

**Economic incentives and survival probabilities for
chronic and multimorbidity patients -
Do the relationships depend on patient pathways?**

by

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Abstract

Background: The Norwegian Coordination Reform (CR) in 2012 introduced new economic incentives aimed at weaknesses in interaction between primary care, social care and specialist care. This paper studies the association of a new co-payment scheme on the 30-day and 90-day survival probabilities for chronic and multimorbidity patients. We also analyse whether admission types —planned or emergency— matters for survival rates, and the importance of patient pathways. Several different pathways are possible, depending on where patients came from before being admitted to hospital and their destination after discharge from hospital.

Methods: The study uses data from three different registers for the period 2010 to 2013. We consider 30 common chronic conditions for which administrative data are available (n=563,096 in-patient episodes). We look at three mutually exclusive pathways. They are relevant and important in terms of the number of patients depending on co-operation and coordination between health care providers. Using a quasi-experimental design—the difference-in-differences approach—we estimate the associations between the co-payment scheme and survival probability by admission type and by patient pathway.

Results: Overall, the changes in survival probabilities are found positively and significantly associated with the co-payment scheme. For emergency admissions such a significant positive association is observed for the 30-day survival only, whereas, for planned admissions a significant positive relationship is evident for the 90-day survival only. Pathway-specific results indicate positive and significant associations with survival probabilities (both the 30- and 90-day) for all admissions and emergency admissions for two specific pathways. Multimorbidity subgroup analysis generally shows no significant relationship with survival probabilities, but pathway-specific analyses show significant positive associations between emergency admissions and the 90-day survival for patients following two specific pathways. However, for planned admissions we find a significant negative association with the 30-day survival for multimorbidity patients following one specific pathway.

Conclusion: We conclude that the survival probabilities are positively associated with the new economic incentives but the result depends on admission type, patient pathway and multimorbidity status. Without modelling admission type, pathway and multimorbidity explicitly, one may overlook important relationships associated with the economic incentives. Future policy evaluations in any pertinent context should envisage these aspects.

Keywords: Coordination Reform (CR), Economic incentives, Patient pathways, survival probability, Multimorbidity, Difference-in-differences

Background

There is a rising prevalence of chronic conditions and multimorbidity worldwide. In a global context, chronic diseases are the largest cause of death [1, 2]. In the US, chronic health conditions are the leading cause of death and disability and represent the largest component of health care costs [3, 4]. In Europe, the significance of chronic diseases in terms of deaths and health care costs are also well established [5]. Patients with chronic conditions and multimorbidity (defined as co-occurrence of two or more chronic conditions [6]) are the main users of health care services. Recent studies also show that multimorbidity patients account for up to 64 per cent of total health care expenditure [7]. Evidently, a substantial part of these expenditures could be avoided, in particular by reducing inefficiencies in health care organizations and delivery, and by substituting expensive specialist care with adequate and less expensive primary and home/social care.

There is recognition in most health care systems that health and social care delivery to these patients is sub-optimal, which has led many health authorities the world over to redesign their care provision. A concern is the lack of co-ordination between providers within the health and social care sectors. In particular, payment systems are often designed in a way that does not incentivize desired co-ordination, and thus creates a barrier for the desired patient flow, which should provide high-quality health and social care in a cost-efficient way. Ideally, treatment of patients with chronic conditions and multimorbidity should occur through some kind of bundled payment [8, 9].

Trying to accomplish a reorientation of care, the health authorities in Norway implemented the Coordination Reform (CR) in January 2012 [10]. Patients with chronic conditions and/or multimorbidity constitute a substantial share of the patients targeted by the CR. The reform was aimed at rectifying identified weaknesses in primary, social and specialist care interaction highlighted by the large number of patients not treated at ‘the most

effective level of care'. The White Paper argued that far too many people were admitted to hospital when they could have been taken care of at primary and social care, and far too many patients were staying in hospital for too long while waiting for follow-ups at the same services.

To facilitate better follow-up for chronic and multimorbidity patients specifically but not exclusively, the CR reform introduced new economic incentives consequential for both specialist care, primary care and social care. Rather than changing ownership structures and imposing more vertical or horizontal integration of service provision, the local authorities was incentivized to internalize some of the costs associated with both hospitalization and 'bed blocking', i.e., patients ready for discharge from hospital that awaits follow-up from the municipality in which they live. The CR included three new economic incentives designed by the Government to affect the degree of co-ordination between health care providers and patient flows between them [10]. The co-payment scheme— an instrument based on the idea that economic incentives potentially will change providers' behaviour— was introduced as payment per admitted episode, equal to 20 per cent of the national average cost for the specific diagnoses-related groups (DRGs). However *only medical diagnoses, not surgical diagnoses*, were part of the co-payment system. The main aim was to incentivize municipalities to lower the demand for hospital services. The co-payment scheme¹ was financed by reducing the allocations to the state-owned hospital sector by 20 per cent, with a corresponding re-allocation of the financial resources to municipalities. Municipalities received their share based on a per capita remuneration and dependent on pre-reform consumption of the relevant medical DRGs.

Critics of the CR scheme argued that people with chronic conditions, comorbidities and elderly patients, which are most likely to be affected if municipalities adapted to the

¹ The co-payment regime was abolished early 2015, the main arguments being that the scheme did not work as envisaged and that it placed too much risk on the municipalities, many of them small.

incentive by providing more services locally, faced the prospect of receiving lower quality of health care services compared to the pre-reform situation [11]. A particular concern was that hospitals would have stronger incentives to shorten the length of stay (LOS) compared to the pre-reform situation, and that municipalities would have incentives to avoid hospitalization relying instead on the provision of medical resources of inferior quality.

Several aspects of the CR have been previously evaluated. Askildsen et al. [12]. concluded that the use of specialist somatic health care services *did not change*. Melberg and Hagen [13]. found that the LOS in hospital is reduced —although not substantially— because of the new penalty scheme for patients waiting to be discharged. Ambugo and Hagen [14]. found little evidence that the new penalty scheme influenced death rates and readmissions for COPD/asthma, heart failure, hip fracture, and stroke. Islam and Kjerstad [15]. found negative associations between subsidies to municipalities establishing 24/7 emergency bed capacity (EBC) within their primary/social care facilities and changes in emergency admissions to hospitals.

Whether the quality of health services changed, however, is an issue that has been sparsely addressed. In a recent study, Bruvik et al. [16] analysed the changes in survival following the CR with a small sample of patients living at a 35-bed short-term ward in a nursing home. They find that the number of patients that died in the nursing home after hospitalization doubled following the CR while procedures and staffing were unchanged pre- and post-CR. Regarding patients' distribution, particularly the age distribution, they find that during the pre-CR, admitted patients were older than the post-CR. Bruvik et al. [16] also found that shorter hospitalization periods for older patients led to an increase in the number of patients transferred to nursing homes. Referering to Gautun and Syse [17] and Abelsen et al. [11], Bruvik et al. [16] concluded that, '.... the patients being transferred suffer from more

serious, complex and treatment-intensive conditions, when compared to the situation before the introduction of the co-ordination reform.

For our part, we would add that other aspects of the distribution of patients may have contributed to the higher death numbers reported by Bruvik et al. [16]. For instance, Meacock et al. [18] in their study of mortality rates among emergency patients admitted to hospitals on weekends, found fewer deaths but higher mortality rates than for those admitted on weekdays. Their argument is that patients admitted on weekends are a selected group of patients. Kahlon et al. [19] studied the association between frailty and 30-day mortality outcomes after discharge from hospital and find that frailty at the time of admission is associated with a substantially increased risk of early readmission and death after discharge from medical wards

It is of interest to study changes in health outcomes following policy interventions encompassing elements of bundling and co-ordinated payment systems, in particular, for patients with chronic conditions and multimorbidity. For example, elderly people receiving social care services at home or in a nursing home, services typically delivered by municipalities, may suddenly suffer a worsening of their physical functioning. Patients with chronic conditions and/or multimorbidity constitute a substantial share of the patients targeted by the CR. Although the empirical literature has highlighted the limitations of performance measures based on health outcomes, acknowledge one advantage of using mortality rates is that they are unequivocal. A higher mortality rate implies everything else constant, poorer quality of health care services [20, 21]. The 30-day mortality rate after admission to hospital is among the indicators considered to be effective for assessing the quality/outcome of hospital care [22]. The 30-day mortality after admission to hospital due to important chronic conditions, such as, acute myocardial infarction (AMI) and stroke is also considered one of the OECD Health care quality indicators [23]. The Norwegian Knowledge Centre for the Health Services (NOKC) suggests using *30-day survival probabilities* as routinely reported

quality indicators for Norwegian hospitals (see e.g. [24]). As a further control, we also use a 90-day survival.

The main contribution of this paper is to add to the knowledge base concerning how changes in financial incentives influence survival rates for patients with chronic conditions. We use registry data with a battery of contextual (i.e. municipality-level primary and social care attributes) and patient-level control variables. Using a quasi-experimental design—the difference-in-differences (DiD) approach—we estimate several models to test the robustness of the results. Importantly, we have variables that identify patients’ pathways between providers of health care. We study three mutually exclusive pathways. These pathways are the important ones in terms of the number of patients dependent on co-operation and co-ordination between state and municipal health care providers:

- (i) Home–Hospital–Home (hereafter referred to as Ho-H-Ho), where patients are admitted to hospital from home, discharged from hospital and returned home again.
- (ii) Home–Hospital–Social Care Institution (hereafter referred to as Ho-H-Sc), where patients are admitted to hospital from home, discharged from hospital and admitted to a social care institution, and
- (iii) Home/and or Social care to Hospital to another Hospital (hereafter referred to as Ho-H-Oh), where patients are admitted to hospital from home/social care, discharged from hospital and admitted to another specialist hospital.

We hypothesize that through better coordination between a municipality and hospital in charge of treatment, the new economic incentives may affect the distribution of patients allocated to the specific pathways, which in turn will influence both the 30 and 90-day survival probabilities compared to the pre-CR situation. The underlying rationale of our hypotheses is that the changes in economic incentives following the CR potentially encourage municipalities to allocate resources differently (to evade more expensive specialist care, in

particular). Our assumption is that the change in payment systems may alter the distribution/group of patients referred to hospitals, which in turn potentially influences survival rates. However, the compound effect of the CR is difficult to predict a priori. If patients referred to and admitted to the hospitals were older and more fragile during the post-reform compared to the pre-reform situation, then survival rates may be reduced due to the mechanism outlined by Meacock et al. [18]. On the other hand, hospitals are best at treating the “critical/bad cases”, so the new “division of labour” could actually increase survival rates due to a combination of demand and supply effects². Thus, even with a constant demand for hospital services, a more efficient distribution of patients between municipalities and hospitals would allow hospitals to concentrate on more specialised and complicated health services. As a result, more attention to cohesive patient pathways would benefit patients in need of specialised services, and in turn, survival rates may increase.

The changes in the distribution of patients may be patient pathway-specific dependent. However, it is rather difficult to predict the differential pathway-specific impact of financial incentives on the survival rates. The change in economic incentives may lead to a “selection” of patients, such that the potentially frailer patients are admitted to hospital, and upon discharge, they are transferred either to nursing homes (S_c) or to another type of specialist health care (O_h). Thus, the CR-reform may have countervailing effects: On the one hand, patients are frailer and significantly different on average from the pre-CR situation, indicating reduced survival rates. On the other hand, assuming the coordination between hospital in charge of treatment and nursing home or “follow-up” hospital after discharge is adequate, then the post-reform changes in the process and management of patients would positively impact survival probabilities for patients following these pathways.

² Referrals to specialist care - more expensive than primary and social care - are largely the responsibility of general practitioners (GP) under contract with local governments. They are gatekeepers and patients’ advocates, while having no financial incentives concerning admissions to hospital.

Methods

Data and variables

Our patient data come from the Norwegian Patient Registry (NPR), from which we extracted information on in-patient hospital admissions (emergency or planned), patient age, gender, diagnoses, admission and discharge dates, death date, patient pathways, DRG codes. The primary NPR data set contains only the main diagnosis of patients admitted to hospital (available for this purpose until the 2014). We obtained another dataset from the NPR with not only the main diagnosis but also the secondary diagnoses involving important chronic conditions. This information is useful for defining the multimorbidity status (co-occurrence of two or more chronic conditions) of the patients. One limitation of the data set is that the data with secondary diagnoses is presently available only through 2013. The effects of the CR on survival are likely to be stronger for chronic illness with complex needs than for the majority of in-patient admissions³. Thus, for the *period 2010 to 2013* (two years pre-reform and two years post-reform), this study uses a subset of NPR data and two other registry data sets, namely, Statistics Norway (SSB)'s data set on patients' socio-economic conditions, and the KOSTRA (Municipality-State-Reporting) data set with municipal level attributes.

During our study period, there were roughly 3.18 million in-patient admissions with length of hospital stay (LOS) greater than or equal to one day, where 67 per cent of admissions were emergencies and the rest were planned. This study considers 30 important chronic and long-term conditions for which administrative data are available, also used in previous literature [9, 25]. These 30 diagnoses include alcohol abuse, asthma, atrial

³ Moreover, assessing the relationships with the 30-day and 90-day survival rates, using data on all in-patients' categories and all diagnoses in a regression specification may produce 'noise' because not all patients or diagnoses are equally important in terms of the CR.

fibrillation, cancer, lymphoma cancer, metastatic cancer, chronic heart failure, chronic kidney disease, chronic pain, chronic pulmonary disease, chronic viral hepatitis B and cirrhosis (see Appendix for the 30 chronic conditions with their ICD-10 codes; [25], Table 1, p 31).

In general, a DRG payment covers all charges associated with an in-patient stay from the time of admission to discharge. Under a DRG-based system, a hospital's income depends on the price per DRG, and the number of patients discharged within each DRG. We define an in-patient stay as an episode of treatment requiring the patient to remain in hospital for a minimum of 1 night, (i.e. episode-specific LOS equal to or greater than one day)⁴. To define a patient's treatment during an episode, we constructed episodes by using patient identifiers, DRGs, and admission dates. Our subset of NPR data involves 563,096 in-patient episodes (around 78 per cent of emergency admissions) with LOS \geq 1. Table 1 describes the name and definition of the variables used in our analyses. Due to missing data for a few covariates, our final dataset consists of 547,101 in-patient episodes, where 435,465 episodes were emergency admissions and the other 111,636 episodes were planned (Table 2).

Table 2 further describes the number of patients for the *surgical DRGs and medical DRGs* by emergency and planned admissions, in both the pre- and post-reform periods. The number of patients in the groups are rather stable during the pre- and post-reform periods. In particular, in pre-reform period, the total number of patients in *surgical* group were 60,670 (where 31,510 were emergency admissions and the rest were planned admissions) and the post-reform the number slightly increased to 63,327 (where 31,627 were emergency admissions). For the *medical* group the number of patients were 211,146 (186,177 were emergency admissions) in the pre-reform period, and increased to 211, 958 (186,151 were emergency admissions) during the post-reform period.

⁴ Patients often appear multiple times within the in-patient records since these are predominantly recorded at the episode level. Sometimes we use the terms "admission" and "episode" interchangeably.

As mentioned, our NPR data consist of two variables that identifies the patient pathways between providers of health care. To determine whether discharged patients are in need of social care services or other health care services, we used these variables describing the patients' pathway after discharge from hospital, and place of residence before and after hospitalization. Table 3 details patient distribution by pathways, comparing the pre- and post-reform periods. Notice that the absolute number of patients following the different pathways changes. While the H_o-H-H_o pathway is stable, the number of patients using the H_o-H-S_c pathway nearly doubled from 11,567 patients to 22,603 patients. The number of patients following the H_o-H-O_h pathway decreased by approximately 4,000 patients.

This study defines two dichotomous *dependent variables* based on survival probability after in-patient hospitalization per episode of admission. The first dependent variable is equal to 1 if a patient survived for 30-days (surv_30), and the second variable equal to 1 if a patient survived for 90-days (surv_90). The reduction in the LOS during the post-CR period is an important reason for measuring survival probabilities from admission to hospital.

Independent variables describe both individual patient-level and municipality-level attributes. To control for patient heterogeneity, we include four age categories, and gender. Three variables are included to capture the complexity and severity of patients. A categorical variable capturing the multimorbidity status (multi) of the patient is defined if the number of chronic comorbidities is greater than or equal to 2⁵. The second variable accounts for case mix heterogeneity and is defined by the yearly-adjusted DRG prices (hrg_log).⁶ The third variable includes the hospital length of stay (LOS). Endogeneity could be a potential problem for LOS, in particular. To limit this problem, instead of using patient day(s) of LOS, we constructed an

⁵ To check robustness of our results, we alternatively constructed multimorbidity status (multi=1) if the number of chronic comorbidities greater or equal to three.

⁶ DRGs provide a flat per-discharge payment that varies based on diagnoses, severity, and procedures were performed. A standard year-specific monetary conversion factor, used to convert DRG weights into base payment rates for each DRG.

average LOS variable by DRG, hospital and year, and subtract this average LOS from patient's day(s) of LOS. We then construct a dummy variable (LOS_M) equal to 1 if patient's in hospital LOS is greater than average LOS⁷.

Since Norwegian municipalities are responsible for providing primary health care and social care, we control for municipality relevant attributes (time-varying). In particular, to control for the magnitude and quality of primary care services, we include the number of patients per GP and percentage of the GPs with open lists (as an indicator of effective supply of primary care in municipalities) [26]. Proxy variables for social care service capacity in municipalities are the number of home care receivers relative to the number of inhabitants aged 80 years and over ('home care') and the number of institutional care receivers relative to the number of citizens aged 80 years and over ('institution care'). We further include a municipality-level attribute describing the 'quality of services' offered at social care institutions, such as physician hours per week available for the residents in nursing homes (Phy_Inst). A priori, we believe a higher number of physician hours in nursing homes indicates higher quality of services, associated with higher survival probability because the care of discharged patients is better facilitated than with municipalities with lower physician capacity. We also control for the share of inhabitants living alone at home, as an indicator of formal care needs. Table 1 describes the variables used in the analyses.

Analytical strategies

All chronic and multimorbidity patients

We examine the associations from introducing a municipal co-payment of 20 per cent of the national DRG price for *medical DRGs* only, *not for surgical diagnoses*, paid by the home

⁷ This might not be an ideal instrument of patient's LOS but could mitigate the problem concerning patients with long LOS (or outliers).

municipality of the patients when they are admitted to hospital. We use this difference as an identifying restriction by assuming that the expected change in *survival probabilities* for a patient admitted for surgical DRGs (control group) is the same as it would have been for the medical DRGs (treatment group) in the absence of the 20 per cent co-payment (the reform). Using a quasi-experimental framework, we estimate a standard DiD equation, which is expressed while including all pathways as:

$$s_{ijt} = \beta_0 + \beta_1 R_t + \beta_2 T_i + \beta_3 R_t \times T_i + \beta_4 multi_i + \beta_5 P_i + X_i \delta + M_j \chi + v_j + \mu_j + \varepsilon_{ijt} \quad (1)$$

The pathway specific DiD equation can be written as:

$$s_{ijt}^p = \beta_0 + \beta_1^p R_t + \beta_2^p T_i + \beta_3^p R_t \times T_i + \beta_4^p multi_i + X_i^p \delta^p + M_j^p \chi^p + v_j^p + \mu_t^p + \varepsilon_{ijt}^p \quad (2)$$

We performed the analysis at the individual patient's spell-level using a linear regression model (i.e. linear probability model, because our dependent variable is dichotomous).

In equation (1), s_{ijt} is the survival probability (the 30-day or 90-day after in-patient hospital admission while considering all patient pathways) of a patient-episode i , living in municipality j at time t ; R_t is defined as the reform, and $R_t = 1$ indicates a post-CR time period of 2012–2013, while $R_t = 0$ indicates the pre-CR time period of 2010–2011. T_i indicates treatment status, where $T_i = 1$ if patient belong to the intervention group (i.e. *medical DRG group*) and $T_i = 0$ if patient belong to the surgical DRG (*control group*). $multi_i$ is a dummy variable indicating whether a patient with multimorbidity. P_i indicates a dummy variable on pathways, where Ho-H-Ho is considered as an omitted category.

In equation (2) s_{ijt}^p indicates patient pathway-specific survival probability (the 30-day or 90-day). All other terms included in the righthand side of equation (2) illustrate the same covariates as indicated in Equation (1) but the superscript p indicates that they are the estimated coefficients for specific pathway. We performed the analysis at the individual patient's spell-level using a linear regression model (i.e. linear probability model, because our dependent variable is dichotomous). To control for observable patient differences, important

patient-level observable characteristics that could influence survival probability. We include in particular, patients' socio-economic attributes and patient-level attributes reveal patients' needs and severity, as mentioned in *Data and variables*. To control for observable contextual differences given patient's residence, we also control for their time-variant municipal level observable characteristics (see Data and variables). In Equation (1), the vector X_i includes patient-level attributes and vector M_j includes municipality-level characteristics. The estimated interaction term, the DiD estimate, $\hat{\beta}_3$ (in Equation 1) measures the effect of CR reform while considering for all patient pathways and $\hat{\beta}_3^p$ (in Equation 2) indicates the effect of CR reform for specific patient pathway. Municipalities make decisions for their inhabitants that may not be observable in our data, but that may lead to changes in patients' health and social care use, and in turn their survival probability (i.e. the source of potential unobservable confounding factors). Given the heterogeneity amongst municipalities in the coverage of different health and social care services, in Equation (1) we include municipality unobservable fixed effects ν_j , to capture municipality differences that are constant over time. To capture survival differences over time that are common to all municipalities we also include yearly fixed effects, μ_t . ε_{ijt} is the idiosyncratic error term.

There might be circumstances when the co-payment affects different types of hospital admission episodes differently because of the selection of patients. For example, financial incentives may *not* affect emergency admissions and in turn the survival probability but may influence planned admissions and the associated survival probability. To capture this sort of heterogeneity in the patient groups and to understand the mechanisms, we estimate separate regressions for emergency and planned admission episodes.

Multimorbidity sub-analysis

To be able to estimate differential relationships of the economic incentives for multimorbidity patients. we add additional interaction terms to examine any differential associations of multimorbidity status. Equation (1) can be rewritten (including all patient pathways) as:

$$s_{ijt}^m = \beta_0 + \beta_1^m R_t + \beta_2^m T_i + \beta_3^m R_t \times T_i + \beta_4^m multi_i + multi_i(\beta_5^m T_i + \beta_6^m R_t + \beta_7^m R_t \times T_i) + \beta_4^m P_i + X_i^m \delta^p + M_j^m \chi^m + v_j^m + \mu_t^m + \varepsilon_{ijt}^m \quad (3)$$

The estimated coefficient for the triple interaction term (difference-in-differences-in-differences (DiDiD) in Equation 3), $\hat{\beta}_7^m$ measures the differential relationships of the reform on multimorbidity patients compared with non-multimorbidity patients. We also estimate Equation (3) for alternative pathways and alternate admission types. Analogous to Equation (2), the pathway specific DiDiD equation can be written as:

$$s_{ijt}^{m^p} = \beta_0 + \beta_1^{m^p} R_t + \beta_2^{m^p} T_i + \beta_3^{m^p} R_t \times T_i + \beta_4^{m^p} multi_i + multi_i(\beta_5^{m^p} T_i + \beta_6^{m^p} R_t + \beta_7^{m^p} R_t \times T_i) + X_i^{m^p} \delta^{m^p} + M_j^{m^p} \chi^{m^p} + v_j^{m^p} + \mu_t^{m^p} + \varepsilon_{ijt}^{m^p} \quad (4)$$

The estimated DiDiD coefficient $\hat{\beta}_7^{m^p}$ in Equation 4 measures the pathway specific differential effects of the reform on multimorbidity patients compared with non-multimorbidity patients.

Parallel trends assumption

A key assumption of the DiD analysis is that of parallel trends. This states in general terms that in the absence of intervention/reform, the average outcomes of the treatment group and the comparison groups are the same in the pre-intervention period [27]. This assumption has been tested graphically and statistically. To test the assumption statistically, we define the pre-reform period as 2010 (*placebo pre-reform*) and the post-reform period as 2011 (*placebo post-reform*) as a way ‘artificially’ to scrutinize the parallel trends assumption. This is tested by evaluating the significance of the coefficients $\hat{\beta}_3$, $\hat{\beta}_3^p$, $\hat{\beta}_7^m$ and $\hat{\beta}_7^{m^p}$ in regression models (1) (2) (3) and (4), respectively. Statistical *insignificance* of the coefficients implies that the parallel trends assumption is valid [28].

Robustness checks

To examine the robustness of our results, we performed a variety of analyses. The size of the Norwegian municipalities is diverse. There are many municipalities in Norway with few inhabitants. The CR reform outcome may be different for smaller municipalities (or create noise in the estimation) than for larger ones. In the first set of robustness checks, we re-estimate (using Equations 1 and 2) our baseline DiD and DiDiD models (for all admissions; emergency and planned admissions separately) by dropping small municipalities (i.e. municipalities with total number of inhabitants less than 10,000). Additional DiDiD models are estimated by using an alternative definition of multimorbidity status of the patients, namely, if the number of chronic comorbidities is greater than or equal to 3.

In the second set of robustness checks, we include all in-patient admissions (chronic and/or non-chronic) during our study period 2010–2013. First, using Equation (1) for this large sample, we estimate our baseline DiD models for all admissions, and emergency and planned admissions separately (because of a lack of information on multimorbidity status we cannot estimate the DiDiD models for this sample). Second, using the same sample and dropping small municipalities, we re-estimate the models (for all admissions, and for emergency and planned admissions separately) by dropping small municipalities (total number of inhabitants less than 10,000).

Results

Descriptive statistics

Table 2 describes the distribution of patients for the *medical DRGs* and *surgical DRGs*, in both the pre- and post-reform periods. The natural survival rates are comparable across the pre- and post-reform periods for all admissions, emergency and planned admissions.

Figure 1 illustrates the 30-day and 90-day natural survival rates for medical and surgical diagnoses for the years 2010-2013. The upper panel of the figure illustrates the survival probabilities by surgical and medical diagnosis for all admissions, the middle panel shows the survival probabilities by surgical and medical diagnosis for emergency admissions and the lower panel describes the survival probabilities by surgical and medical diagnosis for planned admissions. As seen in Figure 1, irrespective of admission types (emergency or planned), the natural survival probabilities are consistently lower for medical than surgical diagnoses, but survival probabilities slightly increased in post-reform period for both surgical and medical diagnoses. Moreover, as expected, the survival rates are lower for emergency admissions than for planned admissions for all groups of patients (see Table 2 & Figure 1).

We observe a slight decline in the share of admissions for multimorbidity patients (*multi*) between the pre- and post-reform period. This gives an indication that the overall patients' health on average may improve over time. The age and gender distributions are rather stable too. However, post-reform, those aged 67–79 years (*age79*) constitute a larger share of both emergency and planned admissions than in the pre-reform period. The share of youngest patients is higher in the medical group than in the surgical group. The distribution of patients in the elderly age groups are comparable across these two groups. Regarding education level, the differences between groups and over periods are small.

The relative use of some of the pathways changed more profoundly. While the share of H_o-H-H_o is rather stable, H_o-H-S_c doubled, driven mainly by changes in emergency admissions, from 4.9 per cent to 10.0 per cent. This increasing share is observed for both surgical (11.2 per cent to 20.0 per cent) and medical (3.9 per cent to 8.3 per cent) emergency patients (Table 2).

The survival probabilities are constant for patients following the pathways H_o-H-H_o but marginally increases for patients following the H_o-H-S_c and H_o-H-O_h pathways (Table 3).

For the latter two pathways, the increasing rate in the survival probabilities are fairly higher for the 90-day survivals than the 30-day. Regarding the age distribution of patients, while there are few noticeable changes to the H_o-H-H_o pathway, there are interesting changes in the other two pathways. The H_o-H-S_c pathway has a noticeable reduction in the share of relatively young patients (age44). Those who are 45–66 years also constitute a smaller percentage in post-reform, a reduction of close to three percentage points. However, the shares are higher for the older groups of patients, with those who are 67–79 years and in particular those who are 80 years and older experiencing a change in share from 68.7 per cent to 69.9 per cent. There was also an increase within the age category 0–44 years for the H_o-H-O_h pathway from 4.2 per cent to 5.2 per cent. For this same pathway there was an increase in share from 23.5 per cent to 25.4 per cent for the age category 45–66 years, and from 26.7 per cent to 28.7 per cent for the age category 67–79 years. However, the share of the oldest groups of patients, those 80 years and older, fell from 45.6 per cent to 40.6 per cent.

Table 2 shows that the mean episode specific LOS and the share of patient with higher than mean LOS days (*LOS_M*) change only moderately between pre- and post-reform period. However, separating the stays according to the pathways the patients follow, reveals a different finding. There are only small changes (both *LOS* and *LOS_M*) for patients taking the H_o-H-H_o pathway, but Table 3 shows that the average LOS for the H_o-H-S_c pathway changes from approximately 9.0 days to 7.5 days, a reduction of 17 per cent or 1.5 days on average. The share of patients with the higher than average LOS (*LOS_M*) is decreased by 1.5 percentage point. The *LOS* (and the *LOS_M*) is also reduced for patients taking the H_o-H-O_h pathway (from 8.1 to 6.5 days), a reduction of approximately 20 per cent, and *LOS_M* is decreased by 4.1 percentage point.

Most of the municipality attributes remain relatively constant between the pre- and post-reform periods. However, it is evident that the *Phys_Inst* attribute increased after the

reform for both the intervention and comparison groups (Table 2) and within the pathways (Table 3).

Table 4 describes the correlation coefficients of survival probabilities with dummy variable post-reform and medical DRGs (intervention group); patient as well as municipal-level variables. Analogous with Figure 1, the correlation coefficients are positive with the post-reform variable implying that the survival rates are positively correlated with the reform. Magnitudes of the coefficients are small, though. The other patient-level covariates are also correlated with survival probabilities with expected signs. For example, multimorbidity status, elderly, low educated patients, severity attributes (i.e. *hrg_log*, *LOS/LOS_M*) – are all attributes negatively correlated with the survival probabilities. Survival correlations also show expected sign with patient pathways. For example, the correlation coefficients are rather large and positive for the patients following H₀-H-H₀ pathway. The survival probabilities seem to be barely correlated with municipality-level attributes.

Analytical results

Main results and results by admission type for all chronic patients

The analytical main results for the 30-day and 90-day survival probabilities are presented in Table 5. As indicated from the descriptive correlations, the regression coefficients of the “*reform*” variable are positively and significantly associated with the survival probabilities, while the “*treatment*” coefficients are negatively and significantly associated with survival probabilities. There are positive and significant CR associations (the *reform*treat* coefficients or the DiD estimator) with the 30-day survival rates for all admission episodes (0.36 per cent) and emergency episodes (0.68 per cent) analysed separately. The magnitude of the associations is also positive and significant, and comparatively higher for the 90-day survival probability for all admissions (0.58 per cent) and planned admissions (0.62 per cent). A

positive but weak significant (at the 10 per cent level) relationship with the 90-day survival probability is observed for emergency admissions. For planned admissions, however, the relationship with the 30-day survival is statistically insignificant.

Table 5 also shows that relative to patients taking the H_o-H-H_o pathway (the omitted category), the other pathways have significantly lower survival rates (for both the 30-day and 90-day), as expected.

We find opposite directions in the relationships between the LOS_M (i.e., whether LOS is greater than the average LOS) and different survival probabilities and admission types. The 30-day survival probability is positively and significantly associated with LOS_M for all and for emergency admissions, whereas the associations are negative and significant for the 90-day survival. However, for planned admissions LOS_M is negatively and significantly associated with both the 30-day and 90-day survival probabilities.

Alternative pathways: overall results and results by admission type

The path specific results from the analyses of the pathways H_o-H-H_o , H_o-H-S_c and H_o-H-S_c are reported in Table 6. For patients following the H_o-H-H_o pathway there are on average no significant associations in survival probabilities. As we predicted at the onset, one could argue that this result is as expected. Patients going home after hospitalization are on average likely to be healthier compared to patients discharged elsewhere. There is also a negative age effect because younger patients have higher survival rates than older ones.

Irrespective of alternative definition of the survival probabilities, patients following the H_o-H-S_c pathway experienced on average significant associations with their survival rates, but there is a substantial difference between emergency and planned admissions. For all admissions, the survival probabilities increase on average by 1.53 and 2.04 per cent for respectively 30-day and 90-day survival. Emergency admitted patients also experience a

significant improvement in their survival rates (1.50 and 1.73 per cent for the 30-day and 90-day survival respectively). However, for planned admissions, the survival probabilities are negatively associated with the reform (7.48 and 13.62 per cent decrease in the survival rates for the 30-day and 90-day survival respectively). The descriptive statistics in Table 3 show that more patients followed this pathway after reform and that the age distributions changed towards larger shares of older cohorts. The LOS also decreased quite substantially. Although not reported in Table 2, in our data we found that the average LOS decreased from 9.4 days to 7.4 days for emergency admissions but increased for planned admissions from 7.2 days to 9.1 days for patients following the H_o-H-S_c pathway. The reduced survival rates for planned admissions indicate that the chronic and multimorbidity patients are older and frailer than in the pre-reform period, while emergency patients are younger and stronger leading to an increase in their survival rates for this pathway. We hypothesized that the CR is likely to be the cause of this shift in the distribution of patients.

The survival rates (both the 30 and 90-day) for all and emergency admitted patients following the H_o-H-O_h pathway are also positively and significantly associated with the reform. There is no significant association for planned admissions for the 30-day but a positive and significant association holds for the 90-day survival rate.

Multimorbidity subgroup: overall results and results by admission type and pathways

Using Equation (3) for multimorbidity patients, the summary results (analogous to those in Table 5) are reported in the first row of Table 7 ($\hat{\beta}_7^m$). For both the 30-day and 90-day survival probabilities, no significant associations are observed for all admissions and alternative admission types, emergency admissions or planned admissions, for these multimorbidity patients.

Table 7 also shows the relationship between the CR and survival probability within the pathways ($\hat{\beta}_7^{mp}$) for multimorbidity patients (analogous to those in Table 6). For all admissions, we find a weak negative and significant association (at the 10 per cent level) with the 30-day survival probability for the multimorbidity patients following the H_o-H-H_o pathway, and this negative and significant relationship (at the 5 per cent level) with survival probability is also observed for planned admissions for patients following this pathway. However, for emergency admissions we find a positive and significant association with the 90-day survival probability for patient following this pathway. For the patients following the H_o-H-S_c pathway, although we find positive and insignificant associations with the 30-day survival for all and emergency patients, the relationships are positively and significantly associated with the 90-day survival probability. For planned admissions, we find negative but insignificant associations with survival probabilities for the multimorbidity patients following the H_o-H-S_c pathway. Negative associations are also observed for all admissions, emergency and planned, for patients following the H_o-H-O_h pathway. However, all coefficients are insignificant. Overall, these results indicate that the positive associations with the 90-day survival rates and the CR-reform on multimorbidity patients is pertinent for the H_o-H-H_o (0.87 per cent) and H_o-H-S_c (3.57 per cent) pathways for the emergency patients. For the H_o-H-H_o pathway and planned patients such an association is negative (0.58 per cent) with the 30-day survival rates.

Testing the parallel trends assumption

The statistical tests for placebo reform effects (test of the *parallel trends assumption*) for chronic patients (DiD estimates) and for the multimorbidity subgroup results (DiDiD estimates) are presented in Table 8. Our graphical (Figure. 1) and statistical results are not

entirely convincing in supporting the parallel trends assumption for all alternative admissions and pathways.

Nevertheless, for our important patient group, that is, patients following the H_o-H-S_c pathway, the *placebo reform effects (DiD estimates)* are found to be *insignificant* for all admissions and emergency admissions and for both survival indicators—30-day and 90-day. These results imply that the positive CR effects on survival rates for this patient pathway may not be biased.

The *placebo DiDiD estimate* for planned admissions is *insignificant* for the multimorbidity subgroup patients following the H_o-H-H_o pathway (for the 30-day survival), which implies that the negative CR effects (reported in Table 7) on the 30-day survival rates for multimorbidity patients (planned admissions) is not biased for this pathway. Analogously, the *placebo DiDiD estimate* for emergency admissions for both survival indicators is *insignificant* for the multimorbidity patients following the H_o-H-S_c pathway, which suggests that the positive CR effects (reported in Table 7) on the 90-day survival rates for multimorbidity patients (emergency admissions) is not also biased for the H_o-H-S_c pathway.

Notice that for all other *placebo DiD and DiDiD estimates* (reported in Table 8), we do not find any positive and significant relationships with any of the alternative admissions and pathways. Intuitively, this result suggests that the *pre-reform trend* in the survival rate was either ‘negative’ or ‘no trend’, though not ‘positive’.

Robustness checks

Table 9 presents the DiD and DiDiD estimates for chronic and multimorbidity subgroup patients with small municipalities omitted. Compared with the DiD coefficients reported in Table 5, we find positive and significant associations with the CR (and larger) for all admissions (0.50 per cent and 0.68 per cent for the 30-day and 90-day survival respectively)

and emergency admission (0.89 per cent and 0.63 per cent for the 30-day and 90-day survival respectively) and no association for planned admissions for the 30-day survival but positive association with the 90-day survival (0.54 per cent). Analogously, for this restricted sample, as before, null effect is observed for the H_0 - H - H_0 pathway; positive and significant (rather weak) associations are observed for all admissions for the two other pathways (see Table 6)⁸.

For this restricted sample, our DiDiD estimates for multimorbidity subgroup patients also produce similar results to those reported in Table 7. Moreover, an alternative definition of multimorbidity status of the patients, that is, if the number of chronic comorbidities is greater than or equal to 3, yields similar results.

Using Equations 1 and 2, we further examine the CR effects for all in-patient admissions (chronic and/or non-chronic patients) during the study period 2010–2013. For this vast number of in-patient admissions ($N=1,902,564$), for both survival variables, we also find positive and significant CR effects for all admissions but with a comparatively smaller survival probabilities (0.16 per cent and 0.35 per cent for the 30-day and 90-day respectively) and do not find any significant effect for emergency and planned admission separately⁹. However, we find a small negative and significant association with the 30-day survival (-0.10 per cent but no significant association with the 90-day survival rate) for the H_0 - H - H_0 pathway for this sample. As before, a positive and significant association is observed for all admissions for the H_0 - H - O_h pathway; but no significant relationship is observed for all admissions for the H_0 - H - S_c pathway (not reported here but results can be available upon request). As a further robustness check, we repeat the same analyses for all in-patient admissions, but excluding small municipalities, and obtain similar results as those when including all municipalities.

⁸ Moreover, we have also estimated the models excluding municipality-level time-varying characteristics, and find similar results (in respect of the magnitude of coefficients and their directions) as reported in Tables 5 & 6. In particular, positive and significant CR effects for all admissions, emergency admission, and null effect for planned admissions.

⁹ For this large sample, in our data we do not have information about the patients' multimorbidity status.

Discussion

This study aims to examine the association of introducing a new economic incentive—the co-payment scheme—with the 30-day and 90-day survival probabilities after hospitalization for chronic and multimorbidity patients. This study hypothesizes that new economic incentives—through changes in the distribution of patients allocated to the specific pathways compared to the pre-Coordination Reform (CR) situation could influence survival probabilities. To add to our understanding of underlying mechanisms behind the association of the CR on survival, the patient pathways among different health care and social care providers are modelled explicitly. In our subgroup analysis, we examine differential effects by alternative in-patient admissions as well.

The descriptive results show that the survival probabilities are slightly increased for both medical and surgical groups in the post reform period. The distribution of the sampled patients by age, gender and education does not change between the pre- and post-reform periods. The distributions of the patients following the different pathways are more or less similar pre- and post-CR. The notable differences are observed for one specific pathway: *patients coming from home and discharged to social care institution after hospitalization* (H_o-H-S_c). The noteworthy differences from the pre-reform period are: (i) a near doubling of the share of patients taking this path, (ii) a decline in the share of relatively young patients (<67 years of age) following this path, and (iii) a sharp decline in average LOS at hospital for patients taking this path.

Our *difference-in-differences* main results show that the *survival probability for patients with chronic conditions is significantly and positively associated with the CR*. The overall findings of a positive association are stable across the majority of robustness checks. After analysing emergency and planned admissions separately, however, we find that the

change in the survival probability is significant and positive for *emergency admissions only*. There is no significant change for planned admissions.

We find no significant difference for patients that are admitted to hospital from home and return home (H_o-H-H_o), the largest group of patients. However, we do find positive and significant associations with survival for *emergency patients* for two specific pathways; patients coming from home and discharged to either a social care institution or to another health care institution after hospitalization (H_o-H-S_c and H_o-H-O_h). The former result potentially contradicts the results reported in Bruvik et al. (16), as we noted in the introduction. They find, based on a case study, that the number of patients who died in the nursing home after hospitalization doubled following the CR, while procedures and staffing were unchanged between pre- and post-CR. They report, as we do, that the distribution of patients changes, particularly the age distribution: patients were older pre-reform than post-reform. Bruvik et al. [16] concluded that shorter hospitalization periods leading to an increase in the number of patients transferred to nursing homes must be a result of a path shifting mechanism: patients that stay longer in hospital would be in better health when discharged thus avoiding the need to be admitted to social care institutions. As far as we know, Bruvik et al. [16] do not distinguish between patients admitted to hospital from home or from a social care institution, which would potentially be an indicator of health status upon admission. Their argument is that patients are frailer when discharged sooner, thus, the survival rates for the patients will drop. We argue that through better coordination between hospital in charge of treatment and nursing home or “follow-up” hospital after discharge, the new economic incentives may have positively influenced the survival probabilities for patients following these paths. Nevertheless, we find that for *planned admissions* of patients coming from home and subsequently discharged to social care institutions (a small number of patients), the survival probabilities (both 30-day and 90-day) are *reduced* significantly. Multimorbidity

subgroup analysis shows that this negative survival relationship is consistent across all pathways for the 30-day survival, and most evidently for the patients following the H_o-H-O_n pathway. However, based on our analysis we cannot support the notion that the CR led to a reduction in survival rates more generally, at least not for all chronic patients.

Theoretically, we argue that the new economic incentives may have countervailing effects. It could be the case that the co-payment system might induce selection of patients, i.e. for a given level of effort and quality a municipality could be induced to hospitalize the relatively more demanding patients while taking care of the less demanding patients. Thus, one could argue that the co-payment system might lead to a situation in which hospitals would have to take care of the comparatively more sick or frail patients. The fact that the average LOS is reduced quite substantially may at first contradict the selection hypothesis, i.e. if patients were more ill, they would be expected to stay longer in hospital. However, the penalty scheme may also come into play. The penalty scheme allows hospitals to unilaterally decide the discharge date, at least in principle, which may have induced hospitals to bring forward discharge dates compared to the pre-reform period. First, the understanding that some patient groups did stay too long in hospital in the pre-reform period from a medical perspective while the hospitals now have an economic incentive to discharge patients sooner. Overall, our results indicate that the CR has influenced municipalities and hospitals to change both the number of patients following the different pathways and the distribution of patients. It is likely that the new economic incentives have played a role.

However, some reservations are in place. A concern is the parallel trends assumption on which the DiD approach relies. Although we controlled for the patient and municipal level attributes, and municipality fixed-effects, our main problem is that we have only limited data points both pre- and post-CR to validate whether this assumption is well satisfied. Our statistical evidence is not totally convincing for comparable pre-intervention trends for all

alternative admissions and pathways, except for the H_o -H- S_c pathway. However, our *placebo reform* estimates (Table 8) suggests that the *pre-reform trend* in the survival rate was either ‘negative’ or ‘no trend’ but was not ‘positive’.

An issue we briefly mentioned in the introduction is that the CR introduced several policy instruments simultaneously. Although municipalities could have implemented emergency bed capacity (EBC) ‘at will’ as long as they had met the deadline [13], the interplay between the *co-payment scheme* and the use of *discharge fees in relation to delay* from hospitals are not clear-cut. Nevertheless, Ambugo and Hagen [14] found no statistically significant moderated effects of the *discharge fees* on the municipal level death rates and readmissions across the patient groups, except for patients with stroke. Moreover, we have tried to disentangle one of the links by analysing EBC and non-EBC municipalities separately. We do not find any noteworthy differences in our main results reported here for patients from municipalities with EBC and those without.

Conclusions

Three concluding remarks can be made. *First*, on average the majority of chronic patients experience either a positive association, or experience a status quo, in terms of survival probability following the introduction of the CR. Multimorbidity subgroup analysis shows no significant association with survival probabilities for all chronic patients. *Second*, the survival rates for patients with chronic conditions and multimorbidity depend both on their admission type and on the specific pathway they follow. In general, the positive relationship with the CR applies to the *Home–Hospital–Social care* (H_o -H- S_c) patient pathway. Moreover, the CR seems to have altered the relative importance of the specific pathways. Therefore, we accomplish that without modelling pathways explicitly, one may overlook important changes following the CR. Future policy evaluation studies in any pertinent context should consider

these aspects. *Finally*, emergency admissions represent the largest group of chronic and multimorbidity patients and this group has increased survival rates for two specific pathways. However, the survival probability for a smaller group of patients, following H_o-H-S_c pathway and those with planned admissions, decreased.

Policy recommendations must be made with some reservations. There is no consensus in the economic literature concerning the efficacy, applicability and optimal implementation of alternative incentive schemes under different institutional arrangements. Obviously, thorough theoretical and empirical studies are required to make a valid assessment of any new incentive schemes. It would be useful to study whether the extended patients' lives (benefit) are clinically relevant or large enough to counterbalance the associated social cost with the reform. By estimating the cost and benefits of the CR across pathways and alternate admissions, in future a comprehensive welfare analysis would be beneficial.

Abbreviations

CR: Coordination Reform

GP: General Practitioner

DRG: Diagnoses-Related Group

LOS: Length of Stay

COPD: Chronic Obstructive Pulmonary Disease

EBC: Emergency Bed Capacity

OECD: Organisation for Economic Co-operation and Development

DiD: Difference-in-Differences

H_o-H-H_o: Home–Hospital–Home

H_o-H-Sc: Home–Hospital–Social Care Institution

H_o-H-O_h: Home/and or Social care to Hospital to another Hospital

NPR: Norwegian Patient Registry

KOSTRA: KOrmmune-STat-RApportering (Municipality-State-Reporting)

ICD: International Classification of Diseases

DiDiD: Difference-in-Differences-in-Differences

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Table 1: Variables' name and description

Name	Definition
<i>Patient-level covariates</i>	
surv_30	Survival probability after 30 days of hospital in-patient admission
surv_90	Survival probability after 90 days of hospital in-patient admission
Multi	Equal to 1; if the number of chronic comorbidities is greater than or equal to 2; Equal to 0; if the number of chronic comorbidities is less than 2
age44	Age <45 years
age66	Age between 45 and 66 years
age79	Age between 67 and 79 years
age80	Age 80 years and older
Male	Male = 1; Female = 0
edu1	Seven years of primary school or less
edu2	High school, intermediate school, vocational school, 1–2 years of high school
edu3	University qualifying examination/junior college/University or other post-secondary education or less/more than four years of university/college
H _o -H-H _o	If the patient goes from home to hospital and discharged to home from hospital
H _o -H-S _c	If the patient goes from home to hospital and discharged to social care from hospital
H _o -H-O _h	If the patient goes from home to hospital and discharged to other health care institution from hospital
S _c -H-S _c	If the patient goes from social care to hospital and discharged to social care from hospital
O _h -H-O _h	If patient goes from other health care institution to hospital and discharged to other health care institution from hospital
S _c -H-O _h	If the patient goes from social care institution to hospital and discharged to other health care institution from hospital
hrg_log	Log of DRG prices (yearly adjusted)
LOS	Episode specific length of in-patient hospital stays (in days)
LOS_M	Equal to 1; if patient's LOS is greater than average yearly LOS calculated by each hospital for each DRGs
<i>Municipality-level covariates</i>	
Percap_GP	Per capita general practitioner (GP) at municipality
GP_open	Share of GPs with an open list at the municipality
Phys_Inst	Physician time per week per resident in a nursing home (in hours)
Inst_resi80	Share of residents living in an institution of age 80 years or over
Inst_80	Share of inhabitants of 80 years or over that live in an institution
Liv_alone	Share of living-alone users in a municipality that do not live in an institution (living at home)

Table 2: Descriptive statistics on the distribution of patients with chronic conditions pre- and post-reform by surgical and medical DRGs, and by admission type

Variables	All admissions (N=547,101)				Emergency admissions (N=435,465)				Planned admissions (N=111,636)			
	Surgical DRGs		Medical DRGs		Surgical DRGs		Medical DRGs		Surgical DRGs		Medical DRGs	
	Pre-Reform (n=60,670)	Post-reform (n=63,327)	Pre-Reform (n=211,146)	Post-reform (n=211,958)	Pre-Reform (n=31,510)	Post-reform (n=31,627)	Pre-Reform (n=186,177)	Post-reform (n=186,151)	Pre-Reform (n=29,160)	Post-reform (n=31,700)	Pre-Reform (n=24,969)	Post-reform (n=25,807)
Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)	
surv_30	0.968 (0.177)	0.971 (0.169)	0.941 (0.236)	0.942 (0.233)	0.942 (0.234)	0.946 (0.226)	0.936 (0.244)	0.938 (0.242)	0.995 (0.070)	0.995 (0.068)	0.974 (0.161)	0.974 (0.159)
surv_90	0.942 (0.234)	0.951 (0.219)	0.895 (0.307)	0.902 (0.298)	0.900 (0.300)	0.913 (0.282)	0.890 (0.313)	0.896 (0.305)	0.988 (0.109)	0.989 (0.102)	0.932 (0.252)	0.939 (0.240)
multi	0.325 (0.468)	0.306 (0.461)	0.426 (0.495)	0.404 (0.491)	0.374 (0.484)	0.362 (0.481)	0.435 (0.496)	0.414 (0.493)	0.271 (0.445)	0.250 (0.433)	0.361 (0.482)	0.331 (0.471)
age44	0.062 (0.241)	0.060 (0.238)	0.188 (0.390)	0.188 (0.391)	0.055 (0.228)	0.054 (0.226)	0.174 (0.379)	0.173 (0.378)	0.069 (0.253)	0.067 (0.250)	0.289 (0.453)	0.293 (0.455)
age66	0.349 (0.477)	0.349 (0.477)	0.257 (0.437)	0.248 (0.432)	0.268 (0.443)	0.273 (0.445)	0.249 (0.432)	0.241 (0.427)	0.437 (0.496)	0.425 (0.494)	0.319 (0.466)	0.303 (0.459)
age79	0.296 (0.456)	0.311 (0.463)	0.255 (0.436)	0.266 (0.442)	0.257 (0.437)	0.269 (0.443)	0.254 (0.435)	0.265 (0.441)	0.337 (0.473)	0.353 (0.478)	0.265 (0.441)	0.277 (0.447)
age80	0.293 (0.455)	0.280 (0.449)	0.300 (0.458)	0.297 (0.457)	0.420 (0.493)	0.405 (0.491)	0.323 (0.468)	0.321 (0.467)	0.157 (0.364)	0.155 (0.362)	0.127 (0.333)	0.127 (0.333)
male	0.548 (0.498)	0.553 (0.497)	0.514 (0.500)	0.512 (0.500)	0.491 (0.500)	0.492 (0.500)	0.510 (0.500)	0.509 (0.500)	0.610 (0.488)	0.614 (0.487)	0.544 (0.498)	0.534 (0.499)
edu1	0.347 (0.476)	0.324 (0.468)	0.384 (0.486)	0.373 (0.484)	0.401 (0.490)	0.382 (0.486)	0.393 (0.488)	0.380 (0.485)	0.289 (0.453)	0.266 (0.442)	0.322 (0.467)	0.322 (0.467)
edu2	0.452 (0.498)	0.461 (0.498)	0.385 (0.487)	0.391 (0.488)	0.437 (0.496)	0.445 (0.497)	0.387 (0.487)	0.393 (0.489)	0.468 (0.499)	0.476 (0.499)	0.367 (0.482)	0.370 (0.483)
educ3	0.201 (0.401)	0.215 (0.411)	0.231 (0.421)	0.236 (0.425)	0.162 (0.369)	0.172 (0.378)	0.220 (0.414)	0.226 (0.418)	0.243 (0.429)	0.258 (0.438)	0.311 (0.463)	0.308 (0.462)
H _o -H-H _o	0.653 (0.476)	0.656 (0.475)	0.790 (0.408)	0.772 (0.419)	0.455 (0.498)	0.432 (0.495)	0.773 (0.419)	0.752 (0.432)	0.867 (0.340)	0.880 (0.325)	0.915 (0.279)	0.921 (0.270)
H _o -H-S _c	0.067 (0.250)	0.107 (0.309)	0.036 (0.185)	0.075 (0.263)	0.112 (0.316)	0.201 (0.401)	0.039 (0.193)	0.083 (0.276)	0.018 (0.131)	0.012 (0.111)	0.012 (0.108)	0.017 (0.130)
H _o -H-O _h	0.234 (0.423)	0.205 (0.403)	0.155 (0.362)	0.139 (0.346)	0.354 (0.478)	0.307 (0.461)	0.168 (0.374)	0.151 (0.358)	0.104 (0.305)	0.102 (0.303)	0.059 (0.235)	0.054 (0.225)
S _c -H-S _c	0.010 (0.098)	0.004 (0.066)	0.002 (0.043)	0.002 (0.049)	0.012 (0.110)	0.009 (0.092)	0.002 (0.042)	0.003 (0.051)	0.007 (0.084)	0.000 (0.019)	0.002 (0.048)	0.001 (0.032)
O _h -H-O _h	0.036 (0.185)	0.027 (0.163)	0.017 (0.131)	0.011 (0.104)	0.064 (0.245)	0.050 (0.219)	0.018 (0.133)	0.011 (0.106)	0.005 (0.068)	0.005 (0.068)	0.012 (0.109)	0.007 (0.085)
S _c -H-O _h	0.001 (0.035)	0.001 (0.024)	0.000 (0.019)	0.000 (0.016)	0.002 (0.048)	0.001 (0.035)	0.000 (0.020)	0.000 (0.016)	0.000 (0.000)	0.000 (0.000)	0.000 (0.009)	0.000 (0.019)
hrg_log	9.098 (0.692)	9.152 (0.605)	8.169 (0.519)	8.284 (0.464)	9.321 (0.574)	9.332 (0.505)	8.181 (0.517)	8.292 (0.468)	8.857 (0.726)	8.973 (0.642)	8.081 (0.527)	8.231 (0.431)
LOS	6.379 (8.761)	5.456 (7.648)	5.451 (6.838)	5.015 (6.256)	8.571 (10.51)	7.168 (9.406)	5.272 (6.420)	4.812 (5.751)	4.011 (5.429)	3.748 (4.768)	6.786 (9.279)	6.476 (8.970)
LOS_M	0.342 (0.474)	0.331 (0.471)	0.349 (0.477)	0.352 (0.478)	0.407 (0.491)	0.392 (0.488)	0.354 (0.478)	0.355 (0.479)	0.272 (0.445)	0.271 (0.444)	0.318 (0.466)	0.333 (0.471)
Percap_GP	0.084 (0.016)	0.086 (0.016)	0.084 (0.017)	0.086 (0.016)	0.084 (0.016)	0.086 (0.016)	0.084 (0.016)	0.086 (0.016)	0.084 (0.016)	0.086 (0.016)	0.085 (0.018)	0.087 (0.017)
GP_open	41.08 (23.07)	39.18 (22.64)	40.93 (23.09)	38.70 (22.20)	40.89 (23.06)	39.08 (22.70)	40.80 (22.96)	38.55 (22.06)	41.28 (23.08)	39.29 (22.59)	41.88 (24.01)	39.75 (23.17)
Phys_Inst	0.396 (0.159)	0.469 (0.186)	0.394 (0.158)	0.467 (0.180)	0.396 (0.159)	0.467 (0.186)	0.394 (0.157)	0.466 (0.178)	0.397 (0.159)	0.471 (0.186)	0.389 (0.161)	0.469 (0.189)
Inst_resi80	18.45 (4.343)	18.67 (4.385)	18.45 (4.311)	18.70 (4.393)	18.54 (4.347)	18.73 (4.380)	18.47 (4.280)	18.71 (4.373)	18.35 (4.335)	18.61 (4.390)	18.34 (4.533)	18.59 (4.533)
Inst_80	13.99 (3.299)	13.93 (3.385)	14.03 (3.340)	13.97 (3.366)	14.09 (3.322)	14.03 (3.416)	14.04 (3.328)	13.99 (3.366)	13.87 (3.270)	13.84 (3.350)	13.92 (3.432)	13.79 (3.362)
Liv_alone	38.90 (9.043)	38.41 (8.809)	39.22 (9.219)	38.56 (8.876)	39.05 (9.115)	38.60 (8.831)	39.24 (9.211)	38.58 (8.863)	38.73 (8.962)	38.21 (8.783)	39.11 (9.279)	38.42 (8.968)

Table 3: Descriptive statistics on patient distributions pre- and post-reform period by alternative pathways

Variable	H₀-H-H₀ (N=411,621)		H₀-H-S_c (N=34,170)		H₀-H-O_h (N = 89,421)	
	Pre-reform (N=206,33)	Post-reform (N=205,288)	Pre-reform (N=11,567)	Post-reform (N=22,603)	Pre-reform (N=46,964)	Post-reform (N=42,457)
	Mean (Std. Dev)	Mean (Std. Dev)	Mean (Std. Dev)	Mean (Std. Dev)	Mean (Std. Dev)	Mean (Std. Dev)
surv_30	0.985 (0.123)	0.984 (0.127)	0.895 (0.306)	0.898 (0.301)	0.804 (0.397)	0.815 (0.389)
surv_90	0.954 (0.209)	0.959 (0.199)	0.776 (0.417)	0.794 (0.404)	0.738 (0.440)	0.765 (0.424)
multi	0.365 (0.488)	0.340 (0.473)	0.519 (0.500)	0.518 (0.500)	0.528 (0.499)	0.494 (0.500)
age44	0.198 (0.399)	0.200 (0.400)	0.011 (0.103)	0.006 (0.074)	0.042 (0.201)	0.052 (0.222)
age66	0.299 (0.458)	0.298 (0.457)	0.085 (0.278)	0.070 (0.255)	0.235 (0.424)	0.254 (0.435)
age79	0.266 (0.442)	0.280 (0.449)	0.217 (0.412)	0.226 (0.418)	0.267 (0.442)	0.287 (0.453)
age80	0.237 (0.426)	0.222 (0.416)	0.687 (0.464)	0.699 (0.459)	0.456 (0.498)	0.406 (0.491)
male	0.530 (0.499)	0.533 (0.499)	0.393 (0.489)	0.390 (0.488)	0.517 (0.500)	0.534 (0.499)
edu1	0.358 (0.479)	0.342 (0.474)	0.499 (0.500)	0.464 (0.499)	0.418 (0.493)	0.402 (0.490)
edu2	0.392 (0.488)	0.399 (0.490)	0.387 (0.487)	0.420 (0.494)	0.429 (0.495)	0.432 (0.495)
edu3	0.250 (0.433)	0.259 (0.438)	0.114 (0.318)	0.116 (0.321)	0.152 (0.359)	0.166 (0.372)
hrg_log	8.269 (0.632)	8.389 (0.577)	8.796 (0.633)	8.778 (0.559)	8.697 (0.737)	8.756 (0.698)
LOS	4.856 (6.277)	4.538 (5.969)	9.295 (9.676)	7.509 (7.713)	8.106 (9.349)	6.550 (7.907)
LOS_M	0.323 (0.468)	0.328 (0.469)	0.471 (0.499)	0.456 (0.498)	0.428 (0.495)	0.387 (0.487)
Percap_GP	0.084 (0.016)	0.086 (0.016)	0.084 (0.017)	0.084 (0.016)	0.084 (0.016)	0.086 (0.015)
GP_open	40.66 (23.01)	38.63 (22.38)	44.03 (23.27)	39.70 (20.98)	41.97 (23.07)	39.14 (22.66)
Phys_Inst	0.396 (0.160)	0.468 (0.184)	0.409 (0.162)	0.485 (0.181)	0.388 (0.148)	0.457 (0.172)
Inst_resi80	18.45 (4.312)	18.70 (4.389)	18.42 (4.459)	18.92 (4.274)	18.50 (4.252)	18.56 (4.428)
Inst_80	14.00 (3.322)	13.96 (3.373)	13.81 (3.297)	13.96 (3.183)	14.13 (3.325)	13.96 (3.427)
Liv_alone	39.08 (9.106)	38.50 (8.816)	38.09 (9.137)	37.80 (8.496)	39.61 (9.388)	38.88 (9.145)

Table 4: Correlation coefficient with survival probabilities including patient and municipal-level characteristics

Variable	All		Emergency admission		Planned admission	
	surv_30	surv_90	surv_30	surv_90	surv_30	surv_90
Post_reform	0.005	0.013	0.004	0.012	0.003	0.013
Medical_DRG	-0.052	-0.071	-0.010	-0.015	-0.089	-0.143
multi	-0.131	-0.175	-0.128	-0.169	-0.111	-0.171
age44	0.093	0.126	0.102	0.136	0.046	0.073
age66	0.069	0.087	0.068	0.085	0.023	0.038
age79	0.011	0.001	0.011	0.001	-0.017	-0.033
age80	-0.153	-0.187	-0.150	-0.184	-0.058	-0.087
male	0.003	0.001	-0.002	-0.004	-0.007	-0.014
edu1	-0.045	-0.059	-0.041	-0.055	-0.022	-0.036
edu2	-0.005	-0.007	-0.007	-0.009	-0.005	-0.009
edu3	0.057	0.075	0.057	0.075	0.027	0.046
H _o -H-H _o	0.285	0.287	0.283	0.284	0.206	0.193
H _o -H-S _c	-0.059	-0.109	-0.050	-0.102	-0.061	-0.083
H _o -H-O _h	-0.276	-0.243	-0.279	-0.245	-0.171	-0.145
S _c -H-S _c	-0.005	-0.012	-0.004	-0.011	-0.011	-0.017
O _h -H-O _h	-0.046	-0.049	-0.039	-0.039	-0.104	-0.103
S _c -H-O _h	-0.018	-0.014	-0.017	-0.013	-0.029	-0.027
hrg_log	-0.111	-0.140	-0.137	-0.172	-0.051	-0.061
LOS	-0.043	-0.103	-0.043	-0.109	-0.041	-0.074
LOS_M	-0.012	-0.044	-0.004	-0.038	-0.031	-0.046
Percap_GP	-0.002	-0.001	-0.004	-0.004	0.007	0.005
GP_open	-0.006	-0.008	-0.008	-0.010	-0.002	-0.003
Phys_Inst	0.004	0.008	0.003	0.007	0.007	0.011
Inst_resi80	0.007	0.010	0.010	0.013	0.000	0.001
Inst_80	0.006	0.006	0.009	0.009	0.001	0.001
Liv_alone	-0.001	-0.002	0.000	-0.001	0.002	0.004

Table 5: Main DiD results for all patients with chronic conditions and for alternative in-patient admissions

Variable	All admissions		Emergency admissions		Planned/elective admissions	
	30-day survival	90-day survival	30-day survival	90-day survival	30-day survival	90-day survival
reform	0.0058** (0.0023)	0.0205*** (0.0020)	0.0048 (0.0039)	0.0249*** (0.0036)	0.0027** (0.0011)	0.0087** (0.0023)
treat	-0.0765*** (0.0017)	-0.1302*** (0.0028)	-0.1116*** (0.0037)	-0.1698*** (0.0046)	-0.0323*** (0.0017)	-0.0860*** (0.0034)
reform*treat	0.0036** (0.0016)	0.0058*** (0.0017)	0.0068** (0.0028)	0.0050* (0.0030)	0.0003 (0.0014)	0.0062*** (0.0023)
multi	-0.0231*** (0.0011)	-0.0440*** (0.0014)	-0.0212*** (0.0012)	-0.0404*** (0.0015)	-0.0175*** (0.0012)	-0.0422*** (0.0018)
age66	-0.0039*** (0.0008)	-0.0163*** (0.0011)	0.0009 (0.0010)	-0.0099*** (0.0012)	-0.0101*** (0.0009)	-0.0280*** (0.0016)
age79	-0.0120*** (0.0008)	-0.0343*** (0.0013)	-0.0098*** (0.0010)	-0.0318*** (0.0016)	-0.0120*** (0.0010)	-0.0366*** (0.0020)
age80	-0.0480*** (0.0019)	-0.0867*** (0.0023)	-0.0482*** (0.0021)	-0.0870*** (0.0026)	-0.0224*** (0.0016)	-0.0611*** (0.0027)
male	-0.0061*** (0.0007)	-0.0125*** (0.0008)	-0.0077*** (0.0008)	-0.0149*** (0.0010)	-0.0025*** (0.0007)	-0.0067*** (0.0012)
edu1	-0.0008 (0.0007)	-0.0039*** (0.0010)	-0.0017* (0.0009)	-0.0051*** (0.0013)	0.0004 (0.0010)	-0.0030* (0.0016)
edu2	0.0015** (0.0007)	0.0011 (0.0010)	0.0014* (0.0007)	0.0012 (0.0012)	0.0005 (0.0011)	-0.0014 (0.0015)
H _o -H-S _c	-0.0560*** (0.0036)	-0.1122*** (0.0046)	-0.0596*** (0.0042)	-0.1175*** (0.0053)	-0.0556*** (0.0069)	-0.1012*** (0.0090)
H _o -H-O _h	-0.1583*** (0.0035)	-0.1689*** (0.0039)	-0.1732*** (0.0041)	-0.1851*** (0.0039)	-0.0710*** (0.0039)	-0.0813*** (0.0048)
S _c -H-S _c	-0.0489*** (0.0079)	-0.0930*** (0.0099)	-0.0579*** (0.0096)	-0.1042*** (0.0107)	-0.0319*** (0.0096)	-0.0659*** (0.0207)
O _h -H-O _h	-0.1062*** (0.0064)	-0.1297*** (0.0080)	-0.1120*** (0.0072)	-0.1340*** (0.0085)	-0.1404*** (0.0163)	-0.1947*** (0.0225)
S _c -H-O _h	-0.2157*** (0.0284)	-0.2211*** (0.0326)	-0.2209*** (0.0264)	-0.2232*** (0.0317)	-0.3285*** (0.1262)	-0.4418*** (0.1197)
hrg_log	-0.0366*** (0.0009)	-0.0691*** (0.0017)	-0.0526*** (0.0015)	-0.0900*** (0.0024)	-0.0090*** (0.0007)	-0.0293*** (0.0015)
LOS_M	0.0091*** (0.0009)	-0.0048*** (0.0010)	0.0124*** (0.0010)	-0.0029*** (0.0011)	-0.0039*** (0.0008)	-0.0111*** (0.0015)
Percap_GP	-0.0786 (0.0715)	-0.1055 (0.0848)	-0.0912 (0.0906)	-0.1370 (0.1018)	0.0269 (0.0882)	0.0921 (0.1269)
GP_open	-0.0000 (0.0000)	-0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0001 (0.0001)
Phys_Inst	-0.0006 (0.0042)	-0.0005 (0.0047)	-0.0002 (0.0053)	-0.0021 (0.0056)	-0.0012 (0.0037)	0.0017 (0.0065)
Inst_resi80	-0.0001 (0.0004)	0.0004 (0.0005)	-0.0003 (0.0005)	0.0003 (0.0006)	0.0006* (0.0003)	-0.0009* (0.0005)
Inst_80	0.0004 (0.0004)	-0.0001 (0.0005)	0.0005 (0.0005)	-0.0001 (0.0006)	-0.0001 (0.0004)	0.0004* (0.0006)
Liv_alone	0.0002 (0.0001)	0.0001 (0.0002)	0.0002 (0.0002)	0.0000 (0.0002)	0.0004** (0.0002)	0.0005** (0.0002)
Year fixed effects	Yes		Yes		Yes	
Municipality fixed effects	Yes		Yes		Yes	

Cluster standard errors at municipality level are in parentheses.

, * and **** represent significance at the 10%, 5% and 1% levels, respectively.

Table 6: Results by alternative pathways and by admission type (DiD estimates)

Pathway	All admissions		Emergency		Planned	
	30-day survival	90-day survival	30-day survival	90-day survival	30-day survival	90-day survival
Pathway: H _o -H-H _o	-0.0007 (0.0009)	0.0020 (0.0013)	0.0015 (0.0017)	0.0032 (0.0027)	-0.0007 (0.0010)	0.0031 (0.0019)
	[N = 411,621]		[N = 311,838]		[N = 99,783]	
Pathway: H _o -H-S _c	0.0153** (0.0071)	0.0204** (0.0089)	0.0150** (0.0072)	0.0173* (0.0090)	-0.0748*** (0.0249)	-0.1362*** (0.0411)
	[N = 34,170]		[N = 32,525]		[N = 1,645]	
Pathway: H _o -H-O _h	0.0141** (0.0067)	0.0238*** (0.0068)	0.0176*** (0.0066)	0.0256*** (0.0067)	0.0093 (0.0148)	0.0491*** (0.0165)
	[N = 89,421]		[N = 80,300]		[N = 9,121]	

All models control for the covariates included in Table 4 combined with year and municipality fixed effects. Cluster standard errors at municipality level are in parentheses. The numbers of observations are in brackets. **, *** and **** represent significance at the 10%, 5% and 1% levels, respectively.

Table 7: Results for multimorbidity patients: alternative pathways and by emergency and planned admissions (DiDiD estimates)

	All admissions		Emergency		Planned	
	30-day survival	90-day survival	30-day survival	90-day survival	30-day survival	90-day survival
All chronic patients	-0.0024 (0.0021)	-0.0044 (0.0031)	-0.0024 (0.0027)	0.0050 (0.0039)	-0.0058 (0.0037)	0.0051 (0.0057)
	[N = 547,101]		[N = 99,783]		[N = 111,636]	
Pathway: H _o -H-H _o	-0.0034* (0.0019)	0.0048 (0.0029)	-0.0012 (0.0023)	0.0087** (0.0041)	-0.0058** (0.0028)	0.0030 (0.0052)
	[N = 411,621]		[N = 311,838]		[N = 99,783]	
Pathway: H _o -H-S _c	0.0201 (0.0137)	0.0286* (0.0152)	0.0231 (0.0142)	0.0357** (0.0157)	-0.0352 (0.0593)	-0.0996 (0.0901)
	[N = 34,170]		[N = 32,525]		[N = 1,645]	
Pathway: H _o -H-O _h	-0.0121 (0.0093)	-0.0152* (0.0087)	-0.0095 (0.0107)	-0.0137 (0.0095)	-0.0292 (0.0264)	0.0059 (0.0287)
	[N = 89,421]		[N = 80,300]		[N = 9,121]	

All models control for the covariates included in Table 4 combined with year and municipality fixed effects. Cluster standard errors at municipality level are in parentheses. The numbers of observations are in brackets. **, *** and **** represent significance at the 10%, 5% and 1% levels, respectively.

Table 8: Placebo reform results for chronic and multimorbidity patients: Difference-in-differences (DiD) and Difference-in-differences-in-differences (DiDiD) estimates

	All admissions		Emergency		Planned	
	30-day survival	90-day survival	30-day survival	90-day survival	30-day survival	90-day survival
DiD estimates						
All chronic patients	-0.0055*** (0.0017)	-0.0112*** (0.0024)	-0.0085*** (0.0031)	-0.0169*** (0.0036)	-0.0030 (0.0018)	-0.0073** (0.0035)
	[N = 271,816]		[N = 217,687]		[N = 54,129]	
Pathway: H _o -H-H _o	-0.0026*** (0.0009)	-0.0091*** (0.0020)	-0.0069*** (0.0019)	-0.0173*** (0.0039)	-0.0005 (0.0013)	-0.0034 (0.0032)
	[N = 206,333]		[N = 158,208]		[N = 48,125]	
Pathway: H _o -H-S _c	0.0003 (0.0095)	0.0129 (0.0154)	-0.0028 (0.0098)	0.0067 (0.0155)	-0.1079** (0.0427)	-0.2099*** (0.0605)
	[N = 11,567]		[N = 10,759]		[N = 808]	
Pathway: H _o -H-O _h	-0.0295*** (0.0065)	-0.0336*** (0.0073)	-0.0287*** (0.0078)	-0.0327*** (0.0079)	-0.0205 (0.0192)	-0.0106 (0.0195)
	[N = 46,964]		[N = 42,472]		[N = 4,492]	
DiDiD estimates						
All chronic patients	-0.0104*** (0.0037)	-0.0238*** (0.0047)	-0.0064 (0.0056)	-0.0211*** (0.0067)	-0.0132*** (0.0038)	-0.0302*** (0.0082)
	[N = 271,816]		[N = 217,687]		[N = 54,129]	
Pathway: H _o -H-H _o	-0.0052** (0.0021)	-0.0148*** (0.0041)	-0.0060 (0.0035)	-0.0150** (0.0062)	-0.0041 (0.0033)	-0.0216*** (0.0076)
	[N = 206,333]		[N = 158,208]		[N = 48,125]	
Pathway: H _o -H-S _c	0.0181 (0.0205)	-0.0178 (0.0273)	0.0338 (0.0215)	-0.0031 (0.0284)	-0.1347* (0.0733)	-0.0608 (0.1096)
	[N = 11,567]		[N = 10,759]		[N = 808]	
Pathway: H _o -H-O _h	-0.0181 (0.0123)	-0.0366*** (0.0127)	-0.0220 (0.0133)	-0.0455*** (0.0142)	-0.0523 (0.0420)	-0.0382 (0.0488)
	[N = 46,964]		[N = 42,472]		[N = 4,492]	

All models control for the covariates included in Table 4 combined with year and municipality fixed effects.

Cluster standard errors at municipality level are in parentheses. The numbers of observations are in brackets.

‘*’, ‘**’ and ‘***’ represent significance at the 10%, 5% and 1% levels, respectively.

Table 9: Robustness checks after excluding small municipalities for chronic patients: DiD and DiDiD estimates

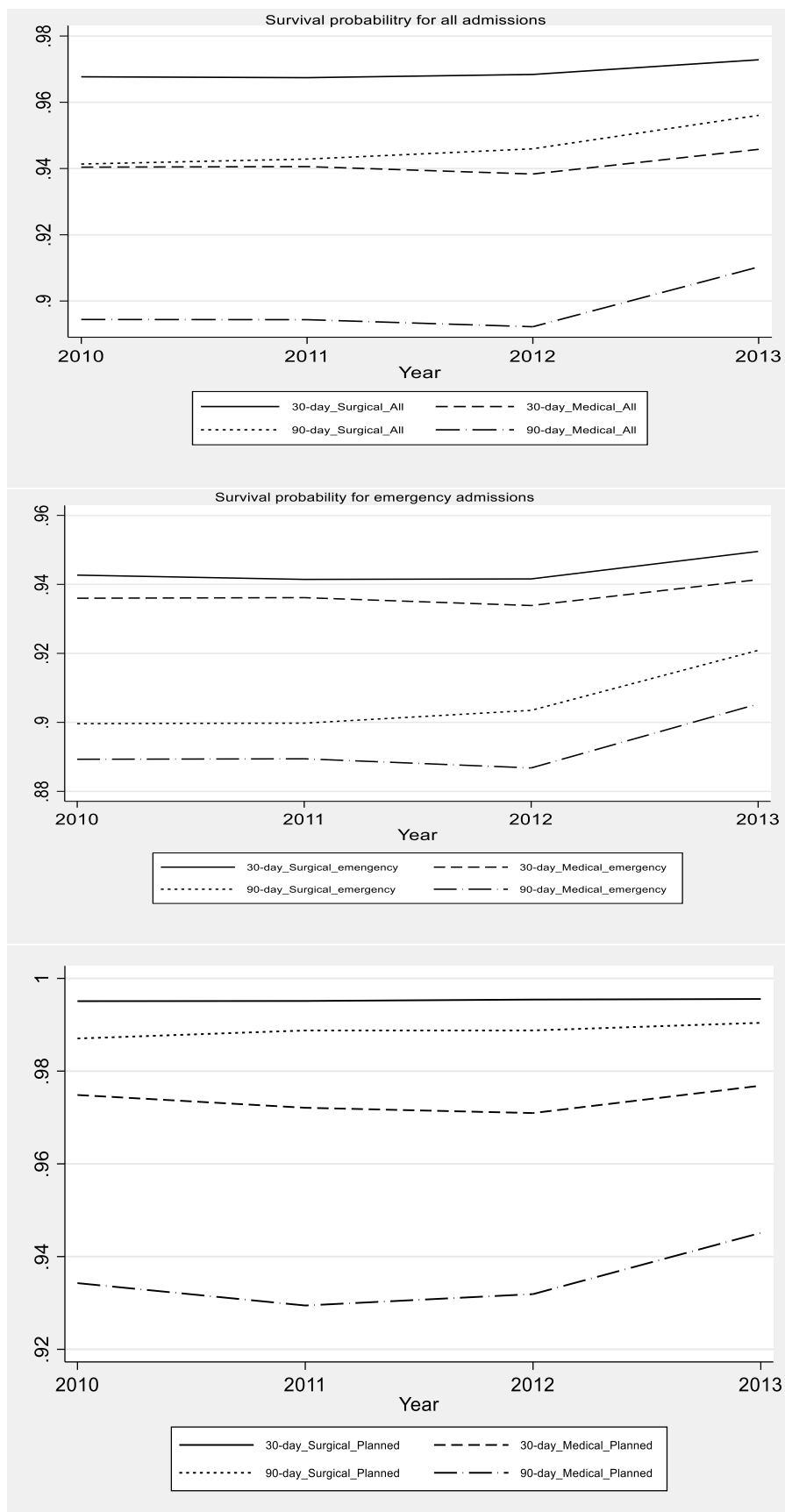
	All admissions		Emergency		Planned	
	30-day survival	90-day survival	30-day survival	90-day survival	30-day survival	90-day survival
DiD estimates						
All chronic patients	0.0050^{***} (0.0018)	0.0068^{***} (0.0019)	0.0089^{**} (0.0034)	0.0063 [*] (0.0036)	0.0000 (0.0016)	0.0054^{**} (0.0027)
	[N = 423,539]		[N = 338,553]		[N = 84,986]	
Pathway: H _o -H-H _o	-0.0003 (0.0010)	0.0020 (0.0015)	0.0014 (0.0018)	0.0020 (0.0031)	-0.0011 (0.0011)	0.0023 (0.0022)
	[N = 319,218]		[N = 243,212]		[N = 76,006]	
Pathway: H _o -H-S _c	0.0146 [*] (0.0079)	0.0181 [*] (0.0094)	0.0122 (0.0081)	0.0136 (0.0093)	-0.0624^{**} (0.0270)	-0.1448^{***} (0.0459)
	[N = 27,320]		[N = 26,070]		[N = 1,250]	
Pathway: H _o -H-O _h	0.0159 [*] (0.0083)	0.0253^{***} (0.0084)	0.0217^{***} (0.0080)	0.0293^{***} (0.0083)	0.0022 (0.0167)	0.0405^{**} (0.0188)
	[N = 68,198]		[N = 61,297]		[N = 6,901]	
DiDiD estimates						
All chronic patients	-0.0023 (0.0023)	0.0047 (0.0036)	-0.0028 (0.0030)	0.0042 (0.0043)	-0.0066 (0.0042)	0.0054 (0.0065)
	[N = 423,539]		[N = 338,553]		[N = 84,986]	
Pathway: H _o -H-H _o	-0.0018 (0.0021)	0.0054 (0.0033)	0.0003 (0.0028)	0.0083 [*] (0.0047)	-0.0060 [*] (0.0032)	0.0044 (0.0060)
	[N = 319,218]		[N = 243,212]		[N = 76,006]	
Pathway: H _o -H-S _c	0.0168 (0.0155)	0.0224 (0.0168)	0.0218 (0.0158)	0.0307 [*] (0.0173)	-0.0340 (0.0666)	-0.1018 (0.1025)
	[N = 27,320]		[N = 26,070]		[N = 1,250]	
Pathway: H _o -H-O _h	-0.0168 (0.0106)	-0.0128 (0.0100)	-0.0153 (0.0121)	-0.0127 (0.0109)	-0.0353 (0.0291)	-0.0037 (0.0325)
	[N = 68,198]		[N = 61,297]		[N = 6,901]	

All models control for the covariates included in Table 4 combined with year and municipality fixed effects.

Cluster standard errors at municipality level are in parentheses. The numbers of observations are in brackets.

'***' and '**' represent significance at the 1% and 5% levels, respectively.

Figure 1: 30-day and 90-day Survival probability of surgical and medical diagnostics, and by emergency and planned admissions for 30 chronic conditions



Declarations

Ethics approval and consent to participate

Not applicable since all data is anonymous.

Consent for publication

Not applicable.

Availability of data and materials

The data used in this study are available from The Norwegian Directorate of Health (www.helsedirektoratet.no/) and Statistics Norway (www.ssb.no), but restrictions apply to the availability of these data, which were used under licence for the current study, and so are not publicly available. However, data are available from the authors upon reasonable request and with included permission from The Norwegian Directorate of Health, Statistics Norway and Norwegian Data Protection Authority.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

MKI and JEA conceived this study. MKI and EK designed the analysis plan. MKI conducted the analysis. MKI and EK wrote the first draft of the paper, and all authors revised the paper and approved the final version.

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