Nurse-led multifactorial care in community-dwelling older people
van Rijn, M.

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Changes in the in-hospital mortality and 30-day post-discharge mortality in acutely admitted older patients: retrospective observational study

Marjon van Rijn
Bianca M. Buurman
Janet L. MacNeil Vroomen
Jacqueline J.M. Suijker
Gerben ter Riet
Eric P. Moll van Charante
Sophia E.J.A. de Rooij

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Abstract

Objectives: To compare changes over time in the in-hospital mortality and the mortality from discharge to 30 days post-discharge for six highly prevalent discharge diagnoses in acutely admitted older patients as well as to assess the effect of separately analysing the in-hospital mortality and the mortality from discharge to 30 days post-discharge.

Study design and setting: Retrospective analysis of Dutch hospital and mortality data collected between 2000 and 2010.

Subjects: The participants included 263,746 people, aged 65 years and above, who were acutely admitted for acute myocardial infarction (AMI), heart failure (HF), stroke, chronic obstructive pulmonary disease, pneumonia or hip fracture.

Methods: We compared changes in the in-hospital mortality and mortality from discharge to 30 days post-discharge in the Netherlands using a logistic- and a multinomial regression model.

Results: For all six diagnoses, the mortality from admission to 30 days post-discharge declined between 2000 and 2009. The decline ranged from a relative risk ratio (RRR) of 0.41 (95% confidence interval (CI) 0.38–0.45) for AMI to 0.77 (0.73–0.82) for HF. In separate analyses, the in-hospital mortality decreased for all six diagnoses. The mortality from discharge to 30 days post-discharge in 2009 compared to 2000 depended on the diagnosis, and either declined, remained unchanged or increased.

Conclusions: The decline in hospital mortality in acutely admitted older patients was largely attributable to the lower in-hospital mortality, while the change in the mortality from discharge to 30 days post-discharge depended on the diagnosis. Separately reporting the two rate estimates might be more informative than providing an overall hospital mortality rate.
Introduction

Since the implementation of the hospitalised standardised mortality ratio (HSMR) in the Netherlands, hospitals report their mortality rates on an annual basis as an indicator for the quality and safety of their patient care. The HSMR is currently focused on the inpatient period, but this scope might be too limited. In recent decades, several studies have focused on broadening the hospital mortality ratios to 30-day post-discharge mortality ratios. Most researchers conclude that the hospital mortality rates should not be focused on the in-hospital period alone because these may be affected by differences in the discharge policies. Hospitals with a shorter length of stay (LOS) might have better results for the hospital mortality ratios, whereas hospitals with a palliative care unit perform worse.

In addition to discharge policies, different patient groups affect the mortality rates. For example, acutely hospitalised older patients have in-hospital mortality rates ranging from 7 to 25%. Increased age, functional disabilities upon admission, multimorbidity and pre-existing cognitive impairment are associated with both higher in-hospital and post-discharge mortality rates. In the past two decades, hospitals in the Netherlands have implemented improved treatment strategies. System-wide interventions to identify older patients who are at risk for functional decline and medication reconciliation have contributed to a decline in the in-hospital mortality of older patients.

At the same time, the mean LOS decreased from weeks to days. Nordström et al. concluded that a shorter LOS for patients with a hip fracture is associated with an increased post-discharge mortality rate among patients with a LOS of 10 days or less. However, the influence of improved treatment strategies and new patient safety procedures on the in-hospital and 30-day post-discharge mortality for the most common acute diagnoses in older patients is unknown. Therefore, the aims of this study are (i) to separately compare the changes over time in the in-hospital mortality and mortality from discharge to 30 days post-discharge for acute myocardial infarction, heart failure, stroke, chronic obstructive pulmonary disease, pneumonia and hip fracture in acutely admitted older patients and (ii) to assess the effect of separately analysing the in-hospital mortality and the mortality from discharge to 30 days post-discharge.

Methods

Data

Data on hospital admissions were retrieved from the Dutch Hospital Discharge Register (LMR). The LMR has a national coverage with missing values of less than 5% before 2006, 10.5% in 2006 and 12.7% in 2009 respectively. Data on the type of hospital, hospital admission dates, main (discharge) diagnoses
and secondary diagnoses, acute and elective admissions, discharge dates, length of hospital stay, sex, age and mortality are stored in this database. Statistics Netherlands linked records from the LMR to the Dutch population register. The Dutch population register contains personal characteristics of all persons registered in the Netherlands. More than 85% of all hospital discharges in the LMR were successfully linked, at the patient level, to the population register. To retrieve the date of death, we linked the LMR to the Causes of Death Registry (CDR). The CDR is maintained by the Statistics Netherlands and collects data on all Dutch deceased patients as well as documents the patients’ places of death, primary causes of death, and up to three secondary causes of death.

**Population**

The study population included acutely admitted patients, aged 65 years or older, with a first index hospitalisation in the years 2000, 2003, 2006 or 2009. Eligible patients had an acute hospitalisation for either acute myocardial infarction (AMI), heart failure (HF), stroke, chronic obstructive pulmonary disease (COPD), pneumonia or hip fracture based on their discharge diagnoses. The LMR uses the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9 CM) to register the discharge diagnosis. Table 1 shows the codes of the selected discharge diagnoses. If a person was acutely admitted more than once during the single index year, the first acute hospitalisation was included (Fig A-1.), although a new first index admission was selected every index year; therefore, an individual patient could have been included more than once in the complete dataset.

**Outcome measures and covariates**

To compute the mortality from discharge to 30 days post-discharge, the time of discharge was subtracted from the time of death. Covariates in our final model were, where possible, according to previous literature on standardised hospital mortality ratios. Age, sex, LOS in days, type of hospital (academic versus non-academic), socioeconomic status score and Charlson comorbidities were included as covariates in our final model. The socioeconomic status scores (SES) were calculated by the Netherlands Institute for Social Research and include the average income in a district, the percentage of people with low incomes, the percentage of people with low education level and the percentage of people not working. Through factor analysis, these variables are summarised into one variable. At discharge, the main (primary) diagnosis of the admission and up to 10 secondary diagnoses can be registered. From the primary and the secondary diagnoses a comorbidity score was derived by converting all diagnosis codes into the 17 clinical conditions that are used in the Charlson comorbidity index.
Table 1. Characteristics of patients acutely admitted according to discharge diagnoses and year of discharge

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>ICD-9 CM Code</th>
<th>Year</th>
<th>N</th>
<th>Sex (F)</th>
<th>Age (mean, SD)</th>
<th>Length of stay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myocardial infarction</td>
<td>410</td>
<td>2000</td>
<td>11,083</td>
<td>4,615 (41.6)</td>
<td>75.6 (6.8)</td>
<td>9 (6–12)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2003</td>
<td>10,538</td>
<td>4,524 (42.9)</td>
<td>76.3 (7.1)</td>
<td>8 (5–12)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006</td>
<td>8,125</td>
<td>3,503 (43.1)</td>
<td>76.8 (7.4)</td>
<td>7 (4–11)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2009</td>
<td>8,468</td>
<td>3,482 (41.1)</td>
<td>76.7 (7.5)</td>
<td>5 (5–9)</td>
</tr>
<tr>
<td>Heart failure</td>
<td>428</td>
<td>2000</td>
<td>13,216</td>
<td>6,908 (52.3)</td>
<td>78.9 (7.2)</td>
<td>9 (6–15)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2003</td>
<td>13,208</td>
<td>6,990 (52.9)</td>
<td>79.3 (7.2)</td>
<td>9 (5–15)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006</td>
<td>12,721</td>
<td>6,873 (54.0)</td>
<td>80.2 (7.4)</td>
<td>9 (5–14)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2009</td>
<td>13,893</td>
<td>7,519 (54.1)</td>
<td>80.6 (7.4)</td>
<td>8 (4–12)</td>
</tr>
<tr>
<td>Stroke</td>
<td>430–434, 436–438</td>
<td>2000</td>
<td>12,836</td>
<td>6,895 (53.7)</td>
<td>77.4 (7.1)</td>
<td>14 (7–30)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2003</td>
<td>14,080</td>
<td>7,588 (53.9)</td>
<td>77.8 (7.1)</td>
<td>12 (6–22)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006</td>
<td>13,798</td>
<td>7,259 (52.6)</td>
<td>78.4 (7.3)</td>
<td>10 (5–17)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2009</td>
<td>13,895</td>
<td>7,484 (53.9)</td>
<td>78.6 (7.4)</td>
<td>8 (4–14)</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease</td>
<td>490–492, 493, 494, 496</td>
<td>2000</td>
<td>7,858</td>
<td>3,094 (39.4)</td>
<td>75.6 (6.5)</td>
<td>12 (8–17)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2003</td>
<td>7,524</td>
<td>3,046 (40.5)</td>
<td>75.8 (6.4)</td>
<td>11 (7–15)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006</td>
<td>6,961</td>
<td>3,054 (43.9)</td>
<td>76.3 (6.6)</td>
<td>10 (7–14)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2009</td>
<td>7,280</td>
<td>3,269 (44.9)</td>
<td>76.6 (6.8)</td>
<td>8 (6–12)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>480–486</td>
<td>2000</td>
<td>7,457</td>
<td>3,016 (40.4)</td>
<td>78.0 (7.4)</td>
<td>12 (8–18)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2003</td>
<td>9,209</td>
<td>3,729 (40.5)</td>
<td>78.0 (7.4)</td>
<td>11 (7–16)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006</td>
<td>10,689</td>
<td>4,437 (41.5)</td>
<td>78.5 (7.6)</td>
<td>10 (7–15)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2009</td>
<td>13,040</td>
<td>5,535 (42.4)</td>
<td>78.8 (7.7)</td>
<td>9 (6–13)</td>
</tr>
<tr>
<td>Hip fracture</td>
<td>820, 821</td>
<td>2000</td>
<td>11,692</td>
<td>9,064 (77.5)</td>
<td>81.6 (7.5)</td>
<td>16 (10–27)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2003</td>
<td>12,511</td>
<td>9,570 (76.5)</td>
<td>81.9 (7.4)</td>
<td>14 (9–23)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2006</td>
<td>11,429</td>
<td>8,610 (75.3)</td>
<td>82.4 (7.5)</td>
<td>12 (8–19)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2009</td>
<td>12,235</td>
<td>9,068 (74.1)</td>
<td>82.3 (7.6)</td>
<td>10 (7–15)</td>
</tr>
</tbody>
</table>
Statistical analysis

Descriptive analyses were performed for each year to characterise the population. Separate analyses were performed for AMI, HF, stroke, COPD, pneumonia and hip fracture. We calculated the unadjusted percentages of observed in-hospital mortality and mortality from discharge to 30 days post-discharge at 3-year time intervals between 2000 and 2009. Logistic regression analyses were performed to compare the probabilities of dying from the start of an acute hospitalisation to 30-days post-discharge in 2009 compared to 2000.

To compare the time-trends in the in-hospital mortality and mortality from discharge to 30 days post-discharge, multinomial regression analyses were performed, and those patients who were alive at 30-days post-discharge were included in the reference category. We included age, sex, LOS type of hospital, SES and Charlson comorbidities in our final adjusted model. A P-value of <0.05 was used as threshold for statistical significance. All analyses were performed with SPSS 20 software (SPSS Inc., Chicago, IL, USA).

Results

A total of 263,746 patients were included. Table 1 reports the socio-demographic characteristics of the patients who were acutely admitted in 2000, 2003, 2006 and 2009. The most prevalent acute discharge diagnoses were stroke (2009: n = 13,895) and HF (2009: n = 13,893). From 2000 to 2009, the absolute number of hospitalisations for patients with a discharge diagnosis of AMI decreased by 24%, whereas an increase of 75% was observed for a discharge diagnosis of pneumonia. Between 2000 and 2009, we observed an overall increase in the patients’ mean age at admission. Older patients with HF had the largest mean difference in age between 2000 and 2009 (+1.7 years). For all diagnoses, the LOS decreased. The largest reductions in the LOS were found for stroke; there was a mean difference between 2000 and 2009 of −14.2 days. The lowest decline was found for AMI (−3.2 days).

Unadjusted percentages in the in-hospital mortality and mortality from discharge to 30 days post-discharge

The unadjusted percentages of in-hospital mortality and mortality from discharge to 30 days post-discharge for each diagnosis group are shown in Figure 1. A decline in the in-hospital mortality between 2000 and 2009 was observed for all diagnoses. The largest decline was observed for stroke; in 2000, 29% (n = 3,701) of older patients who were acutely admitted for AMI died in the hospital, whereas in 2009, 17% (n = 2,373) died in the hospital. Minimal differences were found in the unadjusted percentages of the 30-day post-discharge mortality between 2000 and 2009; the largest difference was found for stroke, and the percentages for stroke changed from 3% (n = 448)
Figure 1. The unadjusted percentages of in-hospital mortality and mortality from discharge to 30 days post-discharge Absolute percentages of in-hospital mortality and 30-day post-discharge mortality between 2000 and 2009 for acute myocardial infarction, heart failure, stroke, pneumonia, chronic obstructive pulmonary disease (COPD) and hip fracture. Trendlines between years show the slope of unadjusted in-hospital mortality percentages and 30-day post-discharge mortality.

Changes in the in-hospital mortality and 30-day post-discharge mortality | Chapter 8
### Table 2. Multinomial regression for in-hospital mortality, mortality from discharge to 30 days post-discharge, and survival

<table>
<thead>
<tr>
<th>Year</th>
<th>In-hospital mortality (versus survival)</th>
<th>30-day post-discharge mortality (versus survival)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unadjusted</td>
<td>Adjusted*</td>
</tr>
<tr>
<td></td>
<td>Relative risk ratio (95% CI)</td>
<td>P</td>
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<td>P</td>
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<td>P</td>
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<td></td>
<td></td>
<td>P</td>
</tr>
</tbody>
</table>

#### Acute myocardial infarction
- **2000**: Ref (-)  (Ref (-))  (Ref (-))  (Ref (-))
- **2003**: 0.902 (0.841–0.968)  0.004  0.799 (0.741–0.861)  ≤0.001  1.045 (0.908–1.203)  0.540  0.968 (0.839–1.117)  0.664
- **2006**: 0.729 (0.673–0.789)  ≤0.001  0.572 (0.525–0.624)  ≤0.001  0.915 (0.784–1.068)  0.261  0.828 (0.706–0.972)  0.020
- **2009**: 0.486 (0.445–0.530)  ≤0.001  0.339 (0.308–0.373)  ≤0.001  0.859 (0.736–1.001)  0.051  0.754 (0.640–0.889)  ≤0.001

#### Heart failure
- **2000**: Ref (-)  (Ref (-))  (Ref (-))  (Ref (-))
- **2003**: 0.916 (0.858–0.978)  0.008  0.900 (0.841–0.962)  0.002  1.178 (1.063–1.305)  0.002  1.211 (1.091–1.344)  ≤0.001
- **2006**: 0.771 (0.720–0.826)  ≤0.001  0.745 (0.695–0.800)  ≤0.001  1.108 (0.998–1.229)  0.054  1.149 (1.032–1.279)  0.011
- **2009**: 0.722 (0.675–0.773)  ≤0.001  0.665 (0.619–0.714)  ≤0.001  1.076 (0.972–1.192)  0.159  1.116 (1.002–1.243)  0.045

#### Stroke
- **2000**: Ref (-)  (Ref (-))  (Ref (-))  (Ref (-))
- **2003**: 0.754 (0.713–0.797)  ≤0.001  0.626 (0.591–0.663)  ≤0.001  1.272 (1.125–1.439)  ≤0.001  1.330 (1.171–1.521)  ≤0.001
- **2006**: 0.572 (0.540–0.606)  ≤0.001  0.416 (0.391–0.443)  ≤0.001  1.326 (1.174–1.497)  ≤0.001  1.370 (1.204–1.560)  ≤0.001
- **2009**: 0.517 (0.488–0.548)  ≤0.001  0.347 (0.325–0.370)  ≤0.001  1.354 (1.200–1.527)  ≤0.001  1.356 (1.189–1.547)  ≤0.001

#### COPD
- **2000**: Ref (-)  (Ref (-))  (Ref (-))  (Ref (-))
- **2003**: 0.892 (0.805–0.990)  0.023  0.884 (0.796–0.983)  0.019  1.015 (0.872–1.182)  0.847  1.051 (0.900–1.227)  0.531
- **2006**: 0.688 (0.615–0.770)  ≤0.001  0.685 (0.610–0.769)  ≤0.001  0.952 (0.813–1.113)  0.535  0.955 (0.846–1.170)  0.948
- **2009**: 0.594 (0.530–0.667)  ≤0.001  0.575 (0.509–0.649)  ≤0.001  0.913 (0.781–1.067)  0.253  0.959 (0.813–1.131)  0.619

#### Pneumonia
- **2000**: Ref (-)  (Ref (-))  (Ref (-))  (Ref (-))
- **2003**: 0.884 (0.818–0.955)  ≤0.001  0.857 (0.791–0.928)  ≤0.001  1.003 (0.871–1.155)  0.965  1.047 (0.907–1.209)  0.527
- **2006**: 0.676 (0.625–0.730)  ≤0.001  0.649 (0.599–0.704)  ≤0.001  1.050 (0.918–1.201)  0.477  1.131 (0.984–1.299)  0.082
- **2009**: 0.631 (0.586–0.681)  ≤0.001  0.596 (0.525–0.617)  ≤0.001  1.046 (0.919–1.191)  0.493  1.088 (0.949–1.248)  0.226
Table 2. Continued

<table>
<thead>
<tr>
<th>Year</th>
<th>Unadjusted</th>
<th>Adjusted*</th>
<th>Unadjusted</th>
<th>Adjusted*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In-hospital mortality (versus survival)</td>
<td>30-day post-discharge mortality (versus survival)</td>
<td>30-day post-discharge mortality (versus survival)</td>
<td>30-day post-discharge mortality (versus survival)</td>
</tr>
<tr>
<td></td>
<td>Relative risk ratio (95% CI)</td>
<td>P</td>
<td>Relative risk ratio (95% CI)</td>
<td>P</td>
</tr>
<tr>
<td>2003</td>
<td>0.81 (0.749–0.880)</td>
<td>≤0.001</td>
<td>0.82 (0.769–0.880)</td>
<td>≤0.001</td>
</tr>
<tr>
<td>2006</td>
<td>0.69 (0.603–0.779)</td>
<td>≤0.001</td>
<td>0.59 (0.506–0.606)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>2009</td>
<td>0.55 (0.497–0.606)</td>
<td>&lt;0.001</td>
<td>0.52 (0.469–0.586)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

*Final adjusted models were adjusted for age, sex, LOS in days, type of hospital, socioeconomic status score and Charlson comorbidities. A P-value of <0.05 was used as threshold for statistical significance.

In 2000 to 5% (n = 752) in 2009.

Trends over time in the mortality from admission to 30 days post-discharge

Between 2000 and 2009, the adjusted relative risk ratios (RRR) for mortality from admission to 30 days post-discharge decreased for all discharge diagnoses. For all discharge diagnoses, mortality from admission to 30 days post-discharge was lower in 2009 than in 2000. The adjusted RRRs in 2009 were 0.41 (95% CI 0.38–0.45) for AMI, 0.77 (95% CI 0.73–0.82) for HF, 0.44 (95% CI 0.42–0.47) for stroke, 0.68 (95% CI 0.62–0.76) for COPD, 0.67 (95% CI 0.62–0.72) for pneumonia and 0.70 (95% CI 0.64–0.76) for hip fracture. The results of logistic regression analysis are shown in Supplementary data, Appendix 2, available in Age and Ageing online.

Trends over time in the in-hospital mortality

Unadjusted and adjusted multinomial logistic regression models are shown in Table 2. In 2009, patients were less likely than in 2000 to die in-hospital. The RRRs in 2009 were 0.34 (95% CI 0.31–0.37) for AMI, 0.67 (95% CI 0.62–0.71) for HF, 0.35 (95% CI 0.33–0.37) for stroke, 0.58 (95% CI 0.51–0.65) for COPD, 0.60 (95% CI 0.53–0.62) for pneumonia and 0.52 (95% CI 0.47–0.58) for hip fracture.

Trends over time in the mortality from discharge to 30 days post-discharge

Older patients with a discharge diagnosis of HF or stroke were more likely to die from discharge to 30 days post-discharge in 2009 than in 2000. The RRRs were 1.12 (95% CI 1.00–1.24) for HF and 1.36 (95% CI 1.19–1.55) for stroke. We found no
significant changes in the RRR for the mortality from discharge to 30 days post-discharge for COPD, pneumonia and hip fracture in 2009 compared to 2000. The RRRs were 0.96 (95% CI 0.81–1.13) for COPD, 1.09 (95% CI 0.95–1.25) for pneumonia and 1.03 (95% CI 0.91–1.16) for hip fracture. Older patients with AMI were less likely to die from discharge to 30 days post-discharge in 2009 than in 2000 with a RRR of 0.75 (95% CI 0.64–0.89) (see Table 2).

Discussion

In this large nationwide study, older patients had lower probabilities of dying from admission to 30 days post-discharge in 2009 compared to 2000. However, the decline was largely due to the lower in-hospital mortality rates over time. The in-hospital mortality in older patients decreased between 2009 and 2000, while the results for mortality from discharge to 30 days post-discharge in older patients depended on the diagnosis and either declined, remained unchanged or increased. No significant changes in the RRR for the mortality from discharge to 30 days post-discharge between 2000 and 2009 were found for COPD, pneumonia and hip fracture. In 2009, older patients with a discharge diagnosis of HF or stroke were more likely to die from discharge to 30 days post-discharge than those in the year 2000. Only for AMI did we find a declining RRR between 2000 and 2009 for dying from discharge to 30 days post-discharge.

Strengths and limitations of the study

The strength of this study is a national sample of mortality in 263,746 older patients who were acutely admitted for one out of six common discharge diagnoses over a 10-year period. However, the administrative databases containing the data used for this study have some limitations. Approximately 10% of the admissions could not be linked to the population registry and were excluded. Nevertheless, Statistics Netherlands considers this number of linkable admissions reliable for performing statistical analysis. Furthermore, detailed information on the precise location of death outside the hospital and the care patients received after discharge was not available. Therefore, we could not evaluate the impact of discharge care on the mortality rates.

Comparison with other studies

Our results of declining in-hospital mortality rates are in accordance with previous studies. However, most of these studies focused on all patients who were admitted to the hospital instead of specifically on acutely hospitalised older patients. Acutely hospitalised older patients are characterised by high mortality ratios. In this study, we detected a mean overall mortality rate at 30 days (both in-hospital and out of hospital) of 19% for the 2000–2009 period, whereas Pouw et al. reported a mean overall mortality rate of 7.2%.
A possible explanation for this difference may be the inclusion of a highly vulnerable population of acutely hospitalised older patients in our study. A mean 30-day post-discharge mortality ratio of 5% was observed in our study. A study with a comparable vulnerable population, by Drye et al. 5, found similar 30-day mortality ratios in older patients who were admitted for HF, AMI and pneumonia. Bueno et al. 21 previously observed reductions in the in-hospital mortality and less marked reductions in the 30-day mortality in patients admitted for HF.

**Implications of findings**

Many of the efforts in the past decades have focused on improving the treatment strategies for a variety of diagnoses, reducing the LOS and improving care for older persons during hospitalisation 23. This could have contributed to the lower in-hospital mortality rates. After the manifest 'to err is human', many countries have implemented system-wide patient safety interventions, such as medication reconciliation 24, improved handovers 25 and malnutrition prevention programmes 26. There is increasing awareness that older hospital patients are especially vulnerable shortly after hospital discharge 27. Due to the presence of geriatric conditions that are often not resolved after hospital discharge 28 and the presence of cognitive impairments that continue after hospital discharge, this patient population is at a higher risk for adverse events. Forster et al. already demonstrated that adverse events shortly after discharge are common, such as adverse drug events, inadequate follow-up and hospital-acquired airway and/or urinary tract infections, resulting in higher readmission and mortality rates 29. As the ageing population across the world increases we would expect hospital mortality ratios to increase as this population is known to be at higher mortality risk than younger adults. In order to improve evaluations on mortality ratios across the world, we advise to keep the two mortality ratios separate. Our results highlight the need for the development of new interventions that address the needs of older persons in the post-discharge period to further reduce post-discharge mortality. Transitional care interventions, extended collaboration with pharmacists, and better handovers to the practice or district nurse may help to reduce this post-discharge mortality 30. Mortality from discharge to 30 days post-discharge may also be affected by factors outside of the hospital, such as the quality of primary care and long-term care. If mortality from discharge to 30 days post-discharge becomes a more important quality indicator, hospitals might invest more in developing optimal handover and post-discharge care. The mortality ratios from discharge to 30 days post-discharge are less vulnerable to discharge bias than the in-hospital mortality ratios.
Conclusion
In this large, nationwide study, a decline was observed in six highly prevalent discharge diagnoses in terms of the in-hospital mortality, while the change in mortality from discharge to 30 days post-discharge depended on the diagnosis, and it either declined, remained unchanged or increased. Because the decline was largely from the lower in-hospital mortality rates over time, separately reporting both rate estimates might be more informative than providing an overall hospital mortality rate from admission to 30 days post-discharge. We need more detailed insight into the causes and consequences of changes in the in-hospital mortality and mortality from discharge to 30 days post-discharge to optimise hospital and post-discharge care.
References

20. Frenkel WJ, Jongerius EJ, Mandjes-van Uitter MJ, van Munster BC, de Rooij SE. Validation of the Charlson Comorbidity Index in acutely hospitalized elderly
Chapter 8 | Changes in the in-hospital mortality and 30-day post-discharge mortality

Figure A-1. Flow chart of selection of acutely hospitalised older patients from the Dutch Hospital Discharge Register.