Featured Article

How skilled are skilled facilities? Post-discharge complications after colorectal cancer surgery in the U.S.

Mohamed A. Abd El Aziz ¹, Fabian Grass ¹, Kevin T. Behm, Anne-Lise D'Angelo, Kellie L. Mathis, Eric J. Dozois, David W. Larson ^{*}

Division of Colon and Rectal Surgery, Department of Surgery, Mayo Clinic, Rochester, MN, USA

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ABSTRACT

Background: Characteristics and indications for discharging patients to home or a specific facility type have been studied; however, critical evaluation of these facilities through analysis of post-discharge complications and readmission rates is mandatory. The aim of this study was to compare complications occurring after discharge to home, skilled, and unskilled care facilities to identify potential pitfalls.

Methods: All adult (≥ 18 years) patients who underwent surgery for colon or rectal cancer from 2012 to 2017 as reported in the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database were included. Patients were categorized according to the discharge destination into: home, skilled care (rehabilitation center, separate acute care, skilled facility), and unskilled care (multilevel senior community, facility which is home, unskilled facility). Demographics, surgical risk factors and pre-discharge complications were compared between the three groups. Primary endpoints were overall, major, surgical, and medical complications occurring post-discharge, within 30 days of surgery. Further assessed were specific complications, readmission, length of stay, and 30-day mortality. **Results:** A total of 108,617 patients were identified. Of them, 100,478 (92%) discharged to home, 7313 (7%) to skilled, and 826 (1%) to unskilled care. Of patients discharged to skilled care, 1928 (26%) discharged to rehabilitation centers, 368 (5%) to separate acute care, and 5017 (69%) to skilled facilities. Adjusted overall, major, surgical, and medical post-discharge complications were highest among patients discharged to skilled care destinations. Subgroup analysis revealed separate acute care (inter-hospital transfer) to be associated with the highest morbidity. Main reasons for readmission were primarily related to surgical site infection and intestinal obstruction among the three main destinations, whereas readmissions for systemic sepsis and medical complications were more frequent in patients admitted to skilled care.

Conclusion: This study identified higher rates of post-discharge complications associated with skilled care destinations, despite risk adjustment. This over-morbidity is potentially related to prevailing medical complications and inter-hospital transfers. Further studies are needed to better understand those findings and to improve quality of post-acute care and related outcomes.

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Introduction

Skilled care facilities are licensed healthcare residences providing both short term rehabilitation and long term care for patients with complex medical needs. Post-acute care is important to unburden acute care hospitals given the growing focus on

financial considerations in a value-based health-care market.¹ However, recent studies demonstrated conflicting results regarding quality of care and related outcomes of patients admitted to skilled care, especially with regards to the quality-metric of unplanned readmission.^{2–4}

Comparison of facilities for quality assessment requires thorough risk stratification considering patient characteristics, surgical management and postoperative recovery including pre-discharge complications.⁵ While several studies aimed to define criteria and indications for discharging patients to home or a specific facility type, critical evaluation of these facilities through analysis of post-

^{*} Corresponding author. Chair of Colon and Rectal Surgery Department of Surgery, Mayo Clinic, 200 first St. Southwest, Rochester, MN, 55905, USA.

E-mail address: Larson.David2@mayo.edu (D.W. Larson).

¹ Shared first authorship.

discharge complications and readmission rates is important to identify potential quality improvement initiatives.^{6,7} National datasets such as the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) represent a platform for such comparative analysis given the massive data pool and the focus on short-term morbidity through highly standardized outcome assessment and definitions. Furthermore, ACS-NSQIP stratifies facilities further according to level of care in skilled and unskilled facility types.

This six-year longitudinal study compared complications occurring after discharge to home, skilled and unskilled care facilities in order to identify negative trends and potential pitfalls.

Material and methods

Data source

The ACS-NSQIP database was queried to include all patients who underwent an elective (defined as patient presented to planned surgery from home) surgery for colon or rectal cancer between 2012 and 2017.

ACS-NSQIP is a national quality improvement program gathering abstract patient information through predesigned data extraction sheets managed by trained data abstractors from all participating institutions. Overall, a random sample of 20% of the pooled patients from the participating institutions is included in the final Participant User Files (PUF).

After merging the PUF files from 2012 to 2017, patients who underwent elective surgery for colon or rectal cancer were selected using the Current Procedure Terminology (CPT) codes (44140, 44141, 44143, 44144, 44145, 44146, 44147, 44150, 44151, 44155, 44156, 44157, 44158, 44160, 44188, 44204, 44205, 44206, 44207, 44208, 44210, 44211, 44212, 45110, 45111, 45112, 45113, 45114, 45116, 45119, 45120, 45121, 45123, 45126, 45395, 45397) and the International Classification of Disease (ICD) medical codes (for colon cancer, ICD-9-CM: 153. x and ICD-10-CM: C18. x; and for rectal cancer (ICD-9-CM: 154. x and ICD-10-CM: C19, and C20).

Discharge destinations

According to ACS-NSQIP definitions, discharge destinations were categorized into three main groups: home, skilled care and unskilled care. Patients who discharged against medical advice, discharged to hospice, expired discharge or unknown discharge destination were excluded. Skilled care destinations included the following: separate acute care, skilled facility, and rehabilitation center. Unskilled care destinations were subcategorized as follows: multilevel senior community, facility which is home, unskilled facility.

Covariates and outcomes

Baseline characteristics and perioperative information were compared between the three main groups. Primary endpoints were overall, surgical or medical complications occurring within 30 days of the index operation. Secondary endpoints were specific complications according to standardized ACS NSQIP definitions including surgical site infection (SSI), wound disruption, need for blood transfusion, systemic sepsis, respiratory complications (pneumonia, unplanned intubation, and/or mechanical ventilation $\geq$ 48 h), renal complications (acute renal failure and/or progressive renal insufficiency), urinary tract infection (UTI), vascular thromboembolism (VTE, including pulmonary embolism (PE) and/or deep venous thrombosis (DVT)), and major adverse cardiovascular events (MACE, including stroke, myocardial infarction, and/or cardiac arrest

requiring cardiopulmonary resuscitation). Further assessed were unplanned reoperation, readmission and mortality within 30 days of surgery.

Specific reasons for unplanned readmission from home or skilled/unskilled care destinations were categorized, summarized and compared.

All outcomes were assessed in-hospital before discharge (pre-discharge complications, until 1st discharge after index surgery) and after discharge (post-discharge complications, until post-operative day (POD) 30).

Subgroup analysis of patients discharged to skilled care destinations was performed to further detail post-discharge morbidity associated with separate acute care, skilled facilities, and rehabilitation centers.

Statistical analysis

The descriptive data were summarized using frequencies and percentages for categorical data and median (interquartile range) for continuous data. Chi-Square test was used to assess the differences between the three groups for categorical data and the Independent Samples Kruskal Wallis test was used for continuous data. Outcomes that had a p-value < 0.1 after univariate analysis were further assessed through multivariable analysis to adjust for the baseline confounders. A p-value < 0.05 was considered statistically significant and all tests were two-sided.

The analysis was performed using the Statistical Package for Social Sciences (SPSS, Version 25; SPSS, Inc., Armonk, NY, USA).

Fig. 1. Discharge destination. Percentages of different discharge destinations a) overall and b) among skilled care destinations.

Table 1
Baseline demographics and surgical specifics.

	Home N = 100478	Skilled N = 7313	Unskilled N = 826	Total N = 108617	P value ^a
Age, Median (IQR)	65 (55–74)	79 (70–85)	72 (60–83)	66 (56–75)	<0.0001
Age > 80 years	10760 (10.7%)	3114 (42.6%)	264 (32.0%)	14138 (13.0%)	<0.0001
Male	54154 (53.9%)	3395 (46.4%)	446 (54.0%)	57995 (53.4%)	<0.0001
ASA class					<0.0001
1–2	42477 (42.3%)	1090 (14.9%)	165 (20.0%)	43732 (40.3%)	
≥3	57871 (57.6%)	6219 (85.0%)	659 (79.8%)	64749 (59.6%)	
Not assigned	130 (0.1%)	4 (0.1%)	2 (0.2%)	136 (0.1%)	
BMI, kg/m ²					
Median (IQR)	27.7 (24.2–32)	27 (23–32)	27 (24–31)	28 (24–32)	<0.0001
DM	18388 (18.3%)	1976 (27.0%)	176 (21.3%)	20540 (18.9%)	<0.0001
Smoker	14339 (14.3%)	805 (11.0%)	119 (14.4%)	15263 (14.1%)	<0.0001
Dyspnea	6944 (6.9%)	1154 (15.8%)	93 (11.3%)	8191 (7.5%)	<0.0001
Functional health status:					<0.0001
Independent	99169 (98.7%)	6538 (89.4%)	614 (74.3%)	106321 (97.9%)	
Dependent	975 (1.0%)	730 (10.0%)	203 (24.6%)	1908 (1.8%)	
Unknown	334 (0.3%)	45 (0.6%)	9 (1.1%)	388 (0.4%)	
COPD	4314 (4.3%)	838 (11.5%)	69 (8.4%)	5221 (4.8%)	<0.0001
Ascites	202 (0.2%)	39 (0.5%)	2 (0.2%)	243 (0.2%)	<0.0001
CHF	607 (0.6%)	173 (2.4%)	15 (1.8%)	795 (0.7%)	<0.0001
HTN	50728 (50.5%)	5147 (70.4%)	501 (60.7%)	56376 (51.9%)	<0.0001
Currently on dialysis	350 (0.3%)	78 (1.1%)	9 (1.1%)	437 (0.4%)	<0.0001
Disseminated cancer	9309 (9.3%)	723 (9.9%)	69 (8.4%)	10101 (9.3%)	0.135
Open wound/wound infection	483 (0.5%)	142 (1.9%)	15 (1.8%)	640 (0.6%)	<0.0001
Chronic steroid use	2814 (2.8%)	315 (4.3%)	24 (2.9%)	3153 (2.9%)	<0.0001
Loss of body weight (>10% within last 6 months)	4065 (4.0%)	485 (6.6%)	46 (5.6%)	4596 (4.2%)	<0.0001
Bleeding disorder	2369 (2.4%)	411 (5.6%)	36 (4.4%)	2816 (2.6%)	<0.0001
Transfusion of ≥1 pRBC/72 h before the surgery	753 (0.7%)	182 (2.5%)	28 (3.4%)	963 (0.9%)	<0.0001
Underlying disease					<0.0001
Colon cancer	66829 (66.5%)	4989 (68.2%)	616 (74.6%)	72434 (66.7%)	
Rectal cancer	33649 (33.5%)	2324 (31.8%)	210 (25.4%)	36183 (33.3%)	
Preoperative laboratories, Median (IQR)					
Albumin, g/dl,	4 (3.6–4.3)	3.6 (3.2–4)	3.6 (3.2–4)	3.9 (3.6–4.2)	<0.0001
Hematocrite, %	38.2 (34.2–41.7)	34.8 (31–41.9)	35.4 (30.6–39.4)	38.2 (34–41)	<0.0001
Platelets, k/mL	250 (203–309)	248 (196–319)	256 (195–330)	249 (202–308)	0.172
Operative approach					<0.0001
Minimally invasive	65038 (64.7%)	3497 (47.8%)	443 (53.6%)	68978 (63.5%)	
Open	35440 (35.3%)	3816 (52.2%)	383 (46.4%)	39639 (36.5%)	
Extent of resection					<0.0001
Segmental colectomy	65027 (64.7%)	5170 (70.7%)	626 (75.8%)	70823 (65.2%)	
Total colectomy	1775 (1.8%)	175 (2.4%)	8 (1.0%)	1958 (1.8%)	
proctectomy	33676 (33.5%)	1968 (26.9%)	192 (23.2%)	35836 (33.0%)	
Diversion					<0.0001
Yes					
Ileostomy	4349 (4.3%)	322 (4.4%)	18 (2.2%)	4689 (4.3%)	
Colostomy	16549 (16.5%)	1793 (24.5%)	166 (20.1%)	18508 (17.0%)	
No	77279 (76.9%)	5064 (69.2%)	626 (75.8%)	82969 (76.4%)	
Unknown	2301 (2.3%)	134 (1.8%)	16 (1.9%)	2451 (2.3%)	
Operation time (minutes), Median (IQR)	178 (124–253)	179 (119–265)	158 (111–233)	178 (124–253)	<0.0001

BMI: body mass index, ASA: American Society of Anesthesiologists, DM: diabetes mellitus, COPD: chronic obstructive pulmonary disease, CHF: congestive heart failure, HTN: hypertension requiring medication, pRBC: packed red blood cells.

^a Derived from Chi-square for categorical variables and Independent Samples Kruskal Wallis test for continuous variables.

Results

A total of 108,617 patients were included and discharged to home, skilled care and unskilled care, as detailed in Fig. 1. Skilled care destinations (n = 7313) included skilled facilities (69%), rehabilitation centers (26%), and separate acute care (5%). Unskilled care destinations (n = 826) included facilities which were home (83%), unskilled facilities which were not home (16%), and multi-level senior communities (1%).

Demographics, comorbidities, and surgical specifics including approach, extent of resection, ostomy creation, and duration of surgery are detailed in Table 1, revealing important differences regarding age, dependence status, co-morbidities, and surgery-related items between the main three groups (home vs. skilled care vs. unskilled care). In-hospital complications occurring before 1st discharge after the primary surgery and index length of stay are specified in Table 2. In general, rates of overall, major, surgical,

medical, and specific complications were highest in patients discharged to skilled care and lowest in patients discharged to home.

Post-discharge complications

Rates of post-discharge complications occurring in different post-acute care settings are illustrated in Fig. 2. Significant differences between the three main groups were observed for overall, major, surgical and medical complications, which were highest in skilled care facilities and lowest in patients discharged to home. Thirty-day mortality was 0.3% (374/108,607 patients) overall and 0.2% in patients discharged to home, 1.8% in patients discharged to skilled care and 1.1% in patients discharged to unskilled care (Fig. 2a). Odds to complications after adjustment for the baseline confounders are displayed in Fig. 2b. No significant differences were observed between home vs. unskilled care destinations, whereas all differences were significant comparing home vs. skilled

Table 2
Pre-discharge postoperative complications.

	Home N = 100478	Skilled N = 7313	Unskilled N = 826	Total N = 108617	P value ^a
Overall morbidity ^b	22792 (22.7%)	4501 (61.5%)	358 (43.3%)	27651 (25.5%)	<0.0001
Major complication ^c	11415 (11.4%)	2776 (38.0%)	205 (24.8%)	14396 (13.3%)	<0.0001
Any Surgical complication	10912 (10.9%)	2471 (33.8%)	184 (22.3%)	13567 (12.5%)	<0.0001
Any SSI	2650 (2.6%)	784 (10.7%)	42 (5.1%)	3476 (3.2%)	<0.0001
Superficial SSI	1144 (1.1%)	236 (3.2%)	16 (1.9%)	1396 (1.3%)	<0.0001
Deep SSI	236 (0.2%)	105 (1.4%)	8 (1.0%)	349 (0.3%)	<0.0001
Organ/Space infection	1396 (1.4%)	498 (6.8%)	21 (2.5%)	1915 (1.8%)	<0.0001
Wound disruption	235 (0.2%)	26 (1.7%)	8 (1.0%)	369 (0.3%)	<0.0001
Need for blood transfusion	7613 (7.6%)	1610 (22.0%)	133 (16.1%)	9356 (8.6%)	<0.0001
Systemic Sepsis	1250 (1.2%)	626 (8.6%)	28 (3.4%)	1904 (1.8%)	<0.0001
Sepsis	1032 (1.0%)	331 (4.5%)	22 (2.7%)	1385 (1.3%)	<0.0001
Septic shock	221 (0.2%)	305 (4.2%)	6 (0.7%)	532 (0.5%)	<0.0001
Unplanned reoperation	1914 (1.9%)	695 (9.5%)	24 (2.9%)	2633 (2.4%)	<0.0001
Any medical complication	2881 (2.9%)	1293 (17.7%)	77 (9.3%)	4251 (3.9%)	<0.0001
Respiratory complications	1089 (1.1%)	785 (10.7%)	38 (4.6%)	1912 (1.8%)	<0.0001
Pneumonia	728 (0.7%)	489 (6.7%)	29 (3.5%)	1246 (1.1%)	<0.0001
Unplanned intubation	399 (0.4%)	366 (5.0%)	13 (1.6%)	778 (0.7%)	<0.0001
On ventilator for > 48 h	199 (0.2%)	361 (4.9%)	7 (0.8%)	567 (0.5%)	<0.0001
Renal complications	350 (0.3%)	174 (2.4%)	5 (0.6%)	529 (0.5%)	<0.0001
Progressive renal insufficiency	271 (0.3%)	99 (1.4%)	4 (0.5%)	374 (0.3%)	<0.0001
AKI	82 (0.1%)	77 (1.1%)	1 (0.1%)	160 (0.1%)	<0.0001
UTI	805 (0.8%)	259 (3.5%)	28 (3.4%)	1092 (1.0%)	<0.0001
MACE	449 (0.4%)	239 (3.3%)	13 (1.6%)	701 (0.6%)	<0.0001
Stroke	42 (0.0%)	62 (0.8%)	6 (0.7%)	110 (0.1%)	<0.0001
Cardiac arrest requiring CPR	58 (0.1%)	55 (0.8%)	2 (0.2%)	115 (0.1%)	<0.0001
MI	359 (0.4%)	136 (1.9%)	5 (0.6%)	500 (0.5%)	<0.0001
VTE	477 (0.5%)	207 (2.8%)	4 (0.5%)	688 (0.6%)	<0.0001
DVT	286 (0.3%)	149 (2.0%)	3 (0.4%)	438 (0.4%)	<0.0001
PE	229 (0.2%)	84 (1.1%)	3 (0.4%)	316 (0.3%)	<0.0001
LOS, days, Median (IQR)	4 (3–6)	8 (5–13)	6 (4–9)	4 (3–7)	<0.0001
LOS > 7 days (>3rd Q)	16664 (16.6%)	3822 (52.3%)	279 (33.8%)	20765 (19.1%)	<0.0001

SSI: Surgical site infection, MACE: major adverse cardiovascular events, VTE: Vascular thromboembolism, PE: Pulmonary embolism, AKI: Acute kidney injury, UTI: Urinary tract infection, CPR: Cardiopulmonary resuscitation, MI: Myocardial infarction, DVT: Deep venous thrombosis, LOS: Length of stay.

^a Derived from Chi-square for categorical variables and Independent Samples Kruskal Wallis test for continuous variables.

^b Overall morbidity includes any surgical, any medical complications, and/or LOS > 7 days.

^c Major complications include VTE, MACE, renal, respiratory, unplanned reoperation, systemic sepsis, need for blood transfusion, wound disruption, organ space infection and/or deep SSI.

care destinations (all $p < 0.05$).

Sub-group analysis of skilled care destinations

Demographic and surgical/postoperative details of the patient population discharged to skilled care are provided in the online appendix. Post-discharge complications (unadjusted and adjusted) related to the three different subgroups of skilled care destinations are detailed in Fig. 3a and b, revealing highest overall, major, surgical, and medical complications associated with separate acute care. After adjustment for the baseline confounders and taking home as a reference, the adjusted OR for 30-day mortality was 2.0; 95% CI 1.2–3.5 for rehabilitation centers vs. OR 11.7; 95% CI 6.3–21.8 for separate acute care vs. OR 3.1; 95% CI 2.2–4.3 for skilled facilities.

Specific surgical and medical complications between the three subgroups of skilled care are presented in Table 3.

Unplanned readmission

The overall unplanned readmission rate was 8.6% (8.4% (home) vs. 11.7% (skilled care) vs. 10.4% (unskilled care), $p < 0.0001$). Main reasons for readmission are illustrated in Fig. 4. Across all discharge settings, SSI and intestinal obstruction were prevailing reasons. For skilled care destination types, readmission rates were 11.5% (adjusted OR compared to home 1.1; 95% CI 0.9–1.4) for rehabilitation centers vs. 9.5% (adjusted OR 0.9; 95% CI 0.6–1.4) for separate acute care vs. 11.9% (adjusted OR 1.3; 95% CI 1.1–1.4) for skilled

facilities Fig. 3.

Discussion

The present large scale study assessing 30-day morbidity within different post-discharge settings revealed higher post-discharge complication-, readmission- and mortality rates associated with skilled care when compared to unskilled care and home destinations. The main determinants for readmission were primarily related to SSI and intestinal obstruction across all three discharge destinations, whereas readmissions for systemic sepsis and medical complications were more frequent in patients admitted to skilled care. Subgroup analysis of skilled care facility types revealed that (inter-hospital) transfer to separate acute care was associated with the highest morbidity.

This nationwide analysis revealed that 8% of patients undergoing colorectal surgery are discharged to post-acute care destinations. These patients were older, predominantly functionally dependent, and had more existing comorbidities and higher rates of postoperative complications prior to discharge. Several former studies used large data pools such as ACS-NSQIP to derive prediction models in order to tailor discharge destinations to the individual patient. Mohanty et al. created a surgical risk calculator to accurately predict the risk of discharge to post-acute care settings.⁸ Similarly, Hyder et al. derived and validated a simple patient-centered calculator to predict home discharge after surgery.⁹ More recently, Al-Mazrou et al. stressed the importance of patient-driven factors leading to extended care after colectomy.⁷

Fig. 2. Post-discharge complications.

Comparison of post-discharge complications of patients discharged to home ($n = 100,478$), skilled discharge destinations ($n = 7313$) and unskilled discharge destinations ($n = 826$) a) unadjusted and b) adjusted for: age, gender, race, BMI, diabetes mellitus, current smoker within one year, dyspnea, functional health status prior to surgery, history of severe COPD, ascites, congestive heart failure (CHF) within 30 days before surgery, hypertension requiring medication, hemodialysis, disseminated cancer, open wound/wound infection, steroid use for chronic condition, >10% loss body weight in last 6 months, bleeding disorders, transfusion ≥ 1 unit within 72 h before surgery, ASA class, underlying disease, pre-operative serum albumin, pre-operative hematocrit, operative approach, diversion, total operation time, days from operation to discharge, any surgical complication before discharge, any medical complication before discharge. Displayed are Odds ratios (dots) with 95% confidence interval. Patients discharged to home are used as reference.

While these tools are useful to help with discharge planning, they are unable to assess the outcomes of different post-acute care settings.¹⁰ This present study used sensitive ACS-NSQIP data stratifying skilled and unskilled facilities in order to focus on post-discharge complications and hospital readmissions. This series attempts to better understand at a macro level the previously described over-morbidity associated with skilled care facilities.^{1,5,11,12}

In line with previous investigations, the present study demonstrated higher rates of overall and specific surgical and medical complications associated with post-acute skilled care after risk-adjustment for demographic, peri- and postoperative risk profiles. Subgroup analysis of three different skilled care settings revealed a particularly higher rate associated with the small group of patients transferred to separate acute care (Fig. 3b). Inter-hospital transfer has been previously linked to increased morbidity and mortality and may actually penalize hospitals that frequently accept transfers.^{13–15} These findings are likely explained by patients

Fig. 3. Post-discharge complications skilled care destinations.

Comparison of post-discharge complications of patients discharged to skilled discharge destinations: rehabilitation center ($n = 1928$), skilled facility ($n = 5017$) and separate acute care ($n = 368$) a) unadjusted and b) adjusted for: age, gender, race, BMI, diabetes mellitus, current smoker within one year, dyspnea, functional health status prior to surgery, history of severe COPD, ascites, congestive heart failure (CHF) within 30 days before surgery, hypertension requiring medication, hemodialysis, disseminated cancer, open wound/wound infection, steroid use for chronic condition, >10% loss body weight in last 6 months, bleeding disorders, transfusion ≥ 1 unit within 72 h before surgery, ASA class, underlying disease, pre-operative serum albumin, pre-operative hematocrit, operative approach, diversion, total operation time, days from operation to discharge, any surgical complication before discharge, any medical complication before discharge. Displayed are Odds ratios (dots) with 95% confidence interval. Patients discharged to home are used as reference. Mortality not plotted given wide range of 95% CI.

transferring to larger regional medical centers for higher levels of care after experiencing complications following their index operation. This has to be considered when interpreting morbidity associated with skilled care destinations since inter-hospital transfers are frequently included in this group.⁶

While post-discharge morbidity associated with rehabilitation centers was close or similar to the home population, the large group of patients admitted to dedicated skilled facilities (69% of skilled facility destinations) exhibited worse outcomes. Specific assessment of post-discharge complications revealed that this increased morbidity was mainly due to medical (adjusted OR 1.8, $p < 0.0001$) rather than surgical complications (adjusted OR 1.1, n. s.) with one notable exception of septic complications (adjusted OR 1.8, $p < 0.0001$, Table 3). These findings suggest that common surgical complications such as SSI and postoperative ileus were safely managed, whereas life-threatening septic complications requiring more invasive treatment represented a challenge. The potential of these complications to overburden the management capacities of skilled facilities represents a serious consideration in our search for value.^{16,17} Among medical complications, respiratory (adjusted OR 2.9, $p < 0.0001$) issues were the most critical and emphasize the

Table 3

Multivariable binary logistic regression analysis for specific post-discharge surgical and medical complications of patients admitted to skilled care.

	Rehabilitation center		Separate acute care		Skilled facility	
	Adjusted OR ^a	P value	Adjusted OR ^a	P value	Adjusted OR ^a	P value
Any Surgical complication	1.113 (0.906–1.369)	0.308	1.634 (1.084–2.463)	0.019	1.122 (0.979–1.286)	0.098
Any SSI	1.031 (0.810–1.312)	0.802	1.245 (0.742–2.087)	0.407	1.020 (0.868–1.197)	0.813
Wound disruption	1.384 (0.734–2.611)	0.315	NA		1.103 (0.685–1.779)	0.686
Systemic Sepsis	1.470 (0.996–2.171)	0.053	2.959 (1.545–5.669)	0.001	1.815 (1.427–2.309)	<0.0001
Unplanned reoperation	1.276 (0.878–1.855)	0.201	2.717 (1.502–4.915)	0.001	1.028 (0.786–1.344)	0.841
Any medical complication	1.567 (1.230–1.997)	<0.0001	3.643 (2.398–5.536)	<0.0001	1.843 (1.580–2.149)	<0.0001
Respiratory complications	2.902 (1.852–4.548)	<0.0001	13.5 (7.8–23.5)	<0.0001	2.617 (1.908–3.589)	<0.0001
Renal complications	1.734 (1.063–2.829)	0.027	3.684 (1.587–8.547)	0.002	1.692 (1.202–2.381)	0.003
UTI	1.324 (0.885–1.980)	0.171	1.369 (0.504–3.716)	0.538	1.738 (1.363–2.217)	<0.0001
MACE	0.681 (0.247–1.880)	0.459	5.202 (1.863–14.527)	0.002	1.944 (1.265–2.988)	0.002
VTE	1.908 (1.187–3.067)	0.008	3.553 (1.550–8.141)	0.003	1.626 (1.158–2.283)	0.005

OR: Odds Ratio, SSI: Surgical Site Infection, UTI: Urinary Tract Infection, MACE: Major Adverse Cardiovascular Events, VTE: Vascular Thromboembolism.

Adjusted for: age >80 years old, gender, race, BMI, diabetes mellitus, current smoker within one year, dyspnea, functional health status prior to surgery, history of severe COPD, ascites, congestive heart failure (CHF) in 30 days before surgery, hypertension requiring medication, currently on dialysis (pre-op), disseminated cancer, open wound/wound infection, steroid use for chronic condition, >10% loss bodyweight in last 6 months, bleeding disorders, transfusion ≥ 1 units PRBCs in 72 h before surgery, pre-operative serum albumin, preoperative hematocrit, diagnosis, extent of resection, operative approach, diversion, operation time, any surgical complication before discharge, any medical complication before discharge, days from operation to discharge.

^a Patients discharged to home were used as a reference.

importance of preventive measures beyond hospital discharge.¹⁸ Taken together, these results including the associated overmortality (adjusted OR 3.1, $p < 0.0001$) suggest that serious complications can occur and if they do require immediate and facilitated transfer to index facilities.⁴

These previous observations were reflected by the detailed analysis of reasons for readmission (Fig. 4), revealing a comparatively higher proportion of patients with septic complications readmitted from skilled care destinations (Fig. 4). On the other hand, readmissions were comparatively lower for patients with intestinal obstruction (postoperative ileus), which may point towards the successful management of these patients in post-acute care settings. The study revealed further dehydration as a prevailing reason for readmission across all discharge destinations in a cohort yielding an ileostomy rate of 4.3%. Surveillance and maintaining hydration status appears to be of critical importance to prevent costly hospital readmissions.^{19,20}

The present study also evaluated outcomes of those patients (around 1% of the total cohort) admitted to unskilled care destinations. At first glance, outcomes appear encouraging and close to the patient population discharged to home.²¹ However, “unskilled care” represents a vague definition, and underreporting of sensitive

outcomes cannot be excluded.²² Nevertheless, VTE appears to be higher in unskilled care facilities and was overrepresented among patients readmitted from unskilled care compared to the other settings. This emphasizes the importance of pre-discharge education regarding DVT prophylaxis of this fragile, dependent subset of patients.²³

Taken together, the present study identified several potential pitfalls associated with skilled and unskilled care settings. These need to be interpreted within the limitations of this study. First, despite risk stratification of outcomes, residual confounding cannot be excluded. There may notably be an important impact of psychosocial components on the choice of discharge destination not accounted for in this analysis. Second, ACS-NSQIP does not provide data on setting and case volume of contributing centers, which may be important since academic centers tend to discharge fewer patients to post-acute care facilities.²⁴ Third, categorization of discharge destinations is broad, and further specifics on size, experience, and staffing as quality metrics were not available. Moreover, transfer to a higher level of care may impact the results and thus partly explain the higher complication rates in the skilled group. It is unclear whether the transfer was to a long-term care facility or a higher level of care due to complications. Lastly, details on functional recovery (mobilization, oral intake, fluid balance), arguably impacting post-discharge planning, were not available.

In conclusion, this study identified higher rates of post-discharge complications associated with skilled care destinations, despite risk adjustment. This over-morbidity is potentially related to prevailing medical complications and inter-hospital transfers. Further studies are needed to better understand those findings and to improve quality of post-acute care and related outcomes.

Declaration of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amjsurg.2020.12.012>.

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Fig. 4. Reasons for readmission

Most frequent reasons for hospital readmission to index facility from home ($n = 8396$ readmitted patients), skilled care destinations ($n = 852$ readmitted patients) and unskilled care destinations ($n = 86$ patients).

*represent reasons with statistically significant differences (multigroup comparison; all $p < 0.001$).

SSI – any surgical site infection, VTE – venous thromboembolism.

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