td>
<td>50</td>
</tr>
<tr>
<td>Number of emergency adms in previous year</td>
<td>1 or more</td>
<td>31739</td>
<td>45</td>
</tr>
<tr>
<td># prior OPD appts that pt missed in previous year</td>
<td>1 or more</td>
<td>15150</td>
<td>22</td>
</tr>
<tr>
<td>Ischaemic heart disease</td>
<td>yes</td>
<td>27567</td>
<td>39</td>
</tr>
<tr>
<td>Arrhythmias</td>
<td>yes</td>
<td>32575</td>
<td>47</td>
</tr>
<tr>
<td>Heart valve disorders</td>
<td>yes</td>
<td>11613</td>
<td>17</td>
</tr>
<tr>
<td>Hypertension</td>
<td>yes</td>
<td>33592</td>
<td>48</td>
</tr>
<tr>
<td>Diabetes</td>
<td>yes</td>
<td>18622</td>
<td>27</td>
</tr>
<tr>
<td>Chronic lung disease</td>
<td>yes</td>
<td>13883</td>
<td>20</td>
</tr>
</tbody>
</table>
## Results: 30-day readmission odds ratios (selected)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Value</th>
<th>OR (HF)</th>
<th>P</th>
<th>OR (nHF)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (cf 65-69)</td>
<td>90+</td>
<td>1.16 (0.98 to 1.37)</td>
<td>0.079</td>
<td>1.19 (1.06 to 1.32)</td>
<td>0.002</td>
</tr>
<tr>
<td>Deprivation (cf quintile 1)</td>
<td>5</td>
<td>1.16 (1.03 to 1.31)</td>
<td>0.013</td>
<td>1.09 (1.01 to 1.18)</td>
<td>0.028</td>
</tr>
<tr>
<td>Prior PTCA</td>
<td>Yes</td>
<td>1.27 (1.03 to 1.57)</td>
<td>0.027</td>
<td>1.18 (1.02 to 1.37)</td>
<td>0.028</td>
</tr>
<tr>
<td>Prior defib</td>
<td>Yes</td>
<td>0.60 (0.39 to 0.91)</td>
<td>0.015</td>
<td>0.81 (0.63 to 1.02)</td>
<td>0.077</td>
</tr>
<tr>
<td>Prior OPD appts attended</td>
<td>Per appt</td>
<td>1.01 (0.99 to 1.03)</td>
<td>0.337</td>
<td>1.03 (1.01 to 1.04)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Prior OPD DNAs</td>
<td>Per appt</td>
<td>1.05 (1.01 to 1.09)</td>
<td>0.023</td>
<td>1.10 (1.07 to 1.13)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Index LOS (cf 0)</td>
<td>3+</td>
<td>0.70 (0.61 to 0.80)</td>
<td>&lt;0.001</td>
<td>1.04 (0.94 to 1.14)</td>
<td>0.485</td>
</tr>
<tr>
<td>Arrhythmias</td>
<td>yes</td>
<td>1.13 (1.06 to 1.22)</td>
<td>&lt;0.001</td>
<td>0.98 (0.94 to 1.03)</td>
<td>0.390</td>
</tr>
<tr>
<td>Renal disease</td>
<td>yes</td>
<td>1.39 (1.28 to 1.51)</td>
<td>&lt;0.001</td>
<td>1.19 (1.13 to 1.26)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Any mental health condition</td>
<td>yes</td>
<td>1.11 (0.98 to 1.27)</td>
<td>0.104</td>
<td>1.25 (1.15 to 1.35)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Heart valve disorders</td>
<td>yes</td>
<td>1.12 (1.03 to 1.22)</td>
<td>0.007</td>
<td>1.03 (0.97 to 1.09)</td>
<td>0.348</td>
</tr>
</tbody>
</table>
Index LOS more imp for HF readms and soon after discharge
Summary of patient-level readm analyses

- Post-discharge death did not seem to invalidate logistic regression (phew)
- Predictors except LOS were the same for follow-up lengths from 7 to 365d
- Very short index LOS associated with higher odds especially for HF readms short term
- Some predictors differed by readm dx
- Prior OPD non-attendance strongly associated with readm
STUDY 2: HOSPITAL-LEVEL CORRELATIONS
Study 2 rationale and aims

• Given that some readm predictors vary by readm dx and that most readms in HF pts are for non-HF dxx, do hospital-level readm rates split by readm dx correlate?

• Which (if any) type of readm rates correlate with HF process measures from the national HF 2011 audit?
Methods

• 105,441 index HF live discharges for 2009/10 to 2011/12, adults only
• Risk-adjusted readm7 and readm30 rates calculated, split by dx as before
• Published 2011 national HF audit results available for 124 hospitals: correlations (linear and non) with readm rates
Funnel plot – dx-specific plots look similar

7 day all-cause readmissions

Total number of Hospitals = 147
Total number of 7 day all-cause readmissions = 6843
30 day all cause readmissions

Total number of Hospitals = 147
Total number of 30 day all cause readmissions = 20113
### Correlation between HF and non-HF readmission rates

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Correlation coefficient</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HF v non-HF readms within 7 days</td>
<td>+0.24</td>
<td>0.004</td>
</tr>
<tr>
<td>HF v non-HF readms within 30 days</td>
<td>+0.13</td>
<td>0.123</td>
</tr>
<tr>
<td>HF v non-HF readms within 365 days</td>
<td>-0.03</td>
<td>0.70</td>
</tr>
</tbody>
</table>
### Correlation between audit measures and readm rates

<table>
<thead>
<tr>
<th>Percentage of patients:</th>
<th>7d for HF</th>
<th>7d not for HF</th>
<th>30d for HF</th>
<th>30d not for HF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Given ACEI or ARB on discharge</td>
<td>-0.18 (0.041)</td>
<td>-0.07 (0.437)</td>
<td>-0.21 (0.023)</td>
<td>-0.05 (0.604)</td>
</tr>
<tr>
<td>Given beta blocker on discharge</td>
<td>-0.24 (0.007)</td>
<td>-0.07 (0.463)</td>
<td>-0.25 (0.005)</td>
<td>-0.06 (0.485)</td>
</tr>
<tr>
<td>Referred to cardiology follow-up</td>
<td>-0.26 (0.004)</td>
<td>-0.16 (0.085)</td>
<td>-0.09 (0.318)</td>
<td>-0.21 (0.021)</td>
</tr>
<tr>
<td>Treated as cardiology inpatient</td>
<td>-0.26 (0.003)</td>
<td>-0.02 (0.808)</td>
<td>-0.20 (0.027)</td>
<td>-0.07 (0.418)</td>
</tr>
<tr>
<td>Received echo</td>
<td>-0.19 (0.036)</td>
<td>+0.08 (0.354)</td>
<td>-0.07 (0.440)</td>
<td>-0.02 (0.842)</td>
</tr>
<tr>
<td>Referred to HF liaison</td>
<td>-0.24 (0.008)</td>
<td>+0.04 (0.680)</td>
<td>-0.11 (0.244)</td>
<td>+0.11 (0.206)</td>
</tr>
</tbody>
</table>

124 out of 148 acute trusts returned audit figures and were included.
Some points on study 2

- Funnel plots show bit > random var
- HF v non-HF readm rates corr at 7d only and weakly
- Care processes corr with HF readm rates only, esp at 7d, and weakly
- Consistent with impt role for primary care esp beyond 7d post-discharge
STUDY 3: COUNT MODELS
Study 3 background and questions

• 30-day readm models have low discrimination (c=0.60): do count models do better or give us more info?
• 50% readmitted within a yr, sometimes multiple times: ‘frequent fliers’
• Aim: compare usual readm30 with count models and ‘bucket’ models from economics
Methods

- Cohort: 3 years of index HF adms in adults
- Outcomes: first readm within 30d, # readms within 365d, bed days within 365d, membership of top 1 or 2 ‘buckets’ (i.e. high resource use)
- Unplanned activity only
- Stats: logistic regression for readm30 and buckets, Poisson and neg bin (ZI and non, hurdle and non) for counts
Stats slide: why count models?

- Standard distributions have nice properties, but biology doesn’t always fit them… often more var than expected
- Many pts had no more hospital use
- Neg bin relaxes mean=var of Poisson
- ZI and hurdle capture excess zeroes: ZI allows always zero and possibly zero; hurdle is two-staged (0 use and >0 use)
Results: basic numbers

- 105,106 patients discharged alive
- 24% died during the following year
- 56% had any emerg readm: 59,154 first readms + 61,529 subsequent readms = 120,000 readms overall
- Half of all bed days within the year were accrued in the first readmission
- Just 1 in 5 readms was for HF
Which model fitted the data best for # readms?
And for # bed days within a year of discharge?
What count models tell us: age

- Young more likely to have no readms or bed days – but if readmitted they were more likely to have multiple readms.
- Old more likely to be readmitted once but not more than once. More likely to be in high-use bucket, so they accrue bed days by one long readm rather than several shorter ones.
Other results

- Renal disease, pneumonia and mental health dxx predicted all outcomes
- Prior OPD appts attended and esp missed predicted most outcomes
- DM, COPD, ischaemic heart disease, PVD, deprivation, living alone assoc with multiple readms
- 0-day index LOS -> higher readm30 odds, but long stays -> long future stays
Summary of the three studies

1: Some comorbs have diff assocs with readms for HF than for non-HF. Time to readm and post-discharge deaths not that imp
t
2: Funnel plots of rates are not quite in control. Modest corrs between readm rates for HF and for non-HF at 7d have gone by 30d. Process performance corr only with HF readms
3: Count and bucket models perform a bit better than readm30 and tell us some (but not many) useful extra things
Some potential further analyses with HES

• OPD atts added value to analysis: could look at follow-up patterns and relation to outcomes
• A&E atts improved coverage recently: use in combo with readms (e.g. conversion rate, time of week/day)
• Look for ‘clusters’ of patients from their NHS contacts. Do high users drive high hospital-level readm rates?
Conclusions

• Some predictors differ by readm dx, HF readms don’t correlate with 30-day non-HF readms, and care processes only correlate with HF readms, so using all-cause loses info for QI

• HES has socio-economic vars that predict outcomes, e.g. OPD DNAs

• Primary care activity is the big missing piece – CPRD?