



# Equivalent Peri-Operative Outcomes for Laparoscopic Roux-En-Y Gastric Bypass Patients Discharged on Post-Operative Day One

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## Abstract

**Background** Previous studies have evaluated the safety of post-operative day one (POD #1) discharge after laparoscopic Roux-en-Y gastric bypass (LRYGB) surgery. Few studies, however, have evaluated the impact of a standardized POD #1 discharge pathway on peri-operative outcomes. This study aims to evaluate peri-operative outcomes after implementation of an enhanced recovery pathway for RYGB patients.

**Methods** Data from a prospectively maintained database identified 2,049 patients (pre-implementation  $n = 904$ ; post-implementation  $n = 1,144$ ) who underwent LRYGB between 2008 and 2016. The POD1 discharge pathway was implemented in July 2011. Patient demographics and outcomes before and after implementation of the POD1 pathway were compared using univariate analysis and propensity matching.

**Results** A propensity-matched group of all patients ( $n = 714$ ) and POD #1 candidates ( $n = 490$ ) pre- and post-pathway implementation were analyzed. Successful POD #1 discharges were significantly increased after introduction of the pathway (54.3 vs 17.8%,  $p < 0.0001$ ). The post-implementation groups demonstrated no differences in mortality, Emergency department (ED) visits, readmissions, reoperations, and major or minor complications.

**Conclusions** Early discharge after bariatric surgery has a significant impact on the cost effectiveness of surgery, patient comfort, potential reduction of medical errors, and exposure to hospital-acquired infections. Our results demonstrate that a standardized POD #1 discharge pathway can be safely implemented and in turn, reduce hospital LOS without negatively affecting peri-operative morbidity, mortality, ED visit, readmission, or reoperation rates.

**Keywords** Equivalent outcomes · LRYGB · Post-operative day one · POD #1

## Introduction

Minimally invasive approaches in bariatric surgery have translated into shorter hospital stays, earlier patient mobilization, and faster recovery when compared with traditional open surgery. Several additional benefits to bariatric patients include reduction in the use of peri-operative narcotics, venous thrombotic events, and earlier access to surgical intervention. The natural trend toward minimally invasive surgery is paired with financial pressures that drive both clinicians and institutions to minimize patients' hospital stay. Understandably, concern has

been raised about the impact that this trend may have on patient outcomes.

In 2005, McCarty et al. published a series of 2000 patients that underwent laparoscopic Roux-en-Y gastric bypass (LRYGB) at a single institution, in which 84% of the patients were discharged within 23 hours. The cited mortality and 30-day readmission rates were 0.1% and 1.7% respectively [1]. Based largely on this single series, Milliman's Care Guidelines recommended a 1-day global length of stay (GLOS) for LRYGB [2]. This notion was met with significant resistance from the bariatric surgery community. Morton et al. (2014) reviewed 51,788 BOLD patients that underwent LRYGB at US and Canadian centers between June 2007 and October 2010 [3]. The results demonstrated a 13-fold increase in 30-day mortality for patients discharged on the same day of surgery, and a twofold increase in 30-day mortality for those discharged on post-operative day one (POD #1) compared with patients discharged on day two or later [3]. Subsequent

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retrospective studies [4–8] have countered this study and demonstrated the safety and feasibility of early discharge after bariatric surgery in a substantial portion of patients without adversely affecting readmission and complication rates.

Our institution previously developed a structured clinical pathway for identification of patients that could be safely discharged on POD #1 [9]. The aim of this paper is to review the 30-day outcomes for LRYGB patients after the implementation of our POD #1 discharge pathway.

## Methods

We identified 2,049 patients in our prospectively maintained institutional database that underwent laparoscopic Roux-en-Y gastric bypass (LRYGB) by three bariatric surgeons between 2008 and 2016. The POD #1 or enhanced recovery protocol was initiated on July 1, 2011. Pre-operative criteria for POD #1 discharge are demonstrated in Table 1. Patients were then divided into a pre-implementation ( $n = 905$ ) and post-implementation group ( $n = 1,144$ ). All patients in the post-implementation group underwent further stratification into POD #1 or non-POD #1 candidates at the initial bariatric surgery visit. The pre-implementation group was matched 1:1 with the post-implementation group. Several factors in the POD #1 criteria (e.g., lives within 90 min of the hospital, committed to calling with problems, and ambulates 200 ft at baseline without assistance) were not documented in the electronic health record for the pre-implementation group. Therefore, propensity matching based on relevant demographics and comorbidities was utilized to identify patients in the pre-implementation group who would likely have met POD #1 criteria. The POD #1 candidates in the pre-implementation group were then matched 1:1 with the post-implementation group for comparison of peri-operative outcomes. The defined 30-day outcomes that were reviewed included the following: readmission, reoperation, ED visitation, mortality, and morbidities (bleeding, anastomotic leak,

stricture, MI, pulmonary complication including pneumonia/PE, renal failure defined as acute kidney injury, *Clostridium difficile* diarrhea/colitis, UTI, and surgical site infection). Minor complications were defined as Clavien-Dindo grade I, II, and IIIa events, while major complications included all grade IIIb, IV, and V events.

## Data Analysis

Propensity scores were developed to control for confounding in treatment implementation timing, defined as the conditional probability of surgery in the post-implementation study period. Patients were matched using an 8:1 greedy match algorithm with a 1:1 patient to patient ratio. Variables included in the propensity matching were as follows: age, pre-operative BMI, number of medications, sex, diabetes, surgical approach, and history of myocardial infarction, congestive heart failure, renal problems, pulmonary, hypertension, lipid, VTE history, obstructive sleep apnea, and GERD.

Categorical data was represented as frequencies (%), and continuous data was represented as mean  $\pm$  standard deviation (SD) unless otherwise specified. Statistical analyses consisted of chi-square or Fisher exact test for comparison of categorical data, Student's *t* test for comparison of continuous parametric data, and the Wilcoxon rank-sum test for continuous non-parametric data. All tests were two-sided and *p* values  $< 0.05$  were considered statistically significant. All analyses were conducted using SAS version 9.4 (SAS Institute Inc., Cary, NC).

## Results

A total of 2,049 patients who underwent LRYGB were included in the study, including 905 (44.2%) patients in the pre-implementation group and 1144 (55.8%) in the post-implementation group. The pre- and post-implementation groups demonstrated modest variation in comorbid conditions, and both groups were pre-dominantly female (82.4 vs 78.8%,  $p < 0.038$ ). The overall POD #1 discharge success rate expectedly increased (16.6% vs 55.9%,  $p < 0.0001$ ) after implementation of the enhanced recovery pathway (Table 2). The post-implementation group had a small but significantly increased rate of emergency department (ED) visits,

**Table 1** Pre-operative criteria for POD #1 discharge

1. Age  $< 60$
2. Live within 90 min of the hospital
3. Committed to calling with any clinical problems and/or returning to hospital
4. No active cardiac comorbidities, history of stents/CABG
5. No renal insufficiency
6. No active pulmonary comorbidities/use of home O<sub>2</sub>
7. No coagulopathy or use of antiplatelet/anticoagulant medications
8. No other medical conditions that preclude POD #1 discharge
9. Ambulates 200 ft at baseline without assistance
10. Completion of comprehensive weight management program ( $> 6$  months)

**Table 2** POD #1 discharge criteria for LRYGB patients

1. Absence of tachycardia, HR  $> 100$
2. Pain control with oral medications only
3. Absence of significant nausea
4. Able to maintain hydration with PO intake
5. Able to ambulate  $> 200$  ft independently

readmissions, and approached significance for a higher rate of minor complications (Table 2). After propensity matching the two cohorts, there was no significant difference in ED visits or readmissions (Tables 3 and 4). The matched cohorts also demonstrated no difference in mortality, morbidity, or reoperations.

A total of 677 patients (59.2%) of the patients in the post-implementation group were categorized as POD #1 candidates. POD #1 candidates in the post-implementation group were then propensity matched to the pre-implementation group to identify patients that would likely have been classified as POD #1 candidates ( $n = 490$ ). The successful POD #1 discharge markedly increased in the post-implementation POD #1 candidates (74.7% vs 20.0%;  $p < 0.001$ ). The post-operative ED visits and readmissions were not significantly different between the two groups. There were no differences in morbidity, mortality, or reoperations between the pre- or post-implementation POD #1 candidates (Table 4).

Post-operative length of stay (LOS) was significantly shorter for the post-implementation patients, both prior to and after propensity matching. The mean LOS was 2.1 days pre-implementation compared with 1.6 days post-implementation in both the non-matched and matched groups [median (IQR) days, 2 (2, 2) vs. 1 (1, 2),  $p < 0.0001$ ; Table 5].

## Discussion

The widespread applications of laparoscopic techniques along with increased surgeon experience and advances in peri-operative care have led to significant improvement in morbidity, mortality, and length of stay after gastric bypass surgery. Additionally, hospitals have financial incentives to shorten length of stay after surgery in the era of global payments and are increasingly experiencing throughput problems and bed shortages, resulting in a trend toward earlier discharges. In 1997, the median LOS for bariatric surgery (including RYGB and VBG) was 4 days with a mortality rate of 0.5% [10]. LRYGB now has a mortality rate of 0.1% and a median LOS of 2 days [3]. A review of the 2015–2016 MBSAQIP database revealed a mean LOS of 2.1 days ( $\pm 2.1$  days) for LRYGB patients, and a median/IQR of 2 (1, 2). Some authors have advocated that POD #1 discharge can be done safely in LRYGB patients; however, Dr. Morton's study utilizing the BOLD database served as a warning that this may not be the case and the role of POD #1 discharge needed to be further defined. Our study highlights that a group of selected LRYGB patients who meet criteria can be discharged on POD #1 without significantly increasing complications or readmissions (Table 6).

Our results were similar to recent retrospective studies that analyzed the impact of early discharge after LRYGB. Khorgami et al. [11] reviewed NSQIP data from 2012 to

2013 and identified 16,483 LRYGB patients, 2960 of which were discharged on POD #1. This paper cited less comorbidities, surgical complications, and a lower 30-day readmission rate (4.3% vs 5.8%,  $p = 0.01$ ) for patients discharged on POD #1 relative to those that were discharged later. Similarly, Rickey et al. [8] demonstrated fewer readmissions in their early LRYGB discharge group (0% vs 8%,  $p = 0.03$ ), no significant difference in ED visits (24% vs 13%,  $p = 0.13$ ), and no difference in mortality, reoperation, leak rates, and other complications. Readmission rates and success of POD #1 discharge after implementation of an enhanced recovery pathway for LRYGB patients were reviewed by Barreca et al. [12]; they demonstrated a marked increase in POD #1 discharge post-pathway implementation (39.6% vs 1.7%,  $p < 0.01$ ) and no difference in 30-day readmissions (4% vs 5.3%,  $p = 0.620$ ).

We developed our POD #1 discharge pathway criteria with the understanding that the primary causes of mortality in the first few days after surgery are related to operative complications (bleeding, anastomotic leak), as well as cardiopulmonary/thromboembolic events and renal failure. Given this insight, patients with significant baseline risk factors for those conditions were excluded (Table 1). Benotti et al. [13] demonstrated that congestive heart failure, ischemic cardiomyopathy, pulmonary hypertension, and increasing age are independent risk factors for 30-day mortality following LRYGB. Other studies [6, 11] have demonstrated increasing age ( $> 50$  years), impaired functional status, baseline elevated serum creatinine/hemodialysis, COPD, and the presence of coagulopathy as independent risk factors for later hospital discharge after bariatric surgery. Given this knowledge, patients who would be at risk for early post-operative bleeding due to anticoagulation/antiplatelet therapy or inherited coagulopathy were likewise excluded from the POD #1 discharge criteria. Our facility serves a large geographic area with patients often traveling greater than 2 hours away for their surgery. There are logistical and financial hardships that make it difficult for many of those patients to return to our facility urgently should problems arise after discharge. Therefore, we limit the POD #1 discharge pathway to those who had the highest likelihood of returning to our facility should complications arise after discharge and chose a travel time to the hospital of greater than 90 minutes as our exclusion criteria for the POD #1 discharge pathway.

Beyond selection criteria, the key to successful implementation of a POD #1 discharge pathway is meticulous attention to detail in the evaluation and care of the patient in the first 24 hours after surgery. For patients to be successfully discharged home on POD #1 with minimal risk of readmission or ED visitation, they must meet certain criteria prior to discharge to include having a normal heart rate, pain that is well controlled on oral medications, absence of significant nausea, being able to successfully ambulate, and being able to maintain an adequate level of oral intake. Failure to pay attention to

**Table 3** Demographics and outcomes of unmatched pre- and post-implementation groups

Variable	Pre-implementation <i>n</i> = 905	Post-implementation <i>n</i> = 1144	<i>p</i> value
POD 1 candidates	–	677 (59.2)	–
Age, mean (SD)	45.1 (11.2)	45.4 (11.8)	0.639
BMI, mean (SD)	47.0 (7.3)	47.1 (7.9)	0.846
<i>n</i> missing	19	2	
Female	746 (82.4%)	901 (78.8%)	0.038
Number of medications	5.6 (3.3)	6.1 (4.1)	0.179
<i>n</i> missing	122	6	
<b>Comorbidities</b>			
Diabetes	422 (46.6%)	516 (45.1%)	0.491
MI	8 (0.9%)	24 (2.1%)	0.028
Congestive heart failure	24 (2.7%)	39 (3.4%)	0.324
Renal	18 (2.0%)	48 (4.2%)	0.005
Pulmonary	197 (21.8%)	190 (16.6%)	0.003
Hypertension	571 (63.1%)	622 (54.4%)	< 0.0001
Lipid	499 (55.1%)	498 (43.5%)	< 0.0001
Venous thromboembolism	41 (4.5%)	73 (6.4%)	0.070
Obstructive sleep apnea	400 (44.2%)	600 (52.5%)	0.000
GERD	420 (46.4%)	556 (48.6%)	0.324
<b>Approach</b>			
Laparoscopic	905 (100%)	1135 (0.8%)	
Robotic assisted	0	9 (0.8%)	0.006
<b>Outcomes</b>			
POD 1 success	150 (16.6%)	639 (55.9%)	< 0.0001
Post-op day discharge, median (IQR)	2 (2, 2)	1 (1, 2)	< 0.0001+
Post-op day discharge, mean (SD)	2.1 (1.6)	1.6 (1.1)	
Post-Op ICU	14 (1.6%)	6 (0.5%)	0.019
<b>30-day outcomes</b>			
Mortality	2 (0.2%)	1 (0.1%)	0.587
ED Visit	92 (10.2%)	153 (13.4%)	0.026
Readmission	50 (5.5%)	92 (8.0%)	0.026
Reoperation	31 (3.4%)	55 (4.8%)	0.121
Major complications**	32 (3.5%)	33 (2.9%)	0.404
Minor complications*	71 (7.9%)	116 (10.1%)	0.073
Renal complications	3 (0.3%)	6 (0.5%)	0.739
C. diff	0 (0%)	3 (0.3%)	0.260
UTI	23 (2.5%)	28 (2.5%)	0.892
SSI	8 (0.9%)	8 (0.7%)	0.637
DVT/PE	0 (0%)	5 (0.4%)	0.071
Bleeding	11 (1.2%)	8 (0.7%)	0.226
Pulmonary complication	22 (2.4%)	19 (1.7%)	0.216
Leak	12 (1.3%)	3 (0.3%)	0.007
Stricture	9 (1.0%)	13 (1.1%)	0.832
MI complication	1 (0.1%)	1 (0.1%)	1.000

The statistical values that are italicized reached statistical significance ( $p < 0.05$ )

+ Wilcoxon rank sum test

\*Minor complication: Clavien score I, II, III

\*\*Major complication: Clavien score IIIb, IV, V

**Table 4** Matched pre- and post-pathway groups, 30-day outcomes

Outcomes	Pre-implementation <i>n</i> = 714	Post-implementation <i>n</i> = 714	<i>p</i> value
<i>POD #1 success</i>	<i>127 (17.8%)</i>	<i>388 (54.3%)</i>	<i>&lt; 0.0001</i>
<i>Post-op ICU</i>	<i>11 (1.5%)</i>	<i>2 (0.3%)</i>	<i>0.022</i>
<i>30-day outcomes</i>			
Mortality	2 (0.3%)	0	0.500
ED visit	74 (10.4%)	91 (12.8%)	0.159
Readmission	41 (5.7%)	50 (7.0%)	0.330
Reoperation	28 (3.9%)	32 (4.5%)	0.598
Major complications**	27 (3.8%)	22 (3.1%)	0.467
Minor complications+	59 (8.3%)	64 (9.0%)	0.637
Renal complications	3 (0.4%)	3 (0.4%)	1.000
<i>Clostridium difficile</i> diarrhea	0 (0%)	2 (0.3%)	0.500
Urinary tract infection	23 (3.2%)	19 (2.7%)	0.531
Surgical site infection	6 (0.8%)	7 (1.0%)	0.781
DVT/PE	0 (0%)	2 (0.3%)	0.500
Bleeding	9 (1.3%)	7 (1.0%)	0.615
<i>Pulmonary complication</i>	<i>18 (2.5%)</i>	<i>8 (1.1%)</i>	<i>0.048</i>
Leak	7 (1.0%)	2 (0.3%)	0.178
Stricture	7 (1.0%)	10 (1.4%)	0.464
MI complication	1 (0.1%)	0 (0%)	1.000

The statistical values that are italicized reached statistical significance ( $p < 0.05$ )

\*Minor complication: Clavien score I, II, III

\*\*Major complication: Clavien score IIIb, IV, V

**Table 5** Matched pre- and post-implementation POD #1 candidates, 30-day outcomes

Outcomes	Pre-implementation <i>n</i> = 490	Post-POD#1 candidates <i>n</i> = 490	<i>p</i> value
<i>POD #1 success</i>	<i>98 (20.0%)</i>	<i>366 (74.7%)</i>	<i>&lt; 0.0001</i>
<i>Post-op ICU</i>	<i>3 (0.6%)</i>	<i>0 (0%)</i>	<i>0.249</i>
<i>30-day outcomes</i>			
Mortality	1 (0.2%)	0 (0%)	1.000
ED visit	48 (9.8%)	57 (11.6%)	0.353
Readmission	24 (4.9%)	27 (5.5%)	0.666
Reoperation	18 (3.7%)	15 (3.1%)	0.595
Major complications**	17 (3.5%)	9 (1.8%)	0.722
Minor complications*	37 (7.6%)	40 (8.2%)	0.112
Renal complications	3 (0.6%)	0 (0%)	0.249
<i>Clostridium difficile</i> diarrhea	0 (0%)	1 (0.2%)	1.000
Urinary tract infection	15 (3.1%)	8 (1.6%)	0.140
Surgical site infection	3 (0.6%)	4 (0.8%)	1.000
DVT/PE	0 (0%)	2 (0.4%)	0.500
Bleeding	6 (1.2%)	3 (0.6%)	0.506
<i>Pulmonary complication</i>	<i>10 (2.0%)</i>	<i>10 (2.0%)</i>	<i>1.000</i>
Leak	5 (1.0%)	0 (0%)	0.062
Stricture	5 (1.0%)	6 (1.2%)	1.000
MI complication	1 (0.2%)	0 (0%)	1.000

The statistical values that are italicized reached statistical significance ( $p < 0.05$ )

\*Minor complication: Clavien score I, II, III

\*\*Major complication: Clavien score IIIb, IV, V

**Table 6** Pre- and post-implementation length of stay outcomes

Outcomes	Pre-implementation <i>n</i> = 905	Post-implementation <i>n</i> = 1144	<i>p</i> value
All pre- and post-implementation			
POD #1 success	150 (16.6%)	639 (55.9%)	< 0.0001
Post-op day discharge, median (IQR)	2 (2, 2)	1 (1, 2)	< 0.0001
Post-op day discharge, mean (SD)	2.1 (1.6)	1.6 (1.1)	
Matched pre- and post-implementation			
POD #1 success	127 (17.8%)	388 (54.3%)	< 0.0001
Post-op day discharge, median (IQR)	2 (2, 2)	1 (1, 2)	< 0.0001
Post-op day discharge, mean (SD)	2.1 (1.6)	1.6 (0.9)	
Matched POD #1 candidates vs pre-implementation			
POD #1 success	98 (20.0%)	366 (74.7%)	< 0.0001
Post-op day discharge, median (IQR)	2 (2, 2)	1 (1, 2)	< 0.0001
Post-op day discharge, mean (SD)	2.1 (1.6)	1.4 (1.2)	

The statistical values that are italicized reached statistical significance ( $p < 0.05$ )

these clinical factors can potentially adversely affect readmission and ED visit rates in patients being considered for early discharge.

We had implemented a system-wide defined clinical care pathway for our LRYGB patients in 2008 which resulted in a standardized, evidence-based approach to each patient's pre-operative, peri-operative, and post-operative care [9]. In this context, we hypothesized that a subset of patients identified by the specific pre-operative criteria described in this paper could be safely discharged on POD #1 without adversely affecting mortality, complication rates, or readmissions. There were no significant changes in our clinical care pathway during this time that allowed us to assess the effects of the pathway implementation. The limitations of this study include its retrospective design and the fact that exact POD #1 discharge criteria were not explicitly recorded in the pre-implementation group in the same manner that they were in the post-implementation group. However, it was possible to get an accurate assessment of whether any pre-implementation patient would have been a candidate for POD #1 discharge based on the information available in the electronic medical record. Additionally, it is possible that operative outcomes may have improved over the study period due to increasing surgeon experience with a shared/common surgical technique.

## Conclusion

Based on our results and consideration given to the strengths and limitations of our study, we conclude that implementation of our POD #1 discharge pathway was safe and dramatically increased the percentage of patients discharged on POD #1. Implementation of the pathway decreased overall LOS

without adversely affecting rates of readmission, ED visits, reoperation, minor or major complications, or mortality.

## Compliance with Ethical Standards

**Conflict of Interest** The authors declare that they have no conflict of interest.

**Ethical Approval** For this type of study, formal consent is not required.

**Informed Consent** Does not apply.

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