**Can vertical integration reduce hospital readmissions? A difference-in-differences approach**

**Supplementary Digital Content**

**Appendix 3 – Individual risk of readmission**

**The individual risk of readmission was estimated with a hierarchical logistic regression model from a database including all public hospitals in mainland Portugal in 2004-13 (7,329,979 admissions). We estimated the risk separately for five different cohorts (medicine, surgery/gynecology, cardiorespiratory, cardiovascular, neurology) to improve model performance1. We also estimated the risk separately for each year, since the database did not contain a patient id to identify multiple admissions from the same patient in the 10 years included. The model we used for each year and cohort is represented by the equation below.**

$$logit[Prob(Readmission\_{k}=1)]= α\_{l}+ β Z\_{kl}+ ε\_{k}$$

$$α\_{l}= μ+ ω\_{l}, ω\_{l} \~N(0,τ^{2})$$

***Readmissionk* denotes if admission *k* was readmitted (1: readmitted; 0: otherwise).**

$α\_{l}$ **represents the underlying risk of a readmission at the hospital accounting for patient risk (hospital specific intercept); *μ* is the adjusted average outcome across hospitals, and** $τ^{2}$ **is the between hospital variance.**

$Z\_{kl}$ **is a vector including three admission-level covariates: age, disease (Clinical Classification Software), and comorbidities (CMS-Condition Category Groups).**

$ε\_{k}$ **is the error term.**

**References**

**1. Yale New Haven Health Services Corporation, Center for Outcomes Research & Evaluation. 2014 measures updates and specifications report: hospital-wide all-cause unplanned readmission: version 3.0. New Haven, CT: Yale New Haven Health Services Corporation. Center for Outcomes Research & Evaluation; 2014.**

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