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.

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Abstract

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

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

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

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

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

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

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

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

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

Samenvatting

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

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

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

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

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

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

1. Introduction

An estimated surgical rate of 4469 surgical procedures per 100.000 people has been reported worldwide[1]. Surgery is often the only curative approach for conditions such as a complicated fractures or malignancy. However, surgery is frequently accompanied by a considerable risk of postoperative short and long term complications[2,3], where a complication is defined as “any undesirable, unintended and direct result of an operation affecting the patient which would not have occurred had the operation gone as well as could reasonably be hoped”[4]. Common postoperative complications are surgical site infections[5,6], deep vein thrombosis, anastomotic leak after abdominal surgery[5], and malnutrition[6]. A postoperative complication during hospitalization often leads to a prolonged hospital stay (LOS)[7,8]. Approximately 15% all postoperative complications develop after hospital discharge, which often leads to unplanned readmissions[3].

Numerous risk factors for the development of postoperative complications have been reported, including physical functions (e.g. age, Body Mass Index (BMI), functional status and American Society of Anesthesiologists Physical Status (ASA) grade)[9] and mental functions (e.g. anxiety, depression and positive expectation)[10]. Furthermore, social isolation has been identified as a risk factor for health disorders, e.g. hypertension, cardiovascular diseases[11], depression[12], and mortality[13], this influences the risk of postoperative outcomes[14,15]. However, aspects of social isolation are often underexposed in studies to predictive factors[6,16,17].

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

Loneliness can arise in a hospital environment due to not being at home, missing important relationships and giving up one’s regular routine[23,24]. Also, social isolation is influenced by stressful events[25], and it is not surprising that hospitalization for a surgical procedure is associated with increase in distress[26,27]. No significant relationship has been reported

between the severity of social isolation and consequences within thirty days in general and surgical patients[15,28]. However, study results of Saito et al. demonstrated a significantly higher rate of unplanned readmissions within ninety days in more socially isolated cardiac surgical patients, compared to patients with a lower sense of social isolation[29]. This has not yet been demonstrated in non-cardiac surgical patients.

To improve clinical outcomes, e.g.to decrease severity of delirium[30] and to reduce LOS[31,32], there is increasing evidence for social related interventions, especially stimulating family involvement in hospital care[33,34], by reducing anxiety levels and improving a feeling of well-being[10,33]. Further research is needed to determine whether increasing social isolation is an active component of these interventions[33,35].

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

2. Method

2.1 Study design and setting

This single-center prospective longitudinal cohort study took place at a University Medical Centre (UMC) in the Netherlands, at five surgical wards: vascular, gastro-intestinal (GI), urology, traumatic or orthopaedic. The study was conducted in accordance with the principles of the Declaration of Helsinki (26th version, October 2013). The ethics review board of the UMC approved the study (W19_335#19.394). Patients gave written informed consent. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline was used to ensure transparent reporting[36].

2.2 Participants

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

2.3 Data collection

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

2.4 Outcome variables

Social isolation was measured with the FS at baseline[22]. This questionnaire consists of five statements about the past four weeks: *'I found it easy to get on with other people', 'I felt lonely', 'I had someone to share my feelings with', 'I found it easy to make contact with people', and 'I felt I was a burden to people'.* Each statement has a five-point Likert scale answer option, ranging from 'almost always' to 'not at all', giving a final range of 0-20. A higher score corresponds with higher sense of social isolation[19]. The questionnaire was translated for and backward from English to Dutch by native speakers.

2.4.1 Baseline

Collected predictive and possible intermediate variables were divided into three categories: patient related variables, surgical related variables and screening measurements. The following variables were collected at baseline: age, gender, rooming-in of a family caregiver during hospitalization, type of admission (primary or readmission, acute or elective), and type of surgery (vascular, GI, oncological-GI, urology, traumatic, orthopaedic or plastic or oncological gastro-intestinal). The screening measurements included: the score of social isolation (measured with the FS)[22], quality-adjusted life years (QALYs) (measured with 5Q-5D-5L[37]), Delirium Observation Scale (DOS)[38] and Short Nutritional Assessment Questionnaire (SNAQ)[39].

2.4.2 Follow-up

Collected additional information and postoperative outcomes included: profession, living situation (marital status, living alone or with others), children living at home, living place after discharge, use of home care agency before and/or after discharge, number of medication at discharge, intraoperative transfusion of blood, intensive care (IC) stay during hospitalization, date of surgery, and LOS. Screenings measurements: included the score of Katz Activities of Daily Living (ADL)[40], ASA grade[41], and Body Mass Index (BMI)[42].

2.4.3 Primary and secondary study outcomes

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

2.5 Statistical Analysis

Assumptions of regression were checked and extreme outliers were assessed with Cook's Distance and if necessary deleted from analyses. When continuous data were not normally distributed, log transformations were applied. Data are presented as mean (*M*) and Standard Deviation (*SD*) and in case of non-normal distributions as median with interquartile range (*IQR*), due to the continuous type of data. Patterns of missing data were analyzed and single stochastic regression with predicted mean matching was applied to impute missing data, followed by a sensitivity analysis[43]. Afterwards, a sensitivity analysis was performed to compare the imputed with the non-imputed data. Results of analyses of non-imputed data were included in the appendix.

The PROCESS macro version 3.4 for SPSS[44] was used to conduct three simple mediation analyses based on different regression models to test the effect of the relationship between the independent variable FS-score, and dependent variables (i.e. unplanned readmission, mortality and LOS), in the presence of the mediator EQ-5D-5L[15], transformed to QALYs[45].

To adjust for covariates, variables related to the outcome or both to exposure and outcome were consolidated into a RAW propensity score[46], using a logistic regression model[47]. The propensity score of unplanned readmissions included the variables: age (as continuous variable), use of home care agency, profession, rooming-in, number of medication at discharge, type of admission, type of surgery and intraoperative infusion. The propensity score of initial and total LOS included: age (as continuous variable), gender, profession, number of medication at discharge, children living at home, living place after discharge, type of surgery, ASA grade and intraoperative infusion.

To calculate the average estimated odds of the outcome unplanned readmissions, an univariate and multivariate logistic regression model were used. The latter controlled for the propensity score and all other predictive variables, based on a likelihood-ratio test with a *p*-value lower than 0.1[48]. Results are presented as odds ratios with corresponding 95%

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

To evaluate the relation with initial and total LOS, multiple regression analysis using backward selection was performed. Thereafter, a hierarchical regression for all variables with five levels was used, by evaluating the contribution of each independent variable[49]. Dependent variables with the lowest correlation were entered into the equation at step one, and each group of variables were added to the previous model. Results were presented as *B* of the FS-score, with corresponding *SE* and *p*-value, and the standard R-squared (R^2) of the total model is shown.

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

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

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Position Figure 1

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3. Results

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

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Position Table 1 and 2

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3.1 Primary Outcome

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

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Position Table 3 and 4

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3.2 Secondary Outcomes

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

The median initial LOS of the total cohort was 10.5 days (*IQR* = 5; 17) and the median total LOS was 12.0 days (*IQR* = 6; 19). Median of total LOS for participants who underwent an unplanned readmission are 20 days (*IQR* 12; 32) (Table 3). Social isolation during hospitalization was not associated with initial LOS (*B* = -.007; CI = -.038, .024; *p* = .657) (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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In the final model, analyses of the relationship between personal and social factors to the FS-score, included the significant related variables living with others, but without partner, (*p* = .009) and less QALYs (*p* = .002) to a higher sense of social isolation. These variables

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

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Position Table 7

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4. Discussion

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

To our knowledge, no other studies have been performed in such a broad surgical population, ranging from oncological gastro-intestinal to vascular surgery. The unplanned readmission rate in our sample was comparable to other studies, ranging from 5% to 30%[50,51]. The findings regarding the short-term consequences of social isolation in the present study are also comparable with a study in general inpatients[28] and patients prior to surgery[15], which is in contrast to cardiac patients[29,52]. They experienced a higher social isolation rate[53], and a relation between social isolation and clinical outcomes were found[29]. Both may be explained by the link between social isolation to other characteristics of patients with heart failure (HF), for instance: being older or debilitating and having progressive disease compromising their functional status[29,53–55]. The group of patients who underwent vascular surgery in the present sample might be more comparable to cardiac patients, however, the sample size of this study was insufficient to explore such relationships.

Identifying the risk factors for hospital readmissions or prolonged hospital stay are important for the benefit of both patients and hospitals[17]. To reduce these risk factors in patients, interventions have been developed allowing patients' families to partner and collaborate in care[35,56], however, results are inconclusive[33]. This could be explained by complexity of these family-related interventions, due to the different interacting components and diversity of stakeholders[35,57]. In turn, the interventions were developed, implemented and described differently by each study, making them difficult to compare[33,57]. In the present study, a small amount of participants used rooming-in of a family caregiver, together with a low average score on the FS, which suggest that complex family-related interventions could not be

directly related to a decrease in the sense of social isolation. The results in the present study showed that a higher sense of social isolation is related to a lower quality of life, living with others but without partner, and unemployment. The propensity score, which included various personal and social aspects, has a strong relationship with unplanned readmissions. Related to the positive effect of family involvement interventions[33], it is essential to remain focused on patient's personal and social aspects in clinical practice.

Future studies are needed to explore the efficacy of the components, process and implementation of social interventions, to further understand what may contribute to reducing the number of unplanned readmissions or decreasing LOS in surgical patients[33]. Next, future research should focus on the validation of the FS in this patient category[58]. When measurement properties are insufficient, it is recommended to use another tool to measure social isolation, taking into account the mental loadability of this patient category[26,27]. Finally, the study population could be specified to major surgical procedures. Possibly, characteristics are more comparable with essential characteristics of patients with chronic heart diseases[29,53–55].

The present study has several strengths. First, a consecutive sampling approach was used: all patients meeting the eligibility criteria at the four time points were invited, which reduced the risk of sampling bias. This has led to generalizable results to general surgical patients[58]. Next, a sensitivity analysis was performed to compare the imputed with the non-imputed data. This showed that in the analyses of unplanned readmissions, the contribution of the FS did increase after imputation, but that this increase was not significant. In the analyses of the relationship with LOS, the explained variance in the imputed data decreased. This was caused by the single stochastic imputation method with predicted mean matching[58]. Despite the weaknesses of this method, its use in this study was appropriate because of the low number of missing values and the use of a propensity score[59,60].

The first and most important limitation is the way social isolation has been measured. A majority of the participants scored low on the FS. The FS is a self-reported questionnaire, which might have led to a lower score on the FS than if it had been measured in a more indirect way. However, the FS is validated to measure social isolation in older adults[22] and general population[19]. Therefore it is expected that the FS is sensitive enough to demonstrate social isolation, also in only surgical patients. Besides, the skewed distribution is similar to the validation study of the FS[19]. As most patients were hospitalized electively, this could have increase social isolation due to affected social and working activities during wait[61]. Another explanation could be that socially isolated patients' are more likely to avoid care, compared

to non-isolated patients[62]. In spite of that the FS might be a suboptimal reference test, it was expected appropriate in the present study, due to the low patient burden that would be caused by this questionnaire. Second, the baseline information, including social isolation, was not measured at a fixed time point after hospital admission. To our knowledge, no studies have been performed to investigate if the time of measurement affects the degree of social isolation. Although the time window of measurement was wide, we do not expect much influence on the conclusion, given the results of this study. Finally, no power calculation for the present study was performed in advance, due to the use of an existing database for the baseline data. Hence, a propensity score was conducted to correct for a small sample size and low occurrence of social isolation[63], with respect for the rule of thumb in the final model[64]. Consequently, the diagnosis groups were too small to perform reliable subgroup analyses for each diagnosis. Diagnosis groups were included in the analyses using the propensity score, as it was related to exposure and outcome[46].

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

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Figure and Tables

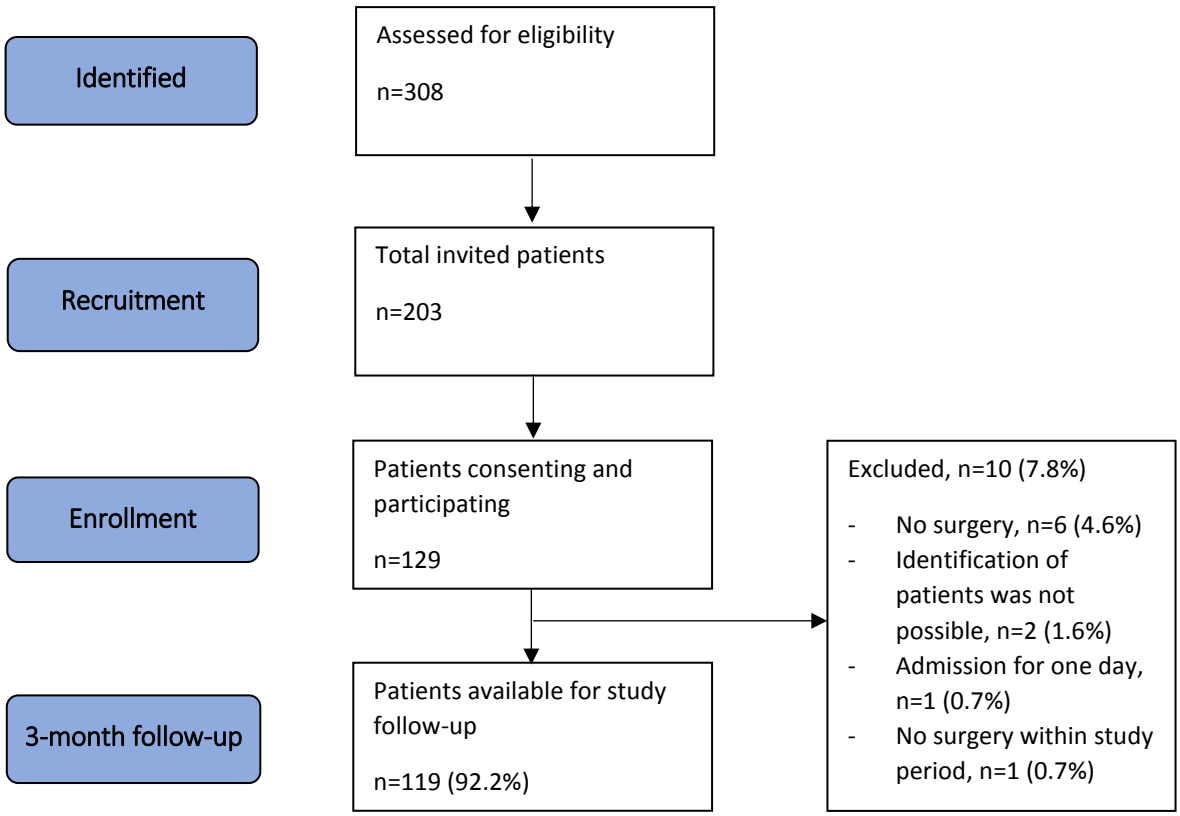

Figure 1. STROBE flow-chart for recruitment

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) (*M* (*SD*))	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 (m (IQR))	7 (4; 10)	7 (4; 10)
Time between measurement and surgery (*M* (*SD*))	6.60 (14.63)	6.60 (14.63)
Screening measurements		
BMI (kg/m^2) (*Mdn* (IQR))	25.16 (22.15; 29.51)	24.42 (21.67; 28.64)
DOS (*Mdn* (IQR))	0 (0; 0)	0 (0; 0)
QALYs (EQ-5D-5L) (*M* (*SD*))	0.53 (0.32)	0.53 (0.32)
Q1. (*Mdn* (IQR))	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) (*Mdn* (IQR))	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 (*Mdn* (IQR))	10.50 (5; 17)	12 (7; 21)
Total length of hospital stay (*Mdn* (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; 10.141	.507					
Living situation, living with others	.019	.863	1.020	.188; 5.533	.982	.459	1.502	1.582	.083; 10.043	.760					
Children living at home (yes)	-.196	.558	.822	.275; 2.453	.725	.990	1.006	2.692	.375; 19.321	.325					
Living place after discharge (other)	-.481	.676	.618	.164; 2.324	.476	.355	1.285	1.427	.115; 17.716	.782					
IC stay during hospitalization (no)	.234	.635	1.264	.364; 4.384	.712	-.134	1.462	.874	.05; 15.338	.927					
QALYs	.168	0.668	1.182	.319; 4.382	.802	.669	1.274	1.953	.161; 23.708	.599					

Initial LOS	.710	.625	2.035	.598; 6.921	.255	.013	1.307	1.013	.078; 13.134	.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),*

[o]Propensity 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 (R^2).

Table 5. Relationship between social isolation and initial LOS.

	Model for initial LOS			
	B	*SE*	*p*	R^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

[o]Propensity 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

[o]Propensity 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), 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 (R^2).

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)	**Unplannend readmission(s)** (n= 29)	**No unplanned readmissions** (n= 89)
Patient related factors			
Age (years) (*M* (*SD*))	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 (*Mdn* (IQR))	7 (4; 10)	7 (4; 11)	7 (4; 10)
Time between measurement and surgery (*M* (*SD*))	6.60 (14.63)	6.60 (14.63)	N/A
Screening measurements			
BMI (kg/m^2) (*Mdn* (IQR))	25.16 (22.15; 29.51)	24.72 (21.62; 29.75)	25.38 (22.21; 28.46)
DOS (*Mdn* (IQR))	0 (0; 0)	0 (0; 0)	0 (0; 0)
QALYs (EQ-5D-5L) (*M* (*SD*))	0.53 (0.32)	0.54 (0.36)	0.52 (0.31)
Q1. (*Mdn* (IQR))	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	refere nce														
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	-.007	.045	.993	.910; 1.084	.881	-.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).*

[o]Propensity 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 (R^2).

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

[o]Propensity 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 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

[o]Propensity 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), 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).

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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 (R^2).