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Better Understanding the Utilization of Damage Control Laparotomy: a Multi-Institutional Quality Improvement Project: The Multi-Institutional DCL QI Project

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Abstract

Background: Rates of damage control laparotomy (DCL) vary widely and consensus on appropriate indications does not exist. The purposes of this multi-center quality improvement (QI) project were to decrease the use of DCL and to identify indications where consensus exists.

Methods: In 2016, six US Level 1 trauma centers performed a year-long, QI project utilizing a single QI tool: audit and feedback. Each emergent trauma laparotomy was prospectively reviewed. DCL cases were adjudicated based upon majority vote of faculty members as being appropriate or potentially, in retrospect, safe for definitive laparotomy. The rate of DCL for two years prior (2014 and 2015) was retrospectively collected and used as a control. To account for secular trends of DCL, interrupted time series was used to effectiveness of the QI interventions.

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Level of Evidence: III; epidemiological study with one negative criterion

Results: 872 emergent laparotomies were performed: 73% definitive laparotomies, 24% DCLs, and 3% intraoperative deaths. Of the 209 DCLs, 162 (78%) were voted appropriate and 47 (22%) were voted to have been potentially safe for definitive laparotomy. Rates of DCL ranged from 16–34%. Common indications for DCL for which consensus existed were packing (103/115 [90%] appropriate) and hemodynamic instability (33/40 [83%] appropriate). The only common indication for which primary closure at the initial laparotomy could have been safely done was avoiding a planned second look (16/32 [50%] appropriate).

Conclusion: A single faceted QI intervention failed to decrease the rate of DCL at six US Level 1 trauma centers. However, opportunities for improvement in safely decreasing the rate of DCL were present. Second look laparotomy appears to lack consensus as an indication for DCL and may represent a target to decrease the rate of DCL after injury.

Keywords

trauma; damage control laparotomy; quality improvement; emergent laparotomy; indications

Background

Damage control laparotomy (DCL) has undoubtedly revolutionized trauma care and resulted in improved outcomes for severely injured patients.(1, 2) However, DCL has been associated with many complications and current use of DCL varies widely between institutions.(3–6) This variation is likely due to a lack of consensus on the indications for the use of DCL.(7–9) In addition to a lack of consensus for various indications, the ideal DCL rate is unknown. Given differences in trauma center patient volumes, demographics, and injury patterns, the ideal rate of DCL may be institution-specific and not broadly applicable.(10)

In a previous single-center study, a multi-faceted quality improvement (QI) project successfully reduced the use of DCL from 38% to 23%, without a change in morbidity and mortality.(11) In that study, we found consensus for the following indications: packing for hemorrhage control, abdominal compartment syndrome treatment/prophylaxis, to expedite transfer to interventional radiology for endovascular hemorrhage control, and persistent hemodynamic instability defined as continuous vasopressor use and/or ongoing transfusion requirement. The effectiveness of indications for DCL for which the group remained unsure included: peritoneal contamination, to expedite post-operative imaging or transfer to the intensive care unit (ICU), second look, and isolated metabolic acidosis.

The two major limitations of the previous QI study were 1) the intervention was multi-faceted, complex, and time-consuming and 2) the consensus-building was based upon single-center data and thus may not have been generalizable. To address these limitations and further better our understanding of DCL, a multi-center QI project was performed utilizing a single QI intervention: audit and feedback.(12) The three goals of the multi-center QI project were: 1) to decrease the use of DCL at each institution, 2) to determine the ideal rate of DCL at each institution, and 3) to identify indications for DCL where consensus exists.

Methods

The described study was a pre-post intervention QI project that was performed from January 1, 2016 through December 31, 2016.⁽¹³⁾ This manuscript was written following the Revised Standards for Quality Improvement Reporting Excellence (SQUIRE 2.0) guidelines.⁽¹⁴⁾ Depending on local norms, each study site either obtained Institutional Review Board approval or performed the study as approved QI.

Study Setting

Six United States Level 1 trauma centers were included: Memorial Hermann Hospital-Texas Medical Center/McGovern Medical School at UT Health (Houston, Texas); the University of Tennessee Health Science Center (Memphis, Tennessee); the University of Cincinnati Medical Center (Cincinnati, Ohio); the Lewis Katz School of Medicine at Temple University (Philadelphia, Pennsylvania); the Indiana University School of Medicine (Indianapolis, Indiana); and MetroHealth System (Cleveland, Ohio). The Memorial Hermann Hospital-Texas Medical Center/McGovern Medical School at UT Health participated for only six months of the twelve month period as a subsequent randomized clinical trial of DCL began in July 2016.⁽¹⁵⁾

Patient Population

The study included all adult trauma patients (age 16 years or older) undergoing emergent trauma laparotomy. Emergent trauma laparotomy was defined as admission to the operating room (OR) directly from the emergency department (ED) or interventional radiology. The historic control group included all emergent laparotomies from January 1, 2014 through December 31, 2015, which were retrospectively collected.

Audit and Feedback

The single QI tool used in this study was audit and feedback. Depending on local norms and feasibility of faculty meetings, the site principal investigator would discuss all DCL cases with faculty during the year-long study. After reviewing the details of a case and the outcomes of the subsequent take back(s) and hospital stay, faculty voted if, in retrospect, the patient could have safely undergone definitive laparotomy. Emphasis was placed on not being judgmental, but simply considering if, in retrospect with the knowledge of the patient's outcome, could they have been safely closed. Local faculty were used to adjudicate, as opposed to outside surgeons, as the reflection on the decision to perform damage control and adjudication was the mechanism by which future decisions might be changed, thus altering the rate of DCL. Majority vote ruled to identify DCLs that could have potentially been treated as definitive laparotomy.

Measures

Goal 1.—Monthly rates of DCL were retrospectively collected from 2014–2015. These rates were compared to the monthly rates of DCL during the QI project using interrupted time series. Interrupted time series analysis evaluates the longitudinal effects of interventions through regression modelling and is best used to evaluate studies where an intervention is introduced at a single time. The main advantage of interrupted time series is that it accounts

for trends prior to an intervention by evaluating the post-intervention rates of an outcome in light of the pre-intervention trends (secular trends).

Goal 2.—To determine the ideal rate of DCL at each institution, the number of DCLs adjudicated as appropriate were divided by all emergent trauma laparotomies, as described above.

Goal 3.—To identify consensus for DCL indications, each indication was evaluated and the percent of DCLs voted appropriate for that indication were calculated. Any indication for which 50% or less of DCLs were voted appropriate was considered an indication for which consensus was lacking.

Analysis

Patient demographics, injury severity, emergency department/operating room/intensive care unit vital signs, laboratory values, and resuscitation, and operating room procedures were recorded. Institutions measured coagulopathy different, with some using thromboelastography and other conventional coagulation tests. To account for this, a composite coagulopathy variable was created and reported. Coagulopathy was defined as: International Normalized Ratio >1.5, partial thromboplastin time>35, activated clotting time >128, alpha angle <56, maximum amplitude <55, and percent lysis at 30 minutes >3%. (16–18) DCL patients were compared to patients who underwent definitive laparotomy and DCL patients voted appropriate were compared to those who may have been safe for primary closure. Variables were analyzed using Wilcoxon rank sum, Chi Square, and Fisher's Exact test for continuous, binary, and sparse binary variables, respectively. All statistical analyses were performed on STATA 15.1 (College Station, Texas).

Results

Entire Cohort

During the study period, the trauma centers performed 872 emergent laparotomies, of which 639 (73%) were definitive, 209 (24%) were DCL, and 24 (3%) were intra-operative deaths. The number of emergent laparotomies performed at each site ranged from 82 to 313. Of the 209 DCLs, the stated indications for DCL were as follows (by highest to lowest frequency): packing 115 (55%), hemodynamic instability 40 (19%), second look 32 (15%), to expedite post-operative imaging/intensive care unit admission 6 (3%), other 5 (2%), to expedite transfer to interventional radiology 4 (2%), contamination 4 (2%), and abdominal compartment syndrome treatment or prophylaxis 3 (1%).

The majority of the cohort was male (80%), black (52%), and had suffered penetrating trauma (64%). The cohort was severely injured, as indicated by a median Injury Severity Score of 17 (IQR 9, 29). In the OR, the most common procedures performed for the entire cohort were enterectomy (25%), splenectomy (21%), colectomy (20%), hepatorrhaphy (18%), and diaphragm repair (17%). The overall mortality rate of the entire cohort was 10%, with the three most common causes of death being hemorrhage (35%), multi-organ failure/sepsis (22%), and traumatic brain injury (21%).

DCL versus Definitive Laparotomy

Tables for the comparison of DCL patients versus patients who underwent definitive laparotomy are available in the Supplement. Compared to the definitive laparotomy group, the DCL group had more women (DCL 26% versus definitive 18%, $p=0.015$), more patients suffering blunt trauma (DCL 49% versus definitive 31%, $p<0.001$), more severe abdominal injury (median Abdomen AIS DCL 4 [IQR 3, 4] versus definitive 3 [2, 3], $p<0.001$), and more severe overall injuries (median Injury Severity Score DCL 27 [IQR 19, 38] versus definitive 14 [9, 22], $p<0.001$). The DCL group was also more physiologically deranged with a lower ED systolic blood pressure (median DCL 105 mmHg [IQR 83, 124] versus definitive 128 mmHg [IQR 110, 148], $p<0.001$), higher ED lactate (median 5.2 mmol/L [IQR 3.2, 8.4] versus definitive 2.8 mmol/L [IQR 1.9, 4.4], $p<0.001$), and lower base excess (median -6 mmol/L [IQR -13 , -3] versus definitive -2 mmol/L [IQR -5 , 0], $p<0.001$).

In the operating room, the DCL group received more transfusions of red blood cells (median DCL 8 units [IQR 4, 13] versus definitive units 0 [0, 0], $p<0.001$), fresh frozen plasma (median DCL 6 units [IQR 2, 10] versus definitive units 0 [0, 0], $p<0.001$), and platelets (median DCL 6 units [IQR 0, 12] versus definitive units 0 [0, 0], $p<0.001$). The DCL group also had a significantly higher estimated blood loss (median DCL 2,000 mL [IQR 1,000, 4,000] versus definitive 300 mL [100, 800], $p<0.001$).

In the definitive laparotomy group, the most common procedures were enterectomy (22%), splenectomy (18%), diaphragm repair (18%), and colorrhaphy (17%). In the DCL group, the most common procedures were enterectomy (37%), colectomy (34%), splenectomy (32%), hepatorrhaphy (31%), and major vascular repair or ligation (21%). A thoracotomy/sternotomy was done in 5 (1%) of the definitive laparotomy group and 18 (9%) of the DCL group.

The DCL group had more deaths (DCL 25% versus 2%, $p<0.001$), fewer hospital-free days (median DCL 0 [IQR 0, 14] versus definitive 22 [IQR 16, 25], $p<0.001$), fewer ICU-free days (median DCL 16 [IQR 0, 24] versus definitive 29 [IQR 27, 30], $p<0.001$), and fewer ventilator-free days (median DCL 20 [IQR 0, 27] versus definitive 30 [IQR 29, 30], $p<0.001$). The three most common causes of death in the DCL group were multi-organ failure/sepsis (28%), traumatic brain injury (28%), and hemorrhage (26%). The three most common causes of death in the definitive group were multi-organ failure/sepsis (36%), traumatic brain injury (29%), and cardiopulmonary arrest (15%).

Appropriate DCL versus DCL Voted Safe for Definitive Laparotomy

Of the 209 DCLs, 162 (78%) were voted appropriate and 47 (22%) were voted to have been potentially safe for definitive laparotomy. While the appropriate DCL group was younger, there were no other differences in demographics or injury severity between the two groups (Table 1).

In the ED, the appropriate DCL group and DCL patients voted safe for definitive laparotomy had similar vital signs and resuscitation. The appropriate DCL group had a higher lactate (Table 2). Upon arrival to the OR, the appropriate DCL group had a lower temperature and systolic blood pressure that the DCL patients voted safe for definitive laparotomy (Table 3).

The appropriate DCL group also had significant higher transfusion volumes, lower end OR temperature, lower end OR pH, and lower end OR lactate. The appropriate DCL group also had a higher proportion of patients requiring continuous vasopressor support and ongoing transfusions at the end of the laparotomy. The appropriate DCL group had a higher rate of hepatorrhaphy (38% versus 6%, $p<0.001$), a lower rate of colorrhaphy (8% versus 21%, $p=0.011$), and a higher rate of major vascular repair/ligation (25% versus 6%, $p=0.004$).

The appropriate DCL group had a higher rate of death (Table 4). There was not a significant difference in the cause of death or discharge disposition between the two groups.

Goal 1—The site-specific rate of DCL in the control period ranged from 12%–37% (Table 5). During the QI period, the rates ranged from 16%–34%. Only one site, Site 4, had a significant change in the rate of DCL following institution of the QI intervention, however, this reduction did not last for the entire year (Figure 1).

Goal 2—After adjudication, the ideal rate of DCL at all institutions was 19% (Table 5). The overall percent of DCL cases that were voted to have, in retrospect, been safe for definitive laparotomy was 19%, with site-specific rates ranging from 19%–30%. The difference between actual and ideal rates of DCL for all institutions was 5%, with site-specific opportunity for improvement rates ranging from 3%–8%.

Goal 3—The indications for DCL for which there appeared to be consensus were: packing 103/115 cases (90%) appropriate, hemodynamic instability 33/40 (83%) appropriate, to expedite transfer to interventional radiology 3/4 (75%) appropriate, and abdominal compartment syndrome treatment or prophylaxis 2/3 (67%) appropriate. Conversely, indications in which appropriateness was unsure included: second look 16/32 (50%) appropriate, contamination 2/4 (50%) appropriate, to expedite post-operative imaging/intensive care unit admission 2/6 (33%) appropriate, and other 1/5 (20%) appropriate.

Discussion

In this multi-institutional QI study, a single faceted intervention – audit and feedback – failed to decrease the rate of DCL at each center. While one site had a significant initial decrease in the rate of DCL, this reduction did not persist over the course of the year. In the current study, audit and feedback alone was chosen as the multi-faceted intervention used in the single-center study was complex, time-consuming, and potentially not replicable at all institutions.(11) Though it is unclear if multi-faceted interventions are superior to the single-faceted ones, audit and feedback has alone has been shown to have variable effectiveness. (12, 19, 20)

There were many possible explanations as to why the audit and feedback intervention failed to change practice. First, the single-center study was performed because all surgeons in that group identified a gap in quality care – their DCL rate was too high. In this multi-center study, it is unclear if the majority of surgeons at each institution felt their DCL rate was too high. Second, the single-center study utilized a multi-faceted QI intervention; it is possible

that another, unrecognized facet of the multi-faceted intervention was the main driver of decreasing DCL, rather than audit and feedback.

Despite the failure to broadly decrease the rate of DCL at these trauma centers, important knowledge was gained from the QI intervention. First, the main differences between the appropriate DCL group and the DCL patients voted safe for definitive laparotomy appear to be physiologic derangement at the end of the laparotomy. While both groups appeared similar upon arrival, the DCL patients voted safe for definitive laparotomy seemed to have a superior response to resuscitation and hemorrhage control than the appropriate DCL group. Historically, surgeons were taught to determine damage control as early as possible. However, with changing resuscitation practices, this notion of determining damage control early has changed and it is likely that the patient condition at the end of the operation is a more important indicator of whether damage control is appropriate.

Second, institution-specific ideal rates of DCL were delineated. As expected, the range of ideal rates was heterogeneous across institutions, ranging from 13% to 27%. While this variation may be attributed to the degree that surgeons agreed upon the safety of certain patients for definitive laparotomy, the wide range also suggests that a single ideal rate does not apply to all trauma centers.

Third, no center had an actual DCL rate that was at or less than their ideal rate, indicating the over-utilization of damage control. The range in the difference between actual and ideal rate of DCL was 3% to 8%. Data from this same group of patients (currently unpublished) suggest that while DCL may not place the patient at higher risk of abdominal complications, it was associated with increased hospital lengths of stay, ventilator days, and ICU days. These additional DCL cases over and above the ideal rate represent an opportunity to decrease unnecessary resource utilization at these trauma centers.

Lastly, consensus regarding indications for DCL appear to be forming. Surgeons appear to have consensus on the appropriateness for DCL for the indications packing, hemodynamic instability, to expedite transfer to interventional radiology, and for the treatment or prophylaxis of abdominal compartment syndrome. Hemodynamic instability was not defined in this study and a more granular evaluation what definitions of hemodynamic stability were voted appropriate is needed. These agreed upon indications accounted for 78% of all DCLs in the QI period. Indeed, these four indications are exclusion criteria in the ongoing single-center, pilot, randomized controlled trial of DCL.(15, 21) The four indications for DCL for which consensus was found in this study were similar to the four indications found in the single-center QI project.

Surprisingly, and similar to the findings of the single-center QI project, the appropriateness of second look was unclear. Planned second look has long been a widely accepted indication for damage control primarily based upon expert opinion. In an expert appropriateness study, Roberts et al convened a large group of highly respected trauma surgeons to rate various indications.(7) The need to reassess the extent of bowel viability in a second look was amongst the highest rated indication for the use of damage control. Currently, no published manuscripts reflect the actual rate of finding nonviable bowel at a second look or which

patterns of bowel injury most benefit from a second look. Further investigation is needed into the injury pattern that lead to appropriate and unclear second look laparotomies and whether a substantial additional intervention was performed that could not be performed at the first operation. This may help better delineate why half of second look cases were voted appropriate and half were unclear.

The current study has some important limitations. In the adjudication meetings, surgeons were asked if, in retrospect, the patient could have safely undergone definitive laparotomy. This question was not protocolized and the reasons that centers voted one way or the other may not have been consistent across sites. Second, groups adjudicated their own cases. Some might contend that more accurate information may be gleaned by having external review of a sites' cases. While a valid concern, the primary goal of this QI study was to lower the rate of DCL at each center. Thus, the audit and feedback mechanism was meant to allow local stakeholders to participate and voice their opinions about their group practice. The meetings and votes were meant to inspire discussion and introspection, not to be judgmental. While an external panel may have found a different ideal rate of DCL by providing more consistent and objective adjudication of cases, those outside opinions may have come across as judgmental thus detracting from the primary goal of decreasing DCL use. Additionally, the external panels would lack granular data about the specifics of the case and not be able to wholly understand the context of each laparotomy. Lastly, while the QI data was collected prospectively, the comparative rates from 2014–2015 were collected retrospectively.

In conclusion, a multi-center QI project using audit and feedback failed to lead to a sustained decrease in the utilization of DCL. Nevertheless, important information was generated. Ideal rates of DCL were identified at each institution and can serve as benchmarks moving forward. Additionally, indications for DCL in which consensus exists were found and indications for DCL for which we were unsure of their utility, namely second look laparotomy, were also delineated.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Conflicts of Interest and Source of Funding

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Dr Holcomb is the Chief Medical Officer of Prytime Medical, a founder and on the Board of Directors of Decisio Health, a Co-inventor of the Junctional Emergency Tourniquet Tool and an advisor to Terumo BCT and Arsenal Medical.

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Figure 1. Monthly DCL Rates

Time series analyses of monthly damage control laparotomy (DCL) rates at each institution. Accounting for secular trends in DCL, only Site 4 had a significant change in the rate of DCL. The initial reduction in DCL observed at Site 4, however, did not last for the entire study period.

* $p < 0.05$; m1 = first month of year

Table 1:

Demographics and Injury Severity

	Appropriate DCL (n=162)	DCL Safe for Definitive (n=47)	p-value
<i>Demographics</i>			
Age	32 (23, 45)	39 (27, 54)	0.013
Sex			0.812
Male	120 (74%)	34 (72%)	
Female	42 (26%)	13 (28%)	
Race/Ethnicity			0.356
White	53 (33%)	20 (43%)	
Black	88 (55%)	21 (45%)	
Hispanic	18 (11%)	5 (11%)	
Other	1 (1%)	1 (2%)	
Mechanism			0.310
Blunt	76 (47%)	26 (55%)	
Penetrating	86 (53%)	21 (45%)	
Body mass index	27 (23, 33)	28 (23, 32)	0.907
<i>Injury Severity</i>			
Head AIS	0 (0, 1)	0 (0, 0)	0.546
Face AIS	0 (0, 0)	0 (0, 0)	0.316
Chest AIS	3 (0, 3)	3 (0, 3)	0.626
Abdomen AIS	4 (3, 4)	4 (3, 4)	0.439
Extremity AIS	2 (0, 3)	2 (0, 3)	0.811
External AIS	1 (0, 2)	1 (0, 2)	0.856
Injury Severity Score	27 (19, 38)	25 (18, 38)	0.450

AIS – abbreviated injury score

Table 2:

Emergency Department Vital Signs, Labs, and Resuscitation

	Appropriate DCL (n=162)	DCL Safe for Definitive (n=47)	p-value
<i>Arrival Vital Signs</i>			
Temperature, F	97.6 (97.2, 98.2)	97.7 (97.1, 98.1)	0.431
Systolic blood pressure, mmHg	105 (84, 122)	102 (74, 136)	0.840
Heart rate, bpm	108 (90, 130)	103 (80, 130)	0.728
Glasgow Coma Scale	14 (3, 15)	15 (9, 15)	0.187
<i>First Emergency Department Laboratory Values</i>			
Lactic acid, mmol/L	6.0 (3.3, 9.6)	4.0 (2.5, 6.5)	0.010
Base excess, mmol/L	-6 (-14, -3)	-5 (-9, -2)	0.092
Abnormal coagulation profile	63 (47%)	11 (26%)	0.012
<i>Emergency Department Resuscitation</i>			
Crystalloid, mL	900 (0, 1,800)	500 (0, 1,500)	0.463
Red blood cells, units	1 (0, 2)	1 (0, 2)	0.722
Fresh frozen plasma, units	0 (0, 1)	0 (0, 1)	0.366
<i>Other</i>			
Time in ED	26 (16, 41)	26 (16, 121)	0.272
Positive FAST	80 (68%)	24 (60%)	0.369

F – Fahrenheit; FAST – focused abdominal sonography for trauma; ED – emergency department

Table 3:**Operating Room Vital Signs, Labs, and Resuscitation**

	Appropriate DCL (n=162)	DCL Safe for Definitive (n=47)	p-value
<i>First Documented Operating Room Vital Signs and Labs</i>			
Temperature, F	95.4 (93.4, 96.8)	96.3 (94.7, 98.1)	0.010
Systolic blood pressure, mmHg	107 (85, 130)	120 (100, 138)	0.044
Heart rate, bpm	110 (95, 123)	107 (85, 118)	0.128
pH	7.28 (7.19, 7.35)	7.32 (7.25, 7.37)	<0.001
Lactic acid, mmol/L	7.3 (5.5, 9.8)	3.8 (3.0, 5.1)	<0.001
Base excess, mmol/L	-10 (-16, -6)	-6 (-8, -3)	<0.001
<i>Operating Room Resuscitation</i>			
Crystalloid, mL	300 (2,000, 5,500)	3,000 (2,000, 4,000)	0.237
Red blood cells, units	9 (4, 17)	4 (2, 8)	<0.001
Fresh frozen plasma, units	7 (4, 12)	2 (1, 5)	<0.001
Platelets, units	6 (0, 12)	0 (0, 6)	<0.001
Tranexamic acid	32 (20%)	8 (18%)	0.680
Estimated blood loss, mL	2,500 (1,000, 5,000)	1,000 (400, 1,500)	<0.001
<i>Last Documented Operating Room Vital Signs and Labs</i>			
Temperature, F	95.0 (93.7, 96.6)	96.2 (94.8, 97.2)	0.015
Systolic blood pressure, mmHg	120 (105, 135)	120 (108, 130)	0.772
Heart rate, bpm	100 (90, 117)	90 (80, 100)	<0.001
pH	7.28 (7.19, 7.35)	7.32 (7.25, 7.37)	0.031
Lactic acid, mmol/L	7.1 (5.1, 9.0)	3.5 (2.7, 4.7)	<0.001
Base excess, mmol/L	-6 (-9, -3)	-4 (-7, -3)	0.138
<i>Other</i>			
Continuous vasopressors	43 (29%)	1 (2%)	<0.001
Ongoing transfusions	86 (58%)	3 (7%)	<0.001
OR duration, minutes	139 (93, 199)	134 (93, 164)	0.739

F – Fahrenheit; OR – operating room

Table 4:**Outcomes**

	Appropriate DCL (n=162)	DCL Safe for Definitive (n=47)	p-value
<i>Disposition</i>			
Deaths	46 (28%)	7 (15%)	0.061
Cause of death			0.528
Hemorrhage	14 (30%)	0 (0%)	
Traumatic brain injury	12 (26%)	3 (43%)	
Cardiopulmonary arrest	2 (4%)	0 (0%)	
Respiratory failure	4 (9%)	1 (14%)	
Stroke	2 (4%)	0 (0%)	
Multi-organ failure/sepsis	12 (26%)	3 (43%)	
Disposition			0.497
Home	69 (43%)	21 (45%)	
Skilled nursing facility	8 (5%)	4 (9%)	
Long term acute care	10 (6%)	3 (6%)	
Rehabilitation hospital	27 (17%)	12 (26%)	
Transfer	1 (4%)	0 (0%)	
Death	45 (28%)	7 (15%)	
Unknown	1 (1%)	0 (0%)	
<i>Lengths of Stay</i>			
Hospital-free days	0 (0, 12)	7 (0, 17)	0.119
Intensive care unit-free days	14 (0, 24)	19 (3, 25)	0.104
Ventilator-free days	18 (0, 27)	25 (10, 28)	0.026

Table Five.

Site-Specific Rates and Adjudication of Damage Control Laparotomy

Site	Pre QI DCL Rate	QI DCL Rate	p value	Appropriate	Safe for Definitive	Ideal Rate of DCL	Difference between Actual and Ideal
1	37%	34%	0.305	23 (79%)	6 (21%)	27%	7%
2	23%	20%	0.771	13 (81%)	3 (19%)	16%	4%
3	27%	25%	0.822	28 (70%)	12 (30%)	18%	8%
4	27%	27%	<0.001	66 (80%)	17 (20%)	21%	6%
5	12%	19%	0.848	14 (78%)	4 (22%)	15%	4%
6	21%	16%	0.886	18 (78%)	5 (22%)	13%	3%
All	25%	24%	-	162 (78%)	47 (22%)	19%	5%

DCL – damage control laparotomy; QI – quality improvement