

Social isolation in patients hospitalized for a surgery, does it matter?

A quantitative cohort study on the relationship of patients' social isolation and other predictive factors on clinical outcomes after surgery.

Student (number)	A.J. van der Wind (5956455)
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Supervisor	A.M. Eskes
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3 *factors on clinical outcomes after surgery.*

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5 Hakbijl-van der Wind AJ RN BSc^{1,2,3}, Heidsma CM MSc¹, van Dieren S PhD¹, prof. van Dijk
6 M⁴, Nieveen van Dijkum EJM MD PhD¹, Eskes AM RN PhD¹

7 ¹ Department of Surgery, Academic Medical Centre, University of Amsterdam, The Netherlands

8 ² Centre of Excellence for Rehabilitation Medicine, UMC Utrecht Brain Centre, University Medical Centre Utrecht
9 and De Hoogstraat Rehabilitation, Utrecht, The Netherlands

10 ³ Nursing Sciences, program in Clinical Health Sciences, University Medical Center Utrecht, Utrecht, The
11 Netherlands

12 ⁴ Section of Nursing Science, Department of Internal Medicine, Erasmus MC, Rotterdam, The Netherlands

13 Corresponding author: A.M. Eskes, a.m.eskes@amsterdamumc.nl

14

15 **Abstract**

16 *Background:* Patients undergoing surgery often experience postoperative complications,
17 sometimes leading to unplanned readmissions or prolonged hospital stay. Physical and
18 mental factors have been identified as predictors for postoperative complications, however,
19 the impact of social isolation during hospital admission on clinical outcomes after surgery has
20 not yet been explored.

21 *Aim:* To explore the relationship between inpatient social isolation and unplanned
22 readmissions within 90 days after surgery. Secondary objectives were to evaluate
23 relationships between social isolation and mortality, initial and total hospital length of stay
24 (LOS), and related factors to social isolation.

25 *Methods:* Patients undergoing vascular, gastro-intestinal, urological, trauma or orthopaedic
26 surgery in a Dutch tertiary hospital were included in this cohort study. Social isolation was
27 measured during hospitalization using the Friendship Scale (FS). Logistic and multivariable
28 linear regression models, adjusted for confounders using propensity scores, were used to
29 explore relationships.

30 *Results:* In total, 118 patients were included. Almost half (48.3%) underwent (oncological)
31 gastro-intestinal surgery. 29 patients (24.6%) were readmitted at least once and 3 patients
32 (2.5%) died. Median FS score was 3 out of 21 (*IQR* = 1; 5). No significant relationships were
33 observed between social isolation and unplanned readmission ($p = .478$), initial and total

34 LOS ($p = .657$; $p .601$, respectively). Living with others, but without partner, and less quality-
35 adjusted life years (QALYs) were significantly related to a higher degree of social isolation (p
36 $=.009$, $p = .002$, respectively).

37 *Conclusion and implications of key findings:* No relationship were found between inpatient
38 social isolation and unplanned readmissions, initial or total LOS. Living with others, but
39 without partner, and less QALYs were related to a higher sense of social isolation. Related to
40 other studies, it remains important to focus in clinical practice on patients' personal and
41 social factors.

42 *Key words:* Cohort studies, social isolation, surgery, hospital readmission, length of stay.

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62 **Sociale isolatie van patiënten opgenomen in het ziekenhuis voor een operatie, maakt**
63 **het uit?**

64 *Een kwantitatieve cohort studie naar de relatie tussen sociale isolatie en andere*
65 *voorspellende factoren op klinische postoperatieve uitkomsten.*

66

67 **Samenvatting**

68 *Achtergrond:* Na een operatie ontwikkelen patiënten regelmatig postoperatieve complicaties,
69 welke soms resulteren in ongeplande heropnames of een verlengde ziekenhuisopname.
70 Bekende risicofactoren voor complicaties kunnen zowel lichamelijk als mentaal zijn. Mogelijk
71 heeft sociale isolatie bij patiënten ook invloed op klinische uitkomsten na een operatie, echter
72 is dit nog niet onderzocht.

73 *Doel:* Onderzoeken van de relatie tussen sociale isolatie van opgenomen patiënten en
74 ongeplande heropnames binnen 90 dagen na een operatie. Subdoelstellingen: onderzoeken
75 van relaties tussen sociale isolatie en mortaliteit, eerste opname- en totale opnameduur, en
76 identificeren van gerelateerde factoren aan sociale isolatie.

77 *Methode:* Patiënten opgenomen voor een vasculaire, maag-darm, urologische, traumatische
78 of orthopedische operatie in een Nederlands Academisch ziekenhuis werden in deze
79 cohortstudie geïnccludeerd. Sociale isolatie werd gemeten met de Friendship Scale (FS).
80 Relaties werden onderzocht middels logistische en multivariabele lineaire regressie
81 modellen, gecorrigeerd voor confounders met propensity scores.

82 *Resultaten:* In totaal werden 118 patiënten geïnccludeerd. Bijna de helft (48.3%) onderging
83 een (oncologische) maag-darm operatie. 29 patiënten (24.6%) ondergingen ten minste één
84 heropname en 3 patiënten (2.5%) zijn overleden. Mediaan van de FS-score was 3, van 21
85 (*IQR* = 1; 5). Geen significante relatie werd geobserveerd tussen sociale isolatie en
86 ongeplande heropnames ($p = .478$), eerste en totale opnameduur ($p = .657$; $p = .601$). Levend
87 met anderen, maar zonder partner en minder quality-adjusted life years (QALYs) waren
88 significant gerelateerd aan een hogere mate van sociale isolatie ($p = .009$, $p = .002$).

89 *Conclusie en aanbevelingen:* Geen relatie werd gevonden tussen sociale isolatie tijdens
90 ziekenhuisopname en ongeplande heropnames, eerste of totale opnameduur. Levend met
91 anderen, maar zonder partner, en minder QALYs waren significant gerelateerd aan een
92 hogere mate van sociale isolatie. Vergeleken met andere studies blijft het belangrijk om in de
93 klinische praktijk aandacht te hebben voor persoonlijke en sociale factoren van patiënten.

94 *Trefwoorden:* Cohortstudie, sociale isolatie, operatie, heropname ziekenhuis, opnameduur.

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99 **1. Introduction**

100 An estimated surgical rate of 4469 surgical procedures per 100.000 people has been
101 reported worldwide¹. Surgery is often the only curative approach for conditions such as a
102 complicated fractures or malignancy. However, surgery is frequently accompanied by a
103 considerable risk of postoperative short and long term complications^{2,3}, where a complication
104 is defined as “any undesirable, unintended and direct result of an operation affecting the
105 patient which would not have occurred had the operation gone as well as could reasonably
106 be hoped”⁴. Common postoperative complications are surgical site infections^{5,6}, deep vein
107 thrombosis, anastomotic leak after abdominal surgery⁵, and malnutrition⁶. A postoperative
108 complication during hospitalization often leads to a prolonged hospital stay (LOS)^{7,8}.
109 Approximately 15% all postoperative complications develop after hospital discharge, which
110 often leads to unplanned readmissions³.

111 Numerous risk factors for the development of postoperative complications have been
112 reported, including physical functions (e.g. age, Body Mass Index (BMI), functional status
113 and American Society of Anesthesiologists Physical Status (ASA) grade)⁹ and mental
114 functions (e.g. anxiety, depression and positive expectation)¹⁰. Furthermore, social isolation
115 has been identified as a risk factor for health disorders, e.g. hypertension, cardiovascular
116 diseases¹¹, depression¹², and mortality¹³, this influences the risk of postoperative
117 outcomes^{14,15}. However, aspects of social isolation are often underexposed in studies to
118 predictive factors^{6,16,17}.

119 Social isolation reflects related but distinct concepts: social support and loneliness^{18–20}.
120 Social support refers to “the social resources that people perceive to be available, or that are
121 actually provided to them by nonprofessionals in the context of both formal support groups
122 and informal helping relationships”²¹. Loneliness is defined as a lack of integration and the
123 feeling of the absence of companionship or a significant other^{13,18}. A useful tool to measure
124 social isolation is the Friendship Scale (FS), a self-reported validated questionnaire existing
125 of five multiple-choice questions^{19,22}.

126 Loneliness can arise in a hospital environment due to not being at home, missing important
127 relationships and giving up one’s regular routine^{23,24}. Also, social isolation is influenced by
128 stressful events²⁵, and it is not surprising that hospitalization for a surgical procedure is
129 associated with increase in distress^{26,27}. No significant relationship has been reported

130 between the severity of social isolation and consequences within thirty days in general and
131 surgical patients^{15,28}. However, study results of Saito et al. demonstrated a significantly
132 higher rate of unplanned readmissions within ninety days in more socially isolated cardiac
133 surgical patients, compared to patients with a lower sense of social isolation²⁹. This has not
134 yet been demonstrated in non-cardiac surgical patients.

135 To improve clinical outcomes, e.g. to decrease severity of delirium³⁰ and to reduce LOS^{31,32},
136 there is increasing evidence for social related interventions, especially stimulating family
137 involvement in hospital care^{33,34}, by reducing anxiety levels and improving a feeling of well-
138 being^{10,33}. Further research is needed to determine whether increasing social isolation is an
139 active component of these interventions^{33,35}.

140 Therefore, the objective of the current study was to examine the relationship between social
141 isolation during hospitalization and an unplanned readmission within 90 days after surgery
142 among adult patients who underwent a surgical procedure. The secondary objectives were to
143 explore the relationship between social isolation during hospitalization and 1) mortality within
144 90 days after surgery, 2) hospital length of stay (LOS) and 3) to explore the relationship
145 between personal and social factors during hospitalization and the degree of social isolation.
146 In order to clarify the different components of social related interventions, and contribute to
147 evidence of possible causes of worse health outcomes after surgery.

148 **2. Method**

149 **2.1 Study design and setting**

150 This single-center prospective longitudinal cohort study took place at a University Medical
151 Centre (UMC) in the Netherlands, at five surgical wards: vascular, gastro-intestinal (GI),
152 urology, traumatic or orthopaedic. The study was conducted in accordance with the
153 principles of the Declaration of Helsinki (26th version, October 2013). The ethics review board
154 of the UMC approved the study (W19_335#19.394). Patients gave written informed consent.
155 The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE)
156 guideline was used to ensure transparent reporting³⁶.

157 **2.2 Participants**

158 Patients were included if they were 18 years or older, and admitted to the hospital for a
159 vascular, trauma, orthopedic, plastic or (oncological) GI surgical procedure. Hospital
160 admission had to be for a minimum of 24 hours, and patients could only participate once in
161 the study. Patients were excluded if they did not master the Dutch language.

162 **2.3 Data collection**

163 The present study used the baseline data for another study, to patient satisfaction and quality
164 of care, collected at four time points in 2019 (i.e. two days in October, and two days in
165 November) with a two-week time interval. All hospitalized patients on those wards were
166 screened for eligibility and invited through a patient information letter, thereafter orally
167 approached on the medical ward to participate by nursing students. They collected baseline
168 data with a questionnaire, which took approximately 20 minutes to complete. For the present
169 study, patients' clinical records were reviewed 90 days after surgery to obtain additional
170 demographic, surgical related and follow-up data by the investigator (AH).

171 **2.4 Outcome variables**

172 Social isolation was measured with the FS at baseline²². This questionnaire consists of five
173 statements about the past four weeks: *'I found it easy to get on with other people'*, *'I felt*
174 *lonely'*, *'I had someone to share my feelings with'*, *'I found it easy to make contact with*
175 *people'*, and *'I felt I was a burden to people'*. Each statement has a five-point Likert scale
176 answer option, ranging from 'almost always' to 'not at all', giving a final range of 0-20. A
177 higher score corresponds with higher sense of social isolation¹⁹. The questionnaire was
178 translated for and backward from English to Dutch by native speakers.

179 **2.4.1 Baseline**

180 Collected predictive and possible intermediate variables were divided into three categories:
181 patient related variables, surgical related variables and screening measurements. The
182 following variables were collected at baseline: age, gender, rooming-in of a family caregiver
183 during hospitalization, type of admission (primary or readmission, acute or elective), and type
184 of surgery (vascular, GI, oncological-GI, urology, traumatic, orthopaedic or plastic or
185 oncological gastro-intestinal). The screening measurements included: the score of social
186 isolation (measured with the FS)²², quality-adjusted life years (QALYs) (measured with 5Q-
187 5D-5L³⁷), Delirium Observation Scale (DOS)³⁸ and Short Nutritional Assessment
188 Questionnaire (SNAQ)³⁹.

189 **2.4.2 Follow-up**

190 Collected additional information and postoperative outcomes included: profession, living
191 situation (marital status, living alone or with others), children living at home, living place after
192 discharge, use of home care agency before and/or after discharge, number of medication at
193 discharge, intraoperative transfusion of blood, intensive care (IC) stay during hospitalization,
194 date of surgery, and LOS. Screenings measurements: included the score of Katz Activities of
195 Daily Living (ADL)⁴⁰, ASA grade⁴¹, and Body Mass Index (BMI)⁴².

2.4.3 Primary and secondary study outcomes

196
197 The primary study outcome was one or more unplanned readmission(s) within 90 days after
198 surgery, defined in yes or no. Secondary outcomes were 1) mortality within 90 days after
199 surgery, defined in yes or no, including date of mortality; 2) initial and total LOS: initial LOS
200 was measured in days by subtracting the date of discharge from hospital from the date of
201 admission to hospital. Total LOS is the sum of initial LOS and LOS of unplanned
202 readmission(s); 3) The relationship between personal and social related variables to the FS-
203 score.

2.5 Statistical Analysis

204
205 Assumptions of regression were checked and extreme outliers were assessed with Cook's
206 Distance and if necessary deleted from analyses. When continuous data were not normally
207 distributed, log transformations were applied. Data are presented as mean (*M*) and Standard
208 Deviation (*SD*) and in case of non-normal distributions as median with interquartile range
209 (*IQR*), due to the continuous type of data. Patterns of missing data were analyzed and single
210 stochastic regression with predicted mean matching was applied to impute missing data,
211 followed by a sensitivity analysis⁴³. Afterwards, a sensitivity analysis was performed to
212 compare the imputed with the non-imputed data. Results of analyses of non-imputed data
213 were included in the appendix.

214 The PROCESS macro version 3.4 for SPSS⁴⁴ was used to conduct three simple mediation
215 analyses based on different regression models to test the effect of the relationship between
216 the independent variable FS-score, and dependent variables (i.e. unplanned readmission,
217 mortality and LOS), in the presence of the mediator EQ-5D-5L¹⁵, transformed to QALYs⁴⁵.

218 To adjust for covariates, variables related to the outcome or both to exposure and outcome
219 were consolidated into a RAW propensity score⁴⁶, using a logistic regression model⁴⁷. The
220 propensity score of unplanned readmissions included the variables: age (as continuous
221 variable), use of home care agency, profession, rooming-in, number of medication at
222 discharge, type of admission, type of surgery and intraoperative infusion. The propensity
223 score of initial and total LOS included: age (as continuous variable), gender, profession,
224 number of medication at discharge, children living at home, living place after discharge, type
225 of surgery, ASA grade and intraoperative infusion.

226 To calculate the average estimated odds of the outcome unplanned readmissions, an
227 univariate and multivariate logistic regression model were used. The latter controlled for the
228 propensity score and all other predictive variables, based on a likelihood-ratio test with a *p*-
229 value lower than 0.1⁴⁸. Results are presented as odds ratios with corresponding 95%

230 confidence intervals (CI), p -value, beta coefficients (B) and standard errors (SE), and the
231 Nagelkerke pseudo R-squared (R^2).

232 To evaluate the relation with initial and total LOS, multiple regression analysis using
233 backward selection was performed. Thereafter, a hierarchical regression for all variables with
234 five levels was used, by evaluating the contribution of each independent variable⁴⁹.
235 Dependent variables with the lowest correlation were entered into the equation at step one,
236 and each group of variables were added to the previous model. Results were presented as B
237 of the FS-score, with corresponding SE and p -value, and the standard R-squared (R^2) of the
238 total model is shown.

239 Finally, to explore the relationship between personal and social factors to the FS-score,
240 univariate and multiple regression analysis using backward selection was performed. Results
241 were presented as B , with corresponding SE and p -value, and the standard R-squared (R^2)
242 of the total model is shown.

243 All analyses were done in SPSS version 25.0 (IBM Corp, Armonk, New York, USA) and
244 statistical significance was accepted at a two-sided p -value < 0.05.

245

246

Position Figure 1

247

248 **3. Results**

249 A total of 203 patients were invited to participate, of which 129 patients (63.5%) signed the
250 informed consent form. In total, 10 participants were excluded before the follow-up period
251 (Figure 1). One participant was excluded in the analyses because of an outlier in initial LOS.
252 Initial and total LOS was not normally distributed and redistributed by log transformation. No
253 indications of a mediation between FS-score and unplanned readmission or LOS were found,
254 therefore the EQ-5D-5L was not included as a separate variable in the final analyses. No
255 data were missing with regard to the FS and the primary and secondary study outcomes.
256 Both non-imputed and imputed patient characteristics are presented in table 1. The mean
257 age was 56.7 ($SD = 16.98$) years and approximately half of the cohort was male (53.4%).
258 Most patients underwent surgery for an oncological gastro-intestinal (24.6%), gastro-
259 intestinal (23.7%) or orthopaedic (22.9%) diagnosis. The median score of the FS was 3 (IQR
260 = 1; 5). An overview of patient characteristics, separated for unplanned readmissions, are
261 included in Appendix I.

262

263

Position Table 1 and 2

264

265

266 **3.1 Primary Outcome**

267 There were 29 participants with unplanned readmission(s), giving a 90-day unplanned
268 readmission rate of 24.6% (Table 3). Of them, five participants underwent a second
269 unplanned readmission within the follow-up period. The median time to first unplanned
270 readmission was 13 days (*IQR* = 6; 22). Most indications for readmissions were abscesses
271 ($n = 9$ (31.0%)) and wound infections ($n = 5$ (17.2%)) (Table 2). No indication has been
272 found for malnutrition or general decline, but a small negative change in BMI, SNAQ and
273 Katz are shown (Table 2). Multivariate logistic regression analysis showed that social
274 isolation during hospitalization was not significantly associated with unplanned readmission
275 within 90 days of surgery ($B = -.084$; $CI = .729, 1.159$; $p = .478$). The propensity score was
276 significantly related to unplanned readmissions ($B = .784$; $CI = 1.651, 2.905$; $p < .001$) and
277 Nagelkerke's R^2 of the final model was 0.7 (Table 4).

278

Position Table 3 and 4

279

280

281 **3.2 Secondary Outcomes**

282 Three patients died, resulting in a 90-day mortality rate of 2.5% (Table 3). Due to the low
283 mortality rate, the analyses for this second research question could not be performed. The
284 three participants died after 20, 46 and 51 days post-surgery, respectively.

285 The median initial LOS of the total cohort was 10.5 days (*IQR* = 5; 17) and the median total
286 LOS was 12.0 days (*IQR* = 6; 19). Median of total LOS for participants who underwent an
287 unplanned readmission are 20 days (*IQR* 12; 32) (Table 3). Social isolation during
288 hospitalization was not associated with initial LOS ($B = -.007$; $CI = -.038, .024$; $p = .657$)
289 (Table 5) and total LOS ($B = -.009$; $CI = -.042, .024$; $p = .601$) (Table 6).

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Position Table 5 and 6

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292

293 In the final model, analyses of the relationship between personal and social factors to the FS-
294 score, included the significant related variables living with others, but without partner, ($p =$
295 $.009$) and less QALYs ($p = .002$) to a higher sense of social isolation. These variables

296 together explain 12.9% of the variance. Unemployment was also a significant related variable
297 to a higher sense of social isolation ($p = .033$), but due to the number of participants not
298 included in the final model. All other included variables were not significant in the univariate
299 or multivariate analysis (Table 7).

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Position Table 7

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302

303 **4. Discussion**

304 This prospective cohort study in surgical patients in a tertiary hospital showed no significant
305 relationship between inpatient social isolation and an unplanned hospital readmission within
306 90 days after surgery or LOS. Living with others, but without partner, less QALYs and
307 unemployment were found as significant related variables to a higher sense of self-reported
308 social isolation.

309 To our knowledge, no other studies have been performed in such a broad surgical
310 population, ranging from oncological gastro-intestinal to vascular surgery. The unplanned
311 readmission rate in our sample was comparable to other studies, ranging from 5% to
312 30%^{50,51}. The findings regarding the short-term consequences of social isolation in the
313 present study are also comparable with a study in general inpatients²⁸ and patients prior to
314 surgery¹⁵, which is in contrast to cardiac patients^{29,52}. They experienced a higher social
315 isolation rate⁵³, and a relation between social isolation and clinical outcomes were found²⁹.
316 Both may be explained by the link between social isolation to other characteristics of patients
317 with heart failure (HF), for instance: being older or debilitating and having progressive
318 disease compromising their functional status^{29,53-55}. The group of patients who underwent
319 vascular surgery in the present sample might be more comparable to cardiac patients,
320 however, the sample size of this study was insufficient to explore such relationships.

321 Identifying the risk factors for hospital readmissions or prolonged hospital stay are important
322 for the benefit of both patients and hospitals¹⁷. To reduce these risk factors in patients,
323 interventions have been developed allowing patients' families to partner and collaborate in
324 care^{35,56}, however, results are inconclusive³³. This could be explained by complexity of these
325 family-related interventions, due to the different interacting components and diversity of
326 stakeholders^{35,57}. In turn, the interventions were developed, implemented and described
327 differently by each study, making them difficult to compare^{33,57}. In the present study, a small
328 amount of participants used rooming-in of a family caregiver, together with a low average
329 score on the FS, which suggest that complex family-related interventions could not be

330 directly related to a decrease in the sense of social isolation. The results in the present study
331 showed that a higher sense of social isolation is related to a lower quality of life, living with
332 others but without partner, and unemployment. The propensity score, which included various
333 personal and social aspects, has a strong relationship with unplanned readmissions. Related
334 to the positive effect of family involvement interventions³³, it is essential to remain focused on
335 patient's personal and social aspects in clinical practice.

336 Future studies are needed to explore the efficacy of the components, process and
337 implementation of social interventions, to further understand what may contribute to reducing
338 the number of unplanned readmissions or decreasing LOS in surgical patients³³. Next, future
339 research should focus on the validation of the FS in this patient category⁵⁸. When
340 measurement properties are insufficient, it is recommended to use another tool to measure
341 social isolation, taking into account the mental loadability of this patient category^{26,27}. Finally,
342 the study population could be specified to major surgical procedures. Possibly,
343 characteristics are more comparable with essential characteristics of patients with chronic
344 heart diseases^{29,53-55}.

345 The present study has several strengths. First, a consecutive sampling approach was used:
346 all patients meeting the eligibility criteria at the four time points were invited, which reduced
347 the risk of sampling bias. This has led to generalizable results to general surgical patients⁵⁸.
348 Next, a sensitivity analysis was performed to compare the imputed with the non-imputed
349 data. This showed that in the analyses of unplanned readmissions, the contribution of the FS
350 did increase after imputation, but that this increase was not significant. In the analyses of the
351 relationship with LOS, the explained variance in the imputed data decreased. This was
352 caused by the single stochastic imputation method with predicted mean matching⁵⁸. Despite
353 the weaknesses of this method, its use in this study was appropriate because of the low
354 number of missing values and the use of a propensity score^{59,60}.

355
356 The first and most important limitation is the way social isolation has been measured. A
357 majority of the participants scored low on the FS. The FS is a self-reported questionnaire,
358 which might have led to a lower score on the FS than if it had been measured in a more
359 indirect way. However, the FS is validated to measure social isolation in older adults²² and
360 general population¹⁹. Therefore it is expected that the FS is sensitive enough to demonstrate
361 social isolation, also in only surgical patients. Besides, the skewed distribution is similar to
362 the validation study of the FS¹⁹. As most patients were hospitalized electively, this could have
363 increase social isolation due to affected social and working activities during wait⁶¹. Another
364 explanation could be that socially isolated patients' are more likely to avoid care, compared

365 to non-isolated patients⁶². In spite of that the FS might be a suboptimal reference test, it was
366 expected appropriate in the present study, due to the low patient burden that would be
367 caused by this questionnaire. Second, the baseline information, including social isolation,
368 was not measured at a fixed time point after hospital admission. To our knowledge, no
369 studies have been performed to investigate if the time of measurement affects the degree of
370 social isolation. Although the time window of measurement was wide, we do not expect much
371 influence on the conclusion, given the results of this study. Finally, no power calculation for
372 the present study was performed in advance, due to the use of an existing database for the
373 baseline data. Hence, a propensity score was conducted to correct for a small sample size
374 and low occurrence of social isolation⁶³, with respect for the rule of thumb in the final model⁶⁴.
375 Consequently, the diagnosis groups were too small to perform reliable subgroup analyses for
376 each diagnosis. Diagnosis groups were included in the analyses using the propensity score,
377 as it was related to exposure and outcome⁴⁶.

378 In conclusion, based on the limitations of this study, results should be interpreted with
379 caution. In this study, no relationship between inpatient social isolation and risk of unplanned
380 hospital readmissions within 90 days after surgery, or relationship with initial or total LOS
381 were found in this study. Two personal factors were found as statistically significant related
382 variables for the amount of social isolation. In clinical practice, it remains important to focus
383 on patients' personal and social factors, because the possibility that this can indirectly
384 contribute to the improvement of patient and clinical outcomes.

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392

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Figure and Tables

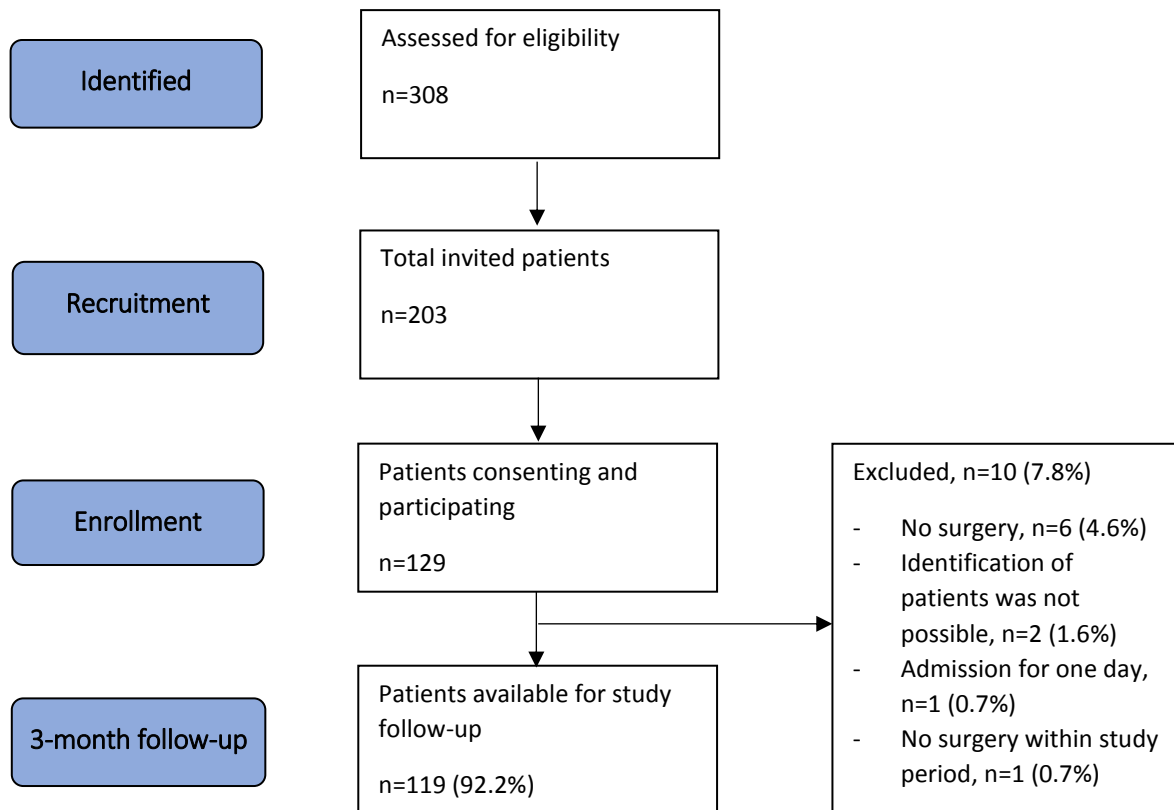


Figure 1. STROBE flow-chart for recruitment

Abbreviation: Number of patients (n)

Table 1. Patient characteristics at baseline or during hospitalization, for the total sample.

	Unimputed sample (N=118)	Imputed sample (N=118)
Patient related factors		
Age (years) (<i>M (SD)</i>)	56.77 (16.98)	56.77 (16.98)
Sex (male, %)	63 (53.4)	63 (53.4)
Living situation (%)		
Living together	68 (57.6)	69 (58.5)
Living alone	37 (31.4)	41 (34.7)
Living with others	7 (5.9)	8 (6.8)
Missing	6 (5.1)	
Children living at home (yes, %)	19 (16.1)	23 (19.5)
Missing (%)	13 (11.0)	
Employment status (%)		
Work, paid	53 (44.9)	58 (49.2)
Work, unpaid	5 (4.2)	6 (5.1)
Student	2 (1.7)	4 (3.4)
Unemployed	11 (9.3)	14 (11.9)
Retired	34 (28.8)	36 (30.5)
Missing	13 (11.0)	
Rooming-in during hospitalization (yes, %)	7 (5.9)	7 (5.9)
Living place after discharge (%)		
Own living environment	101 (85.6)	101 (85.6)
Other, whose:	17 (14.4)	17 (14.4)
Rehabilitation	5 (4.2)	5 (4.2)
Nursing home	5 (4.2)	5 (4.2)
Other hospital	2 (1.7)	2 (1.7)
Received home care (%)		
No	73 (61.9)	81 (68.6)
Yes, after	19 (16.1)	20 (16.9)
Yes, before and after	16 (16.1)	17 (14.4)
Missing	10 (8.5)	
Number of medicines at discharge (<i>m (IQR)</i>)	7 (4; 10)	7 (4; 10)
Time between measurement and surgery (<i>M (SD)</i>)	6.60 (14.63)	6.60 (14.63)
Screening measurements		
BMI (kg/m ²) (<i>Mdn (IQR)</i>)	25.16 (22.15; 29.51)	24.42 (21.67; 28.64)
DOS (<i>Mdn (IQR)</i>)	0 (0; 0)	0 (0; 0)
QALYs (EQ-5D-5L) (<i>M (SD)</i>)	0.53 (0.32)	0.53 (0.32)
Q1. (<i>Mdn (IQR)</i>)	2 (1; 2)	2 (1; 2)
Q2.	2 (1; 2)	2 (1; 2)
Q3.	2 (1; 3)	2 (1; 3)
Q4.	2 (2; 2)	2 (2; 2)
Q5.	1 (1; 2)	1 (1; 2)
Friendship Scale (rating 0-21) (<i>Mdn (IQR)</i>)	3 (1; 5)	3 (1; 5)
Q1.	1 (0; 1)	1 (0; 1)

Q2.	0 (0; 1)	0 (0; 1)
Q3.	0 (0; 1)	0 (0; 1)
Q4.	0 (0; 1)	0 (0; 1)
Q5.	1 (0; 1)	1 (0; 1)
SNAQ (rating 1-5) (Mdn (IQR))	0 (0; 1)	0 (0; 1)
Katz-ADL ((rating 1-7) (Mdn (IQR))	0 (0; 2)	0 (0; 2)
ASA grade (Mdn (IQR))	2 (2; 3)	2 (2; 3)
Surgery related factors		
Elective surgery (yes, %)	88 (74.6)	88 (74.6)
Type of surgery (%)		
Vascular	13 (11.0)	13 (11.0)
Traumatic	11 (9.3)	11 (9.3)
Orthopedic	27 (22.9)	27 (22.9)
Oncological gastro-intestinal	29 (24.6)	29 (24.6)
Gastro-intestinal	28 (23.7)	28 (23.7)
Urology	7 (5.9)	7 (5.9)
Other	3 (2.5)	3 (2.5)
Intraoperative transfusion (yes, %)	6 (5.1)	6 (5.1)
Intensive Care stay during hospitalization (yes, %)	14 (11.9)	14 (11.9)

Abbreviations: Total number of patients (N), median (Mdn), mean (M), Inter Quartile Range (IQR); Standard Deviaton (SD), question(Q), Body Mass Index (BMI), Delirium Observation Scale (DOS), Quality-adjusted life year (QALYs), Short Nutritional Assessment Questionnaire (SNAQ), Katz Activities of Daily Living (Katz), American Society of Anesthesiologists Physical Status (ASA).

Table 2. Indications for unplanned readmission(s), within 90 days after surgery.

Indications for unplanned readmissions*	n (%)
	n=29 (24.6)
Abscess	9 (31.0)
Pain	4 (13.8)
Pneumonia	1 (3.4)
Suture leakage	3 (10.3)
Urinary tract infection	2 (6.9)
Wound infection	5 (17.2)
Infection, other	7 (24.1)
Other	8 (27.6)
BMI, difference (M (SD))	-.53 (4.96)
Katz, difference (M (SD)) (Missing n=3)	.15 (1.91)
SNAQ, difference (M (SD)) (Missing n=8)	.48 (1.33)

*Some patients had more than one indication, therefore the total sum is higher than the total number of patients' unplanned readmissions.

Abbreviations: Number of patients (n), mean (M), Standard Deviation (SD), Body Mass Index (BMI), Short Nutritional Assessment Questionnaire (SNAQ).

Table 3. Clinical outcomes, within 90 days after surgery. Subdivided into the total cohort and patients who underwent an unplanned readmission(s).

	Total sample N=118	Patients with unplanned readmission(s) n=29
Unplanned readmission(s) (yes (%))	29 (24.58)	
Initial length of hospital stay (<i>Mdn</i> (IQR))	10.50 (5; 17)	12 (7; 21)
Total length of hospital stay (<i>Mdn</i> (IQR))	12 (6; 19)	20 (12; 32)
Mortality (yes, %)	3 (2.5)	1 (3.4)

Abbreviations: Total number of patients (N), number of patients (n), Median (*Mdn*), Inter Quartile Range (IQR).

Table 4. Relationship between social isolation and unplanned readmissions.

	Model A – Univariate					Model B – Multivariate					Model C – Multivariate, selected				
	B	SE	OR	CI	p	B	SE	OR	CI	p	B	SE	OR	CI	p
Constant	-1.121	.214	.326		.000	-5.710	.3.827	.003		.136	-3.187	.678	.041		.000
Propensity ^o	.727	.129	2.068	1.607; 2.661	.000**	.853	.165	2.346	1.700; 3.239	.000**	.784	.144	2.190	1.651; 2.905	.000**
Friendship Scale	.044	.081	1.045	.892; 1.224	.589	-.052	.135	.949	.729; 1.236	.698	-.084	.118	.920	.729; 1.159	.478
Sex (male)	.281	.433	1.324	.567; 3.092	.516	-.026	.833	.974	.190; 4.984	.975					
Living situation, together	Reference														
Living situation, alone	-.013	.459	.987	.402; 2.424	.977	.586	.883	1.796	.318; 10.14 1	.507					
Living situation, living with others	.019	.863	1.020	.188; 5.533	.982	.459	1.502	1.582	.083; 10.04 3	.760					
Children living at home (yes)	-.196	.558	.822	.275; 2.453	.725	.990	1.006	2.692	.375; 19.32 1	.325					
Living place after discharge (other)	-.481	.676	.618	.164; 2.324	.476	.355	1.285	1.427	.115; 17.71 6	.782					
IC stay during hospitalization (no)	.234	.635	1.264	.364; 4.384	.712	-.134	1.462	.874	.05; 15.33 8	.927					
QALYs	.168	0.668	1.182	.319; 4.382	.802	.669	1.274	1.953	.161; 23.70 8	.599					

Initial LOS	.710	.625	2.035	.598; 6.921	.255	.013	1.307	1.013	.078; 13.13 4	.992					
BMI	.006	.043	1.006	.926; 1.094	.888	.050	.086	1.051	.889; 1.243	.558					
SNAQ	.022	.158	1.022	.750; 1.392	.890	.161	.353	1.174	.587; 2.348	.649					
Katz	-.036	.129	.965	.749; 1.243	.782	-.381	.314	.683	.369; 1.263	.224	-.348	.253	.706	.430; 1.160	.170
DOS	-.247	.505	.781	.291; 2.102	.625	.449	.759	1.567	.354; 6.929	.554					
ASA	-.103	.301	.902	.500; 1.626	.731	-.143	.636	.867	.249; 3.015	.822					
R ²						.722					.70				

*Significant (0.01 < p < 0.05), **significant (p < 0.01),

^oPropensity score included: age, employment status, rooming-in during hospitalization, received home care, Number of medicines at discharge, type of surgery, elective surgery, intraoperative infusion.

Abbreviations: Beta coefficients (B), Standard error (SE), Odds ratio (OR), 95% confidence interval (CI), probability value (p), Intensive Care (IC), Quality-adjusted life year (QALYs), Length of Hospital stay (LOS), Body Mass Index (BMI), Short Nutritional Assessment Questionnaire (SNAQ), Katz Activities of Daily Living (Katz), Delirium Observation Scale (DOS), American Society of Anesthesiologists Physical Status (ASA), Nagelkerke pseudo R-squared (R²).

Table 5. Relationship between social isolation and initial LOS.

	Model for initial LOS			
	<i>B</i>	<i>SE</i>	<i>p</i>	<i>R</i> ²
Primary-analysis	.003	.013	.822	.000
Corrected for Katz, received home care, QALYs	.000	.013	.991	.009
Corrected for rooming-in, DOS, BMI	.000	.014	.990	.018
Corrected for living situation, SNAQ	.000	.014	.995	.037
Corrected for elective surgery, IC stay during hospitalization	.001	.013	.965	.171
Corrected for propensity score ^o	-.007	.016	.657	.178

^oPropensity score included: Age, sex, children living at home, employment status, living place after discharge, number of medicines at discharge, type of surgery, Intraoperative infusion, American Society of Anesthesiologists Physical Status.

Abbreviations: Beta coefficients (*B*), Standard error (*SE*), probability value (*p*), standard R-squared (*R*²), Katz Activities of Daily Living (*KATZ*), Quality-adjusted life year (*QALYs*), Delirium Observation Scale (*DOS*), Body Mass Index (*BMI*), Short Nutritional Assessment Questionnaire (*SNAQ*), Intensive Care (*IC*).

Table 6. Relationship between social isolation and total LOS.

	Model for Total LOS			
	B	SE	p	R ²
Primary-analysis	.005	.013	.733	.001
Corrected for BMI, QALYs, DOS	.002	.014	.892	.018
Corrected for Katz, rooming-in, living situation	.001	.015	.935	.020
Corrected for SNAQ, received home care	-.001	.015	.970	.049
Corrected for elective surgery, IC stay during hospitalization	.000	.014	.984	.150
Corrected for propensity score ^o	-.009	.017	.601	.158

^oPropensity score included: Age, sex, children living at home, employment status, living place after discharge, number of medicines at discharge, type of surgery, intraoperative infusion, American Society of Anesthesiologists Physical Status.

Abbreviations: Beta coefficients (B), Standard error (SE), probability value (p), standard R-squared (R²), Body Mass Index (BMI), Quality-adjusted life year (QALYs), Delirium Observation Scale (DOS), Katz Activities of Daily Living (Katz), Short Nutritional Assessment Questionnaire (SNAQ), Intensive Care (IC).

Table 7. Results research question 4, relationship between social-related factors and Friendship Scale.

	Model A - Univariate			Model B - Multivariate		
	B	SE	p	B	SE	p
Constant				4.242	.480	.000
Sex (male)	.286	.483	.555			
Age	-.026	.014	.070			
Living situation – living together, reference						
Living alone	-.180	.505	.722	-.248	.487	.612
Living with others	2.317	.956	.017*	2.446	.922	.009**
Children living at home (yes)	-.838	.604	.168			
Employment status – work paid, reference						
Work, unpaid	.017	1.108	.988			
Student	1.267	1.335	.345			
Unemployed	1.660	.769	.033*			
Retired	-.233	.548	.672			
Rooming-in during hospitalization (yes)	1.812	1.008	.075			
QALYs	-2.097	.724	.005**	-2.220	.707	.002**
Type surgery, oncological gastro-intestinal baseline						
Vascular surgery	-.687	.879	.436			
Trauma surgery	.348	.932	.710			
Orthopedic surgery	.139	.704	.844			
Plastic surgery	-3.379	2.667	.210			
Gastro-intestinal surgery	-.379	.697	.588			
urology	-.951	1.109	.393			
other	-2.379	1.924	.219			
R ²				0.129		

*Significant ($0.01 < p < 0.05$), **significant ($p < 0.01$).

Abbreviations: Beta coefficients (B), Standard error (SE), probability value (p), Quality-adjusted life year (QALYs), standard R-squared (R²).

Appendix

Table 1. Patient characteristics at baseline and during hospitalization. Subdivided into patients with and without unplanned readmission(s). Imputed sample.

	All patients (N=118)	Unplanned readmission(s) (n= 29)	No unplanned readmissions (n= 89)
Patient related factors			
Age (years) (<i>M (SD)</i>)	59.64 (47.76; 68.04)	60.95 (15.79)	55.41 (17.21)
Sex (male)	63 (53.4)	17 (58.6)	46 (51.7)
Living situation (%)			
Living together	68 (57.6)	21 (72.4)	47 (52.8)
Living alone	37 (31.4)	7 (24.1)	30 (33.7)
Living with others	7 (5.9)	1 (3.4)	6 (6.7)
Missing	6 (5.1)	0	6 (6.7)
Children living at home (yes, %)	19 (16.1)	5 (17.2)	14 (15.7)
Missing (%)	13 (11.0)	1 (3.4)	12 (13.5)
Employment status (%)			
Work, paid	53 (44.9)	10 (34.5)	43 (48.3)
Work, unpaid	5 (4.2)	0	5 (5.6)
Student	2 (1.7)	1 (3.4)	1 (1.1)
Unemployed	11 (9.3)	3 (10.3)	8 (9.0)
Retirement	34 (28.8)	14 (48.3)	20 (22.5)
Missing	13 (11.0)	1 (3.4)	12 (13.5)
Rooming-in during hospitalization (yes, %)	7 (5.9)	4 (13.8)	3 (3.4)
Living place after discharge (%)			
Own living environment	101 (85.6)	26 (89.7)	75 (84.3)
Other, whose:	17 (14.4)	3 (10.3)	14 (15.7)
Rehabilitation	5 (4.2)	2 (6.9)	3 (3.4)
Nursing home	5 (4.2)	0	5 (5.6)
Other hospital	2 (1.7)	0	2 (2.2)
Received home care (%)			
No	73 (61.9)	17 (58.6)	56 (62.9)
Yes, after	19 (16.1)	5 (17.2)	14 (15.7)
Yes, before and after	16 (16.1)	4 (13.8)	12 (13.5)
Missing	10 (8.5)	3 (10.3)	7 (7.9)
Number of medicines at discharge (<i>Mdn (IQR)</i>)	7 (4; 10)	7 (4; 11)	7 (4; 10)
Time between measurement and surgery (<i>M (SD)</i>)	6.60 (14.63)	6.60 (14.63)	N/A
Screening measurements			
BMI (kg/m ²) (<i>Mdn (IQR)</i>)	25.16 (22.15; 29.51)	24.72 (21.62; 29.75)	25.38 (22.21; 28.46)
DOS (<i>Mdn (IQR)</i>)	0 (0; 0)	0 (0; 0)	0 (0; 0)
QALYs (EQ-5D-5L) (<i>M (SD)</i>)	0.53 (0.32)	0.54 (0.36)	0.52 (0.31)
Q1. (<i>Mdn (IQR)</i>)	2 (1; 2)	2 (1; 2)	2 (1; 2)
Q2.	2 (1; 2)	2 (1; 2)	2 (1; 2)
Q3.	2 (1; 3)	2 (1; 3)	2 (1; 3)
Q4.	2 (2; 2)	2 (1; 2)	2 (2; 2)
Q5.	1 (1; 2)	1 (1; 2)	1 (1; 2)

Friendship Scale (rating 0-21) (Mdn (IQR))	3 (1; 5)	3 (0; 5)	2 (1; 5)
Q1.	1 (0; 1)	1 (0; 1)	1 (0; 1)
Q2.	0 (0; 1)	0 (0; 1)	0 (0; 1)
Q3.	0 (0; 1)	0 (0; 0)	0 (0; 1)
Q4.	0 (0; 1)	1 (0; 1)	0 (0; 1)
Q5.	1 (0; 1)	0 (0; 1)	1 (0; 1)
SNAQ (rating 1-5) (Mdn (IQR))	0 (0; 1)	0 (0; 1)	0 (0; 1)
Katz-ADL (rating 1-7) (Mdn (IQR))	0 (0; 2)	0 (0; 4)	0 (0; 2)
ASA grade (Mdn (IQR))	2 (2; 3)	2 (2; 3)	2 (2; 3)
Surgery related factors			
Elective surgery (yes, %)	88 (74.6)	20 (69.0)	68 (76.4)
Type of surgery (%)			
Vascular	13 (11.0)	3 (10.3)	10 (11.2)
Traumatic	11 (9.3)	1 (3.4)	10 (11.2)
Orthopedic	27 (22.9)	3 (10.3)	24 (27.0)
Oncological gastro-intestinal	29 (24.6)	12 (41.4)	17 (19.1)
Gastro-intestinal	28 (23.7)	8 (27.6)	20 (22.5)
Urology	7 (5.9)	2 (6.9)	5 (5.6)
Other	3 (2.5)	0	3 (3.3)
Intraoperative transfusion (yes, %)	6 (5.1)	3 (10.3)	3 (3.4)
Intensive Care stay during hospitalization (yes, %)	14 (11.9)	4 (13.8)	10 (11.2)

Abbreviations: Total number of patients (N), number of patients (n), Median (Mdn), mean (M), Inter Quartile Range (IQR); Standard Deviation (SD), question(Q), Body Mass Index (BMI), Quality-adjusted life year (QALYs), Delirium Observation Scale (DOS), Short Nutritional Assessment Questionnaire (SNAQ), Katz Activities of Daily Living (Katz), American Society of Anesthesiologists Physical Status (ASA).

Table 2. Relationship between social isolation and unplanned readmissions, unimputed sample.

	Model A – Univariate n=66 (Missing n=52)					Model B – Multivariate					Model C – Multivariate, selected				
	B	SE	OR	CI	p	B	SE	OR	CI	p	B	SE	OR	CI	p
Constant	-1.044	.233	.352		.000	-4.441	2.944	.012		.132	-1.759	.477	.172		.000
Propensity ^o	.130	.079	1.138	.976; 1.328	.099	.210	.137	1.233	.943; 1.613	.125	.163	.098	1.177	.972; 1.425	.096
Friendship Scale	.044	.081	1.045	.892; 1.224	.589	.012	.168	1.013	.729; 1.407	.941	-.037	.111	.964	.776; 1.198	.742
Sex (male)	.281	.433	1.324	.567; 3.092	.516	.282	.710	1.325	.330; 5.330	.692					
Living situation, together	reference														
Living situation, alone	-.650	.495	.522	.198; 1.378	.189	-.334	.802	.716	.149; 3.451	.677					
Living situation, living with others	-.986;	1.112	.373	.042; 3.295	.375	-.099	1.913	.906	.021; 38.503	.959					
Children living at home (yes)	-.022	.575	.978	.317; 3.020	.970	-.238	.826	1.269	.252; 6.398	.773					
Living place after discharge (other)	-.481	.676	.618	.164; 2.324	.476	1.160	1.558	3.191	.151; 67.603	.456					
IC, during hospitalization (no)	.234	.635	1.264	.364; 4.384	.712	.442	1.023	1.556	.210; 11.549	.665					
QALYS	.168	0.668	1.182	.319; 4.382	.802	1.004	1.357	2.730	.191; 39.041	.459					
Initial LOS	.710	.625	2.035	.598; 6.921	.255	..504	1.047	1.655	.213; 12.887	.630					

BMI	-0.007	.045	.993	.910; 1.084	.881	-0.009	.063	.991	.875; 1.122	.886					
SNAQ	.009	.162	1.009	.734; 1.386	.958	-.016	.307	.984	.540; 1.796	.959					
Katz	.137	.123	1.146	.9; 1.46	.268	.399	.221	1.491	.967; 2.299	.071	.211	.143	1.235	.933; 1.634	.140
DOS	-.045	.430	.956	.411; 2.223	.917	-.407	.688	.665	.173; 2.561	.554					
ASA	-.003	.007	.997	.983; 1.011	.697	-.008	.046	.992	.907; 1.085	.863					
R ²						.201					.078				

*Significant ($0.01 < p < 0.05$), **significant ($p < 0.01$).

^aPropensity score included: age, employment status, rooming-in during hospitalization, received home care, Number of medicines at discharge, type of surgery, elective surgery, intraoperative infusion

Abbreviations: Number of patients (n), Beta coefficients (B), Standard error (SE), Odds ratio (OR), 95% confidence interval (CI), probability value (p), Intensive Care (IC), Quality-adjusted life year (QALYs), Length of Hospital stay (LOS), Body Mass Index (BMI), Short Nutritional Assessment Questionnaire (SNAQ), Katz Activities of Daily Living (Katz), Delirium Observation Scale (DOS), American Society of Anesthesiologists Physical Status (ASA), Nagelkerke pseudo R-squared (R²).

Table 3. Relationship between social isolation and initial LOS, unimputed sample.

	Model for initial LOS			
	B	SE	p	R ²
Primary-analysis	.003	.013	.822	.000
Corrected for Katz, received home care, QALYs	-.002	.013	.880	.252
Corrected for rooming-in, DOS, BMI	.008	.014	.588	.295
Corrected for living situation, SNAQ	.010	.016	.525	.345
Corrected for elective surgery, IC stay during hospitalization	.008	.015	.626	.394
Corrected for propensity score ^o	.019	.022	.385	.403

^oPropensity score included: Age, sex, children living at home, employment status, living place after discharge, number of medicines at discharge, type of surgery, Intraoperative infusion, American Society of Anesthesiologists Physical Status.

Abbreviations: Beta coefficients (B), Standard error (SE), probability value (p), standard R-squared (R²), Katz Activities of Daily Living (KATZ), Quality-adjusted life year (QALYs), Delirium Observation Scale (DOS), Body Mass Index (BMI), Short Nutritional Assessment Questionnaire (SNAQ), Intensive Care (IC).

Table 4. Relationship between social isolation and total LOS, unimputed

	Model for Total LOS			
	B	SE	p	R ²
Primary-analysis	.005	.013	.733	.000
Corrected for BMI, QALYs, DOS	.004	.015	.776	.011
Corrected for katz, rooming-in, living situation	.020	.016	.196	.171
Corrected for SNAQ, received home care	.026	.016	.103	.352
Corrected for elective surgery , IC stay during hospitalization	.024	.016	.126	.400
Corrected for propensity score ^o	.021	.022	.337	.383

^oPropensity score included: Age, sex, children living at home, employment status, living place after discharge, number of medicines at discharge, type of surgery, intraoperative infusion, American Society of Anesthesiologists Physical Status.

Abbreviations: Beta coefficients (B), Standard error (SE), probability value (p), standard R-squared (R²), Body Mass Index (BMI), Quality-adjusted life year (QALYs), Delirium Observation Scale (DOS), Katz Activities of Daily Living (Katz), Short Nutritional Assessment Questionnaire (SNAQ), Intensive Care (IC).

Table 5. Relationship between social-related factors and Friendship Scale, unimputed sample.

	Model A - Univariate			Model B - Multivariate		
	B	SE	p	B	SE	p
Constant				2.559	.303	.000
Sex (male)	.286	.483	.555			
Age	-.026	.014	.070			
Living situation – living together, reference						
Living alone	1.360	.511	.009**	1.372	.498	.007**
Living with others	.155	.992	.876	.106	.969	.913
Children living at home (yes)	-.782	.671	.247			
Employment status – work paid, reference						
Work, unpaid	.532	1.160	.647			
Student	2.132	1.786	.235			
Unemployed	1.859	.821	.026*			
Retired	-.162	.545	.767			
Rooming-in during hospitalization (yes)	1.812	1.008	.075			
QALYs	-2.097	.724	.005**	-1.805	.714	.013*
Type surgery, oncological gastro-intestinal baseline						
Vascular surgery	-.687	.879	.436			
Trauma surgery	.348	.932	.710			
Orthopedic surgery	.139	.704	.844			
Plastic surgery	-3.379	2.667	.210			
Gastro-intestinal surgery	-.379	.697	.588			
urology	-.951	1.109	.393			
other	-2.379	1.924	.219			
R ²				0.114		

*Significant ($0.01 < p < 0.05$), **significant ($p < 0.01$).

Abbreviations: Beta coefficients (B), Standard error (SE), probability value (p), Quality-adjusted life year (QALYs), standard R-squared (R²).