Background: Frailty complicates management and worsens outcomes. We assessed the prevalence, determinants and consequences of frailty among elderly patients in a hospital setting.
Design: Retrospective observational study in a Swiss university hospital.
Methods: 22,323 patients aged ≥65 years hospitalized between January 2009 and December 2017 at the internal medicine ward were included. Frailty was defined by the Hospital Frailty Risk Score (HFRS) and patients were categorized as low (HFRS<5), intermediate (HFRS 5-15) and high (HFRS>15) risk.
Results: Overall prevalence of intermediate and high risk of frailty was 43% and 20%, respectively; prevalence was higher in women and increased with age. Prevalence of high risk of frailty increased from 11.4% in 2009 to 31% in 2012, and decreased to 19.2% in 2017. After multivariable adjustment, frailty was associated with increased length of stay: average and (95% confidence interval) 11.9 (11.7-12.1), 15.6 (15.4-15.8) and 19.7 (19.3-20.1) days for low, intermediate and high risk, respectively, and increased likelihood of ICU stay: odds ratio (OR) and (95% CI) 1.57 (1.41-1.75) and 2.10 (1.82-2.42) for intermediate and high risk, respectively, p for trend<0.001. Frailty was associated with increased likelihood of hospital costs >70,000 CHF: OR and (95% CI) 3.46 (2.79-4.29) and 10.7 (8.47-13.6) for intermediate and high risk, respectively, p for trend<0.001, and with a lower likelihood of complete cost coverage: OR and (95% CI) 0.70 (0.65-0.76) and 0.52 (0.47-0.58) for intermediate and high risk, respectively, p for trend<0.001.
Conclusion: Frailty is a frequent condition among hospitalized patients and is associated with higher costs.

## INTRODUCTION

It is estimated that by year 2050 circa 2 billion people aged over 65 years will populate the world [1]. In some parts of Switzerland, the number of people aged over 65 is expected to double, representing one quarter of the total population [2]. This increase poses a considerable pressure in the hospital setting, where increasingly older and more frail patients are admitted. Frailty can be defined by a state of vulnerability following a stress and is a consequence of cumulative decline in multiple physiological systems eroding homeostatic reserve until relative minor stressor events trigger disproportionate changes in health status [3]. In 2005, Rockwood et al. published the Clinical Frailty Scale, grading frailty on a 7 points scale ranging from 1 (very fit) to 7 (severely frail) [4]. Although many other tools to assess frailty have been described since, there is still no gold standard for frailty detection [5]. This multiplicity of available tools has led to widely differing values for the prevalence of frailty, ranging from 10 to 23% among patients aged over 65 [6, 7].

Frailty is an important and independent risk factor for mortality [8], lower quality of life [9], increased hospital length of stay [10] and costs [11], increased risk of nursing-home admission [10] and re-hospitalization [12]. This high burden of frailty on the health system raises the issue of a systematic screening of frailty in older people, the effectiveness of which is currently debated [13]. Indeed, the effectiveness of such a screening is dependent on the screening tool used, which should be easy to apply and with a high sensitivity and specificity. The tools cited earlier do not fulfill these criteria, for instance, the frailty phenotype [14] is time consuming and includes measurements not routinely used for patient assessment like gait speed or grip strength; the Clinical Frailty Scale [4] is dependent on clinical appreciation, and the Frailty Index [15] has not been validated in hospital settings. Recently, Gilbert et al. proposed the Hospital Frailty Risk Score (HFRS), to assess frailty in the acute care setting [16]. To our knowledge, the HFRS is the only tool developed for a hospital setting. Recently, the prognostic value of the HFRS has been validated on an independent patient population and confirmed the ability of the score to identify patients at risk of adverse outcomes [17].

Hence, we aimed to 1) evaluate the prevalence and the 9-year evolution of frailty (as defined by the HFRS) in patients aged ≥65 years hospitalized on the internal medicine ward of the CHUV, and 2) study the association between frailty and length of stay, in-hospital mortality, intensive care unit (ICU) stay, early readmissions, and hospital costs. We hypothesized that the prevalence of frailty would increase and would be associated with all deleterious outcomes and increased costs.

## PATIENTS AND METHODS

### *Setting*

This is a retrospective study using medical information from of the department of internal medicine of the Lausanne University Hospital (CHUV). The CHUV is one of the Swiss university hospitals (www.chuv.ch) and the Internal medicine unit of the CHUV is the largest in Switzerland, with over 4,000 admissions per year. The CHUV serves both as an end-stage hospital and as a general hospital for the population of canton Vaud.

### *Participants*

We included all patients aged 65 or more, hospitalized between January 2009 and December 2017. Over four out of five admissions to the internal medicine ward transit via the emergency department.

### *Methods*

Coded data was extracted from the hospital medical records by an independent office in charge of data extraction and coding at the CHUV. The following information was extracted: gender, age, number of diagnoses at discharge (coded according to the 10$^{th}$ international classification of diseases of the World Health Organization – ICD-10), length of stay (in days), stay in an ICU (yes/no), status at discharge (death, return home or institutionalized), 30-day, 90-day and one-year mortality, total and reimbursable costs. Mortality data was obtained from the population registries, which record the vital status of a person (i.e. alive/death) but not the cause of death.

We computed the Charlson risk score according to an algorithm optimized for Switzerland [18] and categorized the participants into 0, 1-2, 3-4 and 5+ as suggested in the original publication [19].

The rate of readmission was computed taking into account the first admission for each patient within the 2004-2017 period, admissions occurring 30 days after the first one were considered.

Due to changes in the Swiss reimbursement system by the introduction of the Diagnosis Related Groups (DRG), reimbursable costs were obtained only for years 2012 onwards. Total costs were categorized into <70,000 and ≥70,000 CHF; this limit was chosen as it is the approximated cost of one year of chronic hemodialysis in Switzerland [20]. The difference between total and reimbursed costs was computed and categorized as fully covered if the difference was ≥0. Cost of stay was further categorized according to the DRG criteria into lowlier (LOS below the low margin of LOS for the corresponding DRG), inlier (within the low and high margins of LOS for the corresponding DRG) or highlier (above the high margin of LOS for the corresponding DRG).

### *Risk of frailty*

Risk of frailty was defined according to HFRS proposed by Gilbert et al [16]. The HFRS is a sum of different ICD-10 codes, which are weighted according to their clinical impact. The weight for each condition is provided in **Supplemental table 1**. For each admission, the HFRS was computed based on ICD codes and categorized into low (<5), intermediate (5-15) and high (>15) risk.

### *Ethical statement*

The Ethics Commission of Canton de Vaud (www.cer-vd.ch) approved the study protocol (decision N° 2018-01689 of 11.10.2018). The full decision of the CER-VD can be obtained from the authors upon request. The study was performed in agreement with the Helsinki declaration and its former amendments, and in accordance with the applicable Swiss legislation. No individual informed consent was deemed necessary.

*Statistical analysis*

Statistical analysis was performed using Stata version 16.1 for windows (Stata Corp, College Station, Texas, USA). Descriptive results were expressed as number of participants (percentage) or as average±standard deviation (SD). Bivariate analyses were performed using chi-square test for qualitative variables and analysis of variance or Kruskal-Wallis test for continuous variables.

Trends in prevalence of intermediate and high risk of frailty were assessed using multinomial logistic regression and the results were expressed as multivariable-adjusted relative risk ratios (RRR) and (95% confidence interval). For categorical variables, multivariable analysis was conducted using logistic regression and results were expressed as odds ratio (OR) and (95% confidence interval). For continuous variables, multivariable analysis was conducted using analysis of variance and results were expressed as multivariable-adjusted average and (95% confidence interval) . Due to the skewed distribution of length of stay and health costs, negative binomial regression was performed . Survival analysis was conducted using Cox regression and results were expressed as hazard ratios (HR) and (95% confidence interval). All multivariable models were adjusted on gender (man, woman); age group (65-74, 75-84, 85+), number of previous hospitalizations (continuous) and Charlson index categories (0, 1-2, 3-4, 5+). Further adjustments on year of discharge, ICU stay (yes, no) and length of stay (quartiles) were performed whenever necessary. Trends within the different frailty groups were tested using the **contrast p.** command of Stata.

As participants could be hospitalized several times during the study period, a first sensitivity analysis was performed considering only the first hospitalization. As the HFRS uses data from the previous two years, a second sensitivity analysis was performed considering only the period 2011-2017. Due to the number of tests performed, statistical significance was assessed for a two-sided test with $p<0.001$.

**RESULTS**

*Characteristics of patients admitted according to frailty categories*

Overall, 22,323 admissions were included (52% women, mean±SD age 80.2±8.2 years). Prevalence of frailty, defined as an intermediate or high HFRS, was 63% (95% CI: 62.7-64.0), with 43% (N=9656) in the intermediate-risk and 20% (N=4485) in the high-risk group.

The characteristics of the patients admitted overall and according to frailty category are summarized in **table 1**. Patients at intermediate or high risk of frailty were more frequently women, were older, presented more frequently with a main diagnosis of gait problems, delirium and sepsis, and less frequently with a main diagnosis of acute myocardial infarction and chronic obstructive pulmonary disease than patients at low risk. Regarding types of disease, patients at intermediate or high risk of frailty presented more frequently with pneumonia, gait problems, delirium, sepsis, chronic kidney disease, diabetes and hypertension, and less frequently with a main diagnosis of acute myocardial infarction and chronic obstructive pulmonary disease than patients at low risk. Finally, patients at intermediate or high risk of frailty had a higher number of comorbidities and were more frequently in the 3-4 and 5+ categories of the Charlson index (**Table 1**).

*Evolution of frailty between 2009 and 2017*

The trends between 2009 and 2017 for prevalence of the intermediate and the high risk categories of frailty are represented in **Figure 1**. There was an increase in the prevalence of high-risk patients from 2009 to 2012, followed by a sharp decrease afterwards. This evolution was further confirmed after multivariable adjustment (**Figure 2**).

*Association between frailty and length of stay, intensive care unit stay, mortality and costs*

The bivariate associations between frailty categories and destination after hospitalization, ICU stay, LOS, readmission, hospital costs, and 30-, 90-day and one-year mortality are summarized in **table 2**. Patients at intermediate or high risk of frailty were more frequently admitted to the ICU, spent more time in the ICU, and were more frequently institutionalized after discharge than patients at low risk. Patients at high risk of frailty had a higher 30-day, 90-day and one-year mortality than patients at low

risk. Patients at intermediate or high risk had total and reimbursed costs, their stay was less frequently fully covered, and they were more frequently highliers than patients at low risk.

The multivariable associations between frailty categories and ICU stay, LOS, readmission, hospital costs, and 30- 90- and one-year mortality are summarized in **supplemental table 2**. Overall, the results were similar to those from the bivariate analyses, except that the associations with 30-day mortality were no longer significant. Further adjusting on ICU stay and LOS led to similar findings, except that the differences regarding cost coverage were no longer significant (**supplemental table 3**). Finally, adjusting for number of previous hospitalizations showed frailty levels to be positively associated with 30-, 90- and one-year mortality (**table 3**).

*Sensitivity analysis*

The results of the analyses using only first admissions are summarized in **supplemental tables 4 to 6**. On bivariate analysis, patients at intermediate or high risk of frailty were more frequently admitted to the ICU, spent more time in the ICU, and were more frequently institutionalized after discharge than patients at low risk. No differences were found regarding 30- and 90-day mortality, while patients at intermediate or high risk of frailty had a higher one-year mortality than patients at low risk. Patients at intermediate or high risk had a higher total and reimbursed costs, their stay was less frequently fully covered, and they were more frequently highliers than patients at low risk (**supplemental table 4**). Most associations were confirmed after multivariable analysis (**supplemental table 5**). Further adjusting on ICU stay and LOS led to similar findings, except that one-year mortality and the differences between total and reimbursed costs and cost coverage were no longer significant (**supplemental table 6**).

The results of the sensitivity analysis focusing on period 2011-2017 are summarized in **supplemental tables 7 to 10**. Prevalence of intermediate and high risk of frailty were 43.1% and 22.0%, respectively. On bivariate analysis, patients at intermediate or high risk of frailty were more frequently admitted to the ICU, spent more time in the ICU, were more frequently institutionalized after discharge

than patients at low risk, had higher 30-day, 90-day and one-year mortality than patients at low risk. Patients at intermediate or high risk had a higher total and reimbursed costs, their stay was less frequently fully covered, and they were more frequently highliers than patients at low risk, while no differences were found regarding rehospitalization (**supplemental table 7**). These associations were confirmed after multivariable analysis (**supplemental table 8**). Further adjusting on ICU stay and LOS led to similar findings, except that the differences between total and reimbursed costs and cost coverage were no longer significant (**supplemental tables 9 and 10**).

## DISCUSSION

Our results indicate that frailty is a prevalent condition among hospitalized patients, and associated with increased hospital costs. Frailty levels appear to be dependent on the coding system of diseases, and the association between frailty and mortality should be further explored.

### *Prevalence and characteristics of frail patients*

Prevalence of intermediate and high risk of frailty was 63%, a value within the range published in a scoping review by Theou et al.[21], where frailty was measured with various scores. However, this prevalence is higher than reported in other studies, ranging from 32 to 40% [17, 22]. A possible explanation would be the hospital setting (university hospital), where patients with multiple comorbidities and possibly more frail could be transferred from other structures.

### *Evolution of frailty between 2009 and 2017*

Prevalence of high risk of frailty increased from 2009 to 2012, to decrease afterwards. To our knowledge, there is no other study assessing trends in frailty among hospitalized subjects. Interestingly, the decrease in prevalence occurred during the year of DRG implementation in Switzerland. The introduction of the DRG system in Switzerland decreased in-hospital mortality and increased readmission rates but it did not impact LOS [23] or ICU mortality [24]. Although no study assessed the impact of DRG implementation on disease coding, it is likely that some changes occurred

as some ICD codes were no longer valid to calculate DRG and subsequently health care reimbursement [25]. Overall, our results suggest that the prevalence of frailty is heavily dependent on the ICD-10 codes used, and that changes in disease coding can lead to considerable changes in the prevalence of frailty.

*Association between frailty and length of stay, intensive care unit stay, mortality and costs*

Frail patients had a higher likelihood of being admitted in the ICU. Those findings are in agreement with a recent study showing an association between frailty (as measured by the HFRS) and unplanned admission to the ICU [26]. A second study also showed an association between frailty (as measured by Clinical Frailty Scale) and short-term mortality in older patients admitted to the ICU [27]. Conversely, another study found no significant association between frailty and adverse outcome after adjusting for disease severity [28]. However, patients in this last study had a very low mean HFRS (31), probably reflecting a severe selection of patients at ICU admission. Overall, our results strengthen the evidence of frailty as a risk factor for ICU admission.

Risk of frailty was positively associated with hospital costs, a finding in agreement with a study conducted in a community setting [11]. Risk of frailty was also associated with higher reimbursements, but the increase in reimbursements did not fully compensate the increase in hospital costs. Hence, patients at high risk of frailty led to higher financial losses to the hospital. Given the expected increase in the number of frail, older patients being admitted to the hospital, this finding is of great concern for hospital administrations who face a burden of additional costs. Hence, adequate screening and management of frail patients should be implemented to contain the rising associated costs.

Risk of frailty was not associated with hospital readmission, a finding consistent with a previous study [17], but not with another [22]. Still, in the last study, the association between frailty and readmission only held because early readmissions were included in a composite outcome [22]. Hence, our results do not support the hypothesis that risk of frailty is associated with increased risk of hospital readmission.

We found a significant association of frailty with one-year mortality, while the association with 30-day and 90-day mortality was inconsistent. A positive association between frailty and 30-day mortality has been reported [17]. Several explanations can be put forward to explain this inconsistency. First, it could be explained by a much higher 30-day mortality (25% versus 12%) in the high-risk group in the study of Eckart et al [17] than in the present study. Second, caring of high-risk patients could differ largely between hospitals, or even between countries. Overall, our results suggest that frailty is related with one-year mortality after discharge from hospital, while the association with short-term (30 and 90-day) mortality should be further checked.

*Strengths and limitations*

The main strengths of our study are the survey period, which allowed to present trends, and evaluation of status at discharge including institutionalization.

This study also has some limitations. Firstly, it is a monocentric, retrospective, observational study conducted in a Swiss tertiary hospital. Hence, the characteristics of the patients admitted (mostly multimorbid older patients) might not correspond to other settings. Still, the ageing of the population is occurring worldwide, and we believe that our results can be generalizable to most internal unit wards in developed countries. Secondly, as healthcare and reimbursement systems vary between countries, it is possible that the associations between HFRS and LOS or health costs might also change. Hence, it would be of interest that our findings be replicated in countries with different healthcare or reimbursement systems. Thirdly, our definition of frailty may not reflect true frailty because of being based on comorbidities rather than on measurements such as grip strength. Still, they allow comparing our results with those of studies that used the same methodology [16, 17]. Finally, the HFRS calculation is based on the ICD-10 codes from the discharge letter and not on the ICD-10 codes at the admission; further, the coding of the conditions might vary between countries [29]. This can lead to an over- or under- estimation of the frailty risk and complicate between-country comparisons.

*Conclusion*

Frailty is frequent among hospitalized patients and is associated with higher hospital costs. The association between frailty and mortality awaits further investigation.

## CONFLICT OF INTEREST

The authors report no conflict of interest.


## FUNDING

This study was not funded.

## ACKNOWLEDGEMENTS

Nobody to acknowledge.

**FIGURE LEGENDS**

**Figure 1:** trends in the prevalence of intermediate and high risk of frailty in the department of internal medicine of the Lausanne university hospital, 2009-2017. Results are expressed as percentage.

**Figure 2**: trends in the prevalence of intermediate (panel A) and high (panel B) risk of frailty in the department of internal medicine of the Lausanne university hospital, 2009-2017. Results are expressed as relative risk ratio and 95% confidence interval. Analysis conducted using multinomial logistic regression adjusting for gender (man, woman); age group (65-74, 75-84, 85+); Charlson index categories (0, 1-2, 3-4, 5+); intensive care unit stay (yes, no), number of previous hospitalizations (continuous) and length of stay (quartiles).

**TABLES**

**Table 1:** clinical characteristics overall and according to the different frailty risk categories, Lausanne university hospital, Lausanne, Switzerland, 2009-2017.

| | Total | Low | Intermediate | High | p-value |
|---|---|---|---|---|---|
| N | 22,323 | 8182 | 9656 | 4485 | |
| Women (%) | 11579 (51.9) | 4000 (48.9) | 5139 (53.2) | 2440 (54.4) | <0.001 |
| Age (years) | 80.2 ± 8.2 | 78.2 ± 8.1 | 81.0 ± 8.1 | 82.2 ± 7.8 | <0.001 |
| Age group (%) | | | | | <0.001 |
| 65-74 | 6121 (27.4) | 2950 (36.1) | 2340 (24.2) | 831 (18.5) | |
| 75-84 | 8621 (38.6) | 3170 (38.7) | 3699 (38.3) | 1752 (39.1) | |
| 85+ | 7581 (34.0) | 2062 (25.2) | 3617 (37.5) | 1902 (42.4) | |
| Main diagnosis (%) | | | | | <0.001 |
| Heart failure | 2123 (9.5) | 822 (10.1) | 857 (8.9) | 444 (9.9) | |
| Pneumonia | 1643 (7.4) | 633 (7.7) | 709 (7.3) | 301 (6.7) | |
| Gait problems | 922 (4.1) | 61 (0.8) | 501 (5.2) | 360 (8.0) | |
| Delirium | 800 (3.6) | 34 (0.4) | 364 (3.8) | 402 (9.0) | |
| Sepsis | 755 (3.4) | 110 (1.3) | 377 (3.9) | 268 (6.0) | |
| Acute myocardial infarction | 656 (2.9) | 327 (4.0) | 256 (2.7) | 73 (1.6) | |
| COPD | 642 (2.9) | 315 (3.9) | 244 (2.5) | 83 (1.9) | |
| Diabetes | 179 (0.8) | 73 (0.9) | 73 (0.8) | 33 (0.7) | |
| Other | 14,603 (65.4) | 5807 (71.0) | 6275 (65.0) | 2521 (56.2) | |
| Presence of (%) | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Heart failure | 3840 (17.2) | 1243 (15.2) | 1699 (17.6) | 898 (20.0) | <0.001 |
| Pneumonia | 1817 (8.1) | 472 (5.8) | 870 (9.0) | 475 (10.6) | <0.001 |
| Gait problems | 4013 (18.0) | 261 (3.2) | 2103 (21.8) | 1649 (36.8) | <0.001 |
| Delirium | 2281 (10.2) | 128 (1.6) | 1140 (11.8) | 1013 (22.6) | <0.001 |
| Sepsis | 854 (3.8) | 114 (1.4) | 428 (4.4) | 312 (7.0) | <0.001 |
| Acute myocardial infarction | 525 (2.4) | 159 (1.9) | 234 (2.4) | 132 (2.9) | 0.002 |
| COPD | 2051 (9.2) | 718 (8.8) | 885 (9.2) | 448 (10.0) | 0.077 |
| Chronic kidney disease | 5334 (23.9) | 1126 (13.8) | 2597 (26.9) | 1611 (35.9) | <0.001 |
| Diabetes | 3819 (17.1) | 1214 (14.8) | 1683 (17.4) | 922 (20.6) | <0.001 |
| Hypertension | 6395 (28.7) | 2409 (29.4) | 2826 (29.3) | 1160 (25.9) | <0.001 |
| Number of ICD-10 codes | 12 [7 ; 17] | 8 [5 ; 14] | 12 [8 ; 18] | 16 [11 ; 21] | <0.001 ǂ |
| Charlson index | 2 [0 ; 4] | 2 [0 ; 4] | 2 [0 ; 3] | 2 [1 ; 4] | <0.001 ǂ |
| Charlson index categories (%) | | | | | <0.001 |
| 0 | 5796 (26.0) | 2284 (27.9) | 2507 (26.0) | 1005 (22.4) | |
| 1-2 | 8384 (37.6) | 3045 (37.2) | 3695 (38.3) | 1644 (36.7) | |
| 3-4 | 3953 (17.7) | 1229 (15.0) | 1725 (17.9) | 999 (22.3) | |
| 5+ | 4190 (18.8) | 1624 (19.9) | 1729 (17.9) | 837 (18.7) | |

COPD, chronic obstructive pulmonary disease. Results are expressed as number of patients (column percentage) for categorical variables and as average ± standard deviation or median [interquartile range] for continuous variables. Between-group comparisons performed using chi-square for categorical variables and analysis of variance or Kruskal-Wallis test (ǂ) for continuous variables.

**Table 2:** bivariate analysis of the associations between frailty risk categories and different outcomes, Lausanne university hospital, Lausanne, Switzerland, 2009-2017.

| | Low | Intermediate | High | p-value |
|---|---|---|---|---|
| N | 8182 | 9656 | 4485 | |
| Length of stay (days) | 9.5 [6.0 ; 15.0] | 12 [7.9 ; 18.8] | 13.9 [9.0 ; 21.9] | <0.001 ǂ |
| ICU stay (%) | 663 (8.1) | 984 (10.2) | 537 (12.0) | <0.001 |
| ICU stay (hours) * | 68 [28 ; 120] | 97 [48 ; 184] | 143 [61 ; 308] | <0.001 ǂ |
| Destination at discharge (%) | | | | <0.001 |
| Deceased | 655 (8.0) | 783 (8.1) | 486 (10.8) | |
| Returned home | 5413 (66.2) | 4351 (45.1) | 1403 (31.3) | |
| Institutionalized | 2111 (25.8) | 4517 (46.8) | 2595 (57.9) | |
| Mortality (%) | | | | |
| 30-day | 911 (11.1) | 1066 (11.0) | 628 (14.0) | <0.001 |
| 90-day | 1474 (18.0) | 1822 (18.9) | 1035 (23.1) | <0.001 |
| One-year | 2471 (30.2) | 3222 (33.4) | 1856 (41.4) | <0.001 |
| Readmissions (N) § | 7593 | 8941 | 4039 | |
| Rate | 280 (3.7) | 336 (3.8) | 170 (4.2) | 0.347 |
| Costs (N) † | | | | |
| Total (CHF) | 11,161 [7350 ; 17,946] | 13,396 [8918 ; 21,972] | 15,303 [10,359 ; 26,924] | <0.001 ǂ |
| Reimbursed (CHF) | 9553 [7604 ; 14,366] | 10,516 [8591 ; 16,518] | 11,630 [9419 ; 18,543] | <0.001 ǂ |
| Difference (CHF) | -846 [-4491 ; 2231] | -2176 [-6532 ; 1439] | -3216 [-8548 ; 1068] | <0.001 ǂ |
| Costs ≥70,000 CHF (%) | 119 (1.5) | 340 (3.5) | 304 (6.8) | <0.001 |

| | | | | |
|---|---|---|---|---|
| Full coverage (%) | 2204 (42.8) | 2143 (34.8) | 923 (30.4) | <0.001 |
| DRG category (%) | | | | <0.001 |
| Lowlier | 157 (3.1) | 104 (1.7) | 32 (1.1) | |
| Inlier | 4036 (78.4) | 4612 (74.9) | 2094 (68.9) | |
| Highlier | 956 (18.6) | 1442 (23.4) | 913 (30.0) | |

ICU, intensive care unit, DRG, diagnosis-related groups. *, among patients admitted to ICU; §, considering the first hospitalization; †, data for period 2012-2017. Results are expressed as number of patients (column percentage) for categorical variables and as average ± standard deviation or median and [interquartile range] for continuous variables. Between-group comparisons performed using chi-square for categorical variables and analysis of variance or Kruskal-Wallis test (ǂ) for continuous variables.

**Table 3:** survival analysis for the different frailty risk categories, Lausanne university hospital, for the 2009-2017 period.

| | Low | Intermediate | High | P-value for trend |
|---|---|---|---|---|
| 30-day | 1 (ref.) | 1.04 (0.95 - 1.14) | 1.31 (1.16 - 1.47) | <0.001 |
| 90-day | 1 (ref.) | 1.04 (0.97 - 1.12) | 1.22 (1.12 - 1.34) | <0.001 |
| One-year | 1 (ref.) | 1.05 (1.00 - 1.11) | 1.21 (1.13 - 1.30) | <0.001 |

Results are expressed as multivariable-adjusted relative risk (95% confidence interval). Between-group comparisons performed using Cox survival analysis adjusted on year of discharge (categorical); gender (man, woman); age group (65-74, 75-84, 85+); Charlson index categories (0, 1-2, 3-4, 5+); ICU stay (yes, no) , number of previous hospitalizations (continuous) and length of stay (quartiles).

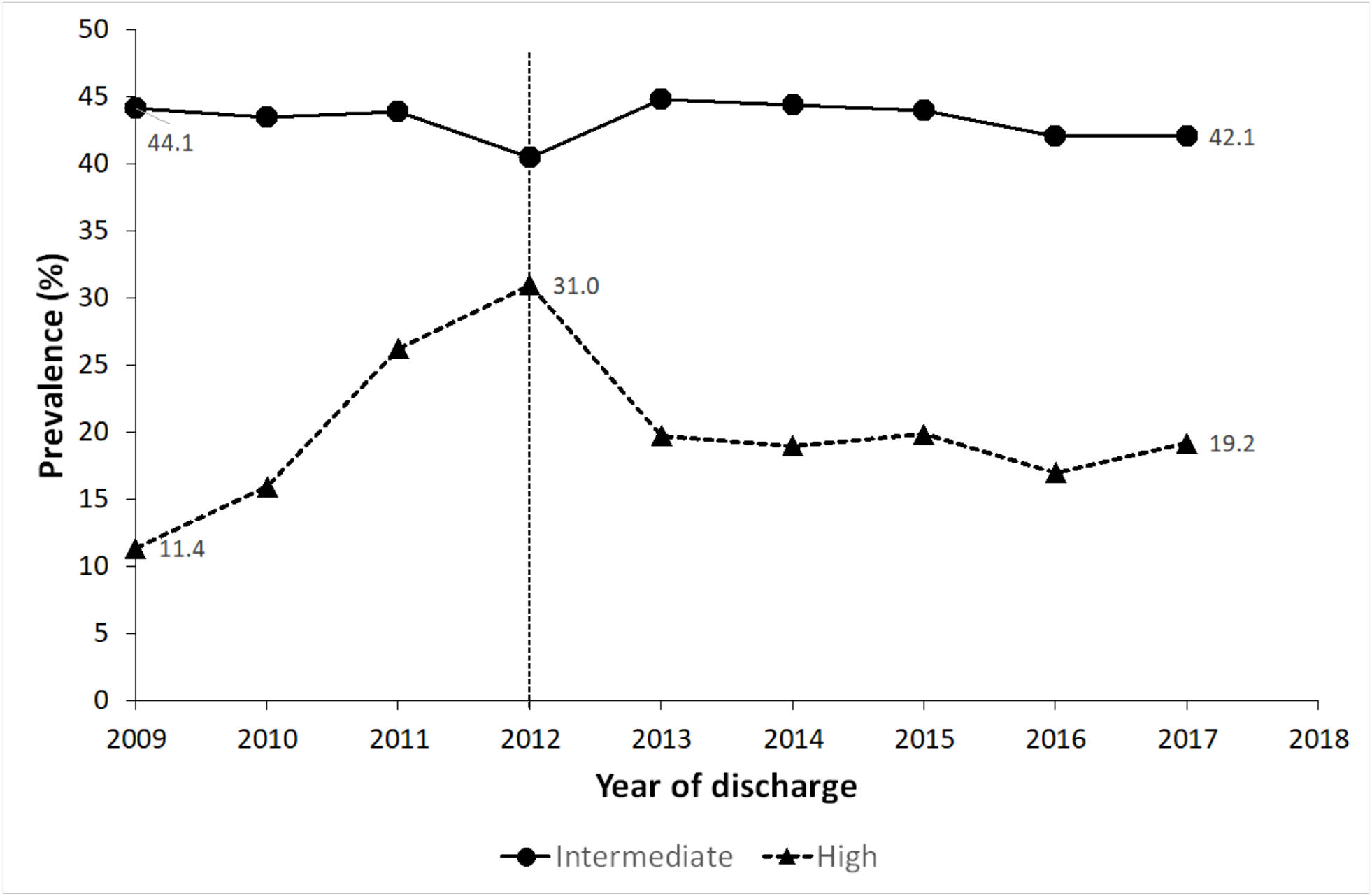
**REFERENCES**

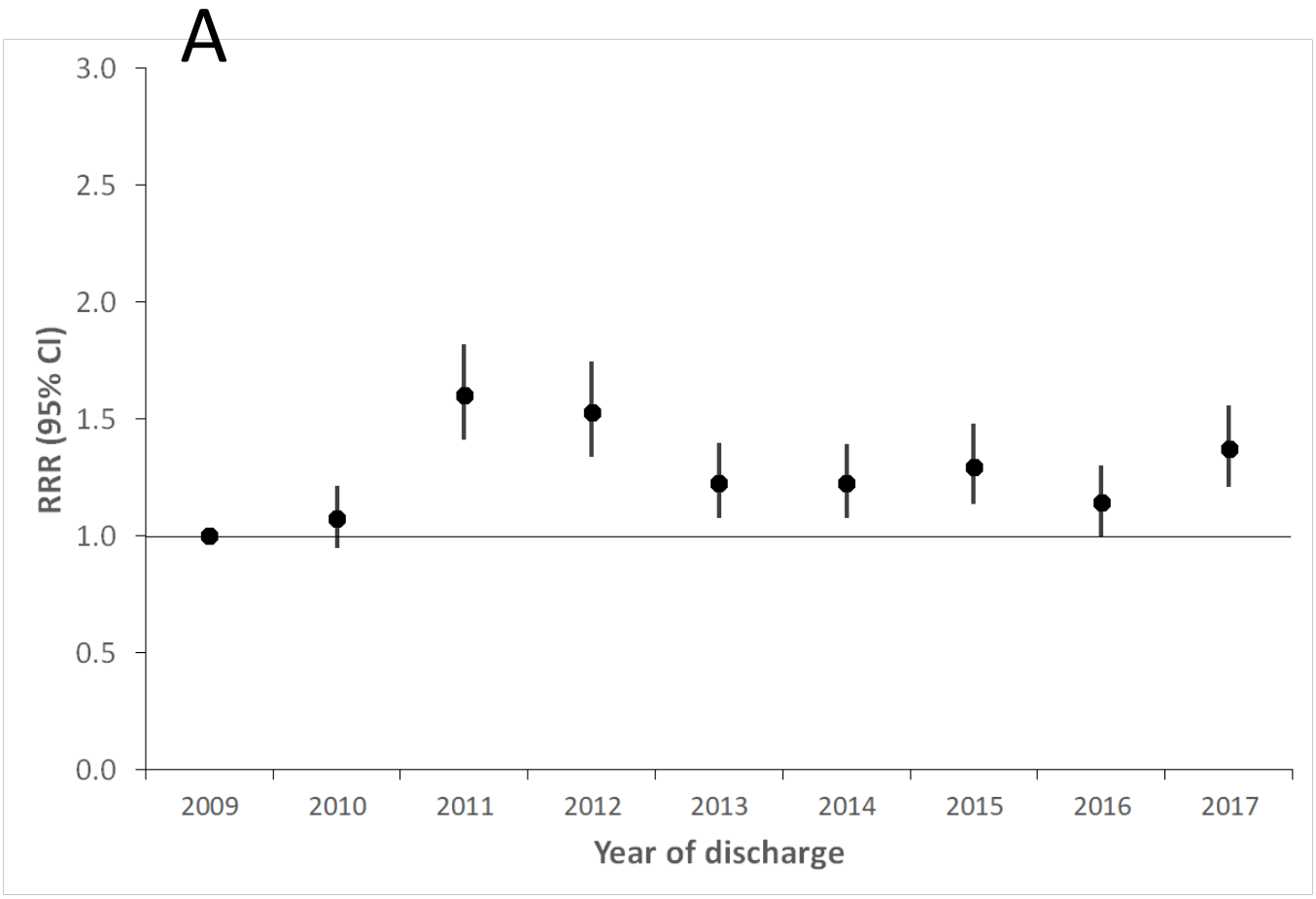

1. Department of Economic and Social Affairs. World population projected to reach 9.8 billion in 2050, and 11.2 billion in 2100. New York, USA 2017 [cited 2020 May]; Available from: https://www.un.org/development/desa/en/news/population/world-population-prospects-2017.html.
2. Kohli R. Scénarios de l'évolution de la population des cantons. Neuchâtel, Switzerland: Federal Office of Statistics,, 2016 Contract No.: 870-1500-03
3. Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. Lancet (London, England). 2013 Mar 2;381(9868):752-62.
4. Rockwood K, Song X, MacKnight C, Bergman H, Hogan DB, McDowell I, et al. A global clinical measure of fitness and frailty in elderly people. CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne. 2005 Aug 30;173(5):489-95.
5. Gilardi F, Capanna A, Ferraro M, Scarcella P, Marazzi MC, Palombi L, et al. Frailty screening and assessment tools: a review of characteristics and use in Public Health. Ann Ig. 2018 Mar-Apr;30(2):128-39.
6. Collard RM, Boter H, Schoevers RA, Oude Voshaar RC. Prevalence of frailty in community-dwelling older persons: a systematic review. J Am Geriatr Soc. 2012 Aug;60(8):1487-92.
7. Song X, Mitnitski A, Rockwood K. Prevalence and 10-year outcomes of frailty in older adults in relation to deficit accumulation. J Am Geriatr Soc. 2010 Apr;58(4):681-7.
8. Kojima G, Iliffe S, Walters K. Frailty index as a predictor of mortality: a systematic review and meta-analysis. Age and ageing. 2018 Mar 1;47(2):193-200.
9. Kojima G, Iliffe S, Morris RW, Taniguchi Y, Kendrick D, Skelton DA, et al. Frailty predicts trajectories of quality of life over time among British community-dwelling older people. Quality

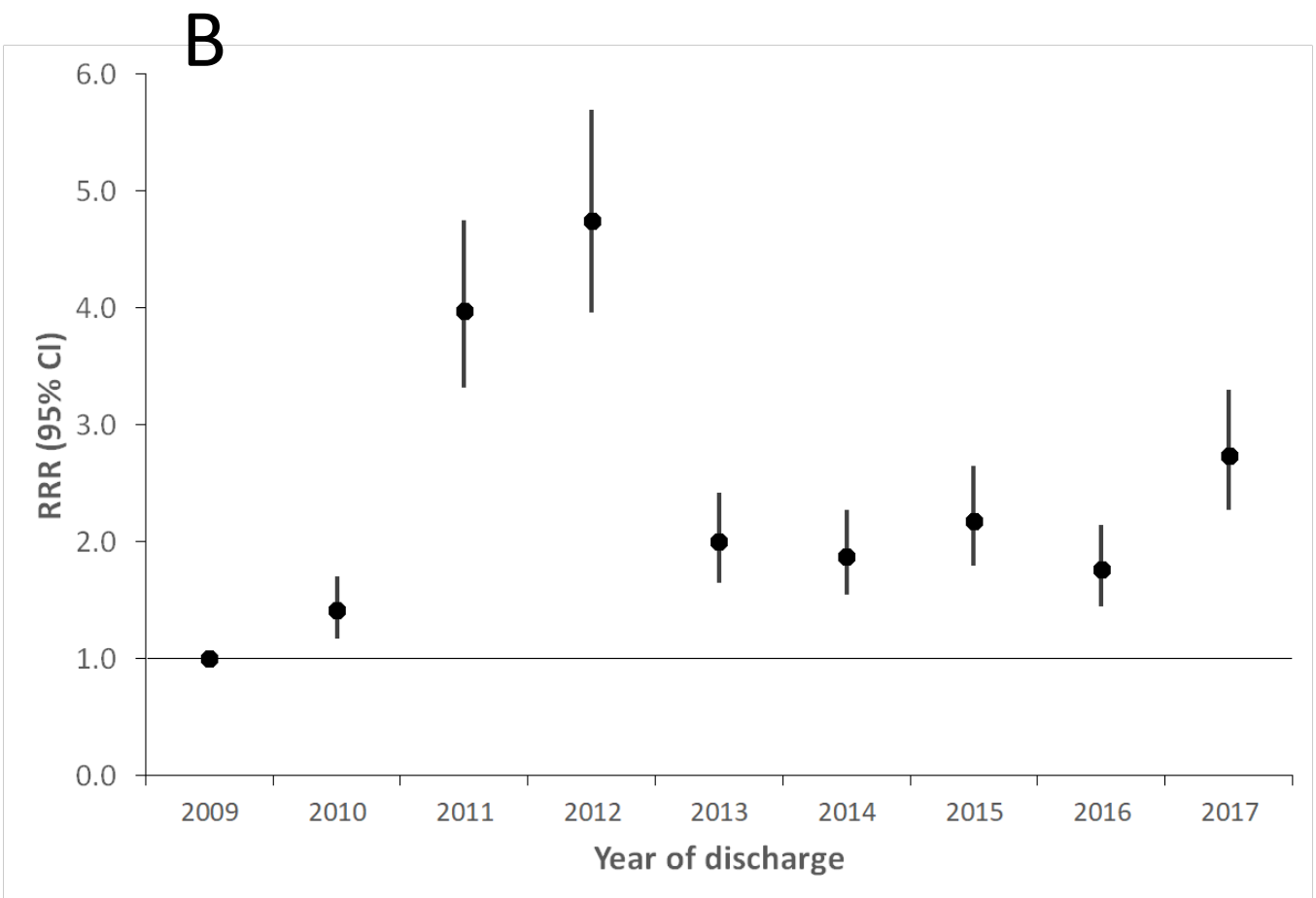
of life research : an international journal of quality of life aspects of treatment, care and rehabilitation. 2016 Jul;25(7):1743-50.

10. Hubbard RE, Peel NM, Samanta M, Gray LC, Mitnitski A, Rockwood K. Frailty status at admission to hospital predicts multiple adverse outcomes. Age and ageing. 2017 Sep;46(5):801-6.
11. Garcia-Nogueras I, Aranda-Reneo I, Pena-Longobardo LM, Oliva-Moreno J, Abizanda P. Use of Health Resources and Healthcare Costs associated with Frailty: The FRADEA Study. The journal of nutrition, health & aging. 2017;21(2):207-14.
12. Comans TA, Peel NM, Hubbard RE, Mulligan AD, Gray LC, Scuffham PA. The increase in healthcare costs associated with frailty in older people discharged to a post-acute transition care program. Age and ageing. 2016 Mar;45(2):317-20.
13. Santos-Eggimann B, Sirven N. Screening for frailty: older populations and older individuals. Public health reviews. 2016;37:7.
14. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci. 2001 Mar;56(3):M146-56.
15. Mitnitski AB, Mogilner AJ, Rockwood K. Accumulation of deficits as a proxy measure of aging. TheScientificWorldJournal. 2001 Aug 8;1:323-36.
16. Gilbert T, Neuburger J, Kraindler J, Keeble E, Smith P, Ariti C, et al. Development and validation of a Hospital Frailty Risk Score focusing on older people in acute care settings using electronic hospital records: an observational study. Lancet (London, England). 2018 May 5;391(10132):1775-82.
17. Eckart A, Hauser SI, Haubitz S, Struja T, Kutz A, Koch D, et al. Validation of the hospital frailty risk score in a tertiary care hospital in Switzerland: results of a prospective, observational study. BMJ open. 2019 Jan 15;9(1):e026923.
18. Sundararajan V, Quan H, Halfon P, Fushimi K, Luthi JC, Burnand B, et al. Cross-national comparative performance of three versions of the ICD-10 Charlson index. Med Care. 2007 Dec;45(12):1210-5.
19. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis. 1987;40(5):373-83.
20. Martin PY, Burnier M. [Dialysis....at what cost?]. Revue medicale suisse. 2005 Feb 23;1(8):531-2.
21. Theou O, Squires E, Mallery K, Lee JS, Fay S, Goldstein J, et al. What do we know about frailty in the acute care setting? A scoping review. BMC geriatrics. 2018 Jun 11;18(1):139.
22. Kahlon S, Pederson J, Majumdar SR, Belga S, Lau D, Fradette M, et al. Association between frailty and 30-day outcomes after discharge from hospital. CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne. 2015 Aug 11;187(11):799-804.

23. Kutz A, Gut L, Ebrahimi F, Wagner U, Schuetz P, Mueller B. Association of the Swiss Diagnosis-Related Group Reimbursement System With Length of Stay, Mortality, and Readmission Rates in Hospitalized Adult Patients. JAMA network open. 2019 Feb 1;2(2):e188332.
24. Chok L, Bachli EB, Steiger P, Bettex D, Cottini SR, Keller E, et al. Effect of diagnosis related groups implementation on the intensive care unit of a Swiss tertiary hospital: a cohort study. BMC health services research. 2018 Feb 5;18(1):84.
25. Vonzun N, Ruhlin M, Sterchi A. [Malnutrition in the era of DRG]. Therapeutische Umschau Revue therapeutique. 2014 Mar;71(3):185-9.
26. Redfern OC, Harford M, Gerry S, Prytherch D, Watkinson PJ. Frailty and unplanned admissions to the intensive care unit: a retrospective cohort study in the UK. Intensive Care Med. 2020 Apr 2.
27. Guidet B, de Lange DW, Boumendil A, Leaver S, Watson X, Boulanger C, et al. The contribution of frailty, cognition, activity of daily life and comorbidities on outcome in acutely admitted patients over 80 years in European ICUs: the VIP2 study. Intensive Care Med. 2020 Jan;46(1):57-69.
28. Bruno RR, Wernly B, Flaatten H, Scholzel F, Kelm M, Jung C. The hospital frailty risk score is of limited value in intensive care unit patients. Critical care (London, England). 2019 Jul 2;23(1):239.
29. Quan H, Moskal L, Forster AJ, Brien S, Walker R, Romano PS, et al. International variation in the definition of 'main condition' in ICD-coded health data. International journal for quality in health care : journal of the International Society for Quality in Health Care. 2014 Oct;26(5):511-5.


50
45
40
35
30
25
20
15
10
5
0
Prevalence (%)
44.1
42.1
31.0
19.2
11.4
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year of discharge
Intermediate
High


A
3.0
2.5
2.0
1.5
1.0
0.5
0.0
RRR (95% CI)
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year of discharge


B
6.0
5.0
4.0
3.0
2.0
1.0
0.0
RRR (95% CI)
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year of discharge