

# RETRACTED ARTICLE: NELA Risk Calculator Significantly Underestimates Mortality Risk of Laparotomy for Mesenteric and Colonic Ischaemia in Older Adult Surgical Patients

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**Aim:** To establish if the NELA risk calculator underestimates mortality risk in older adults undergoing laparotomy for mesenteric or colonic ischaemia.

**Methods:** A retrospective search of the operative database was performed for all patients aged 65 years who underwent laparotomy across two tertiary centres over a 3-year period. Cases of mesenteric and colonic ischaemia were identified from the operative records. Cases where ischaemia occurred secondarily to a primary obstructive or other pathology were excluded. Cases where a NELA score was not documented preoperatively were excluded. We then compared the NELA scores to the observed 30-day mortality rate. Secondary outcomes were hospital length of stay and intensive care unit length of stay.

**Results:** Sixty cases were included in our analysis. There were 27 cases of colonic ischaemia and 33 cases of mesenteric ischaemia (mesenteric ischaemia group included five cases of distal small-bowel and colonic ischaemia). The overall mean NELA score was 21.9%, while the actual 30-day mortality was 43.3% ( $p=0.0094$ ). Mean NELA score for mesenteric ischaemia cases only was 20.6% with an actual mortality rate of 45.5%. Mean NELA score for the colonic ischaemia cases was 23.5% with an actual mortality rate of 40.7%. The median time from operation to mortality was 8 days. Mean age was 77 years. Length of stay for survivors was a mean 27 days with intensive care unit length of stay of 9.3 days.

**Conclusion:** The NELA risk score for mortality prediction after emergency laparotomy underestimates mortality risk by a factor of two in older adults where the primary pathology is mesenteric or colonic ischaemia.

**Keywords:** mesenteric, ischaemia, colonic, NELA, mortality

## Introduction

Risk assessment is a critical element of clinical decision-making in emergency general surgery. Preoperative risk assessment helps to inform surgeons, anaesthetists, and critical care specialists of the expected degree of physiological disturbance and required level of critical care support. It is also essential for informing patients and their families of the expected treatment and outcomes to allow for informed consent to treatment. Developed from the world's largest prospective emergency surgery database, the NELA risk calculator predicts 30-day mortality based on 20 variables.<sup>1</sup> While it is not the only validated prediction tool for mortality risk after emergency laparotomy, NELA has been demonstrated to be the most accurate in comparative studies.<sup>2</sup> Furthermore, the use of NELA score as a preoperative risk assessment is now routine practice in Australia, as it is a preoperative requirement of the national ANZELA-QI emergency laparotomy audit, with which a majority of Australian tertiary hospitals are enrolled.<sup>3</sup> The use of risk-assessment tools has improved the preoperative assessment of emergency laparotomy cases, and coupled with "bundles of care" for high-risk patients has improved emergency laparotomy outcomes.<sup>1,2,4</sup> However, it stands to reason that the NELA risk assessment is more accurate in certain conditions and less in others, particularly in higher-risk pathologies, as the maximal sensitivity and specificity for use of the NELA risk score is at a 5% cutoff.<sup>2</sup>

Mesenteric and colonic ischaemia occur where there is insufficient blood flow to the bowel due to partial or complete impairment of the gastrointestinal system blood flow and oxygen supply, resulting in ischaemia, infarction, and perforation.<sup>5,6</sup> The prognosis of acute mesenteric ischaemia is considered poor, with commonly cited mortality rates of 60%–80%.<sup>5</sup> However, it is likely that this mortality rate has improved in recent years. Karkkainen et al noted a decrease in mortality rate from 82% in a Finnish Hospital cohort from 1972–1990 to 42% in a similar study at a similar Finnish hospital cohort from 2009–2013.<sup>7</sup> While acute mesenteric ischaemia is uncommon, it is an important cause of an acute abdomen in older adults. Indeed, an 80-year-old patient presenting with an acute abdomen is more likely to have acute mesenteric ischaemia than appendicitis or a ruptured aortic aneurysm.<sup>8</sup> The mortality rate for operatively managed colonic ischaemia is similarly high. In a recent retrospective study from South Korea, the mortality rate for operatively managed non-occlusive ischaemic colitis was 30%.<sup>9</sup> In both mesenteric and colonic ischaemia, blood flow may be inadequate due to thrombosis, emboli, recent vascular surgery, or in the setting of systemic hypoperfusion.<sup>5,9</sup> Even taking lower estimates of mortality from recent studies into account, a 30%–40% mortality rate over 30 days is extremely high, and considered with the associated high morbidity of this condition, robust discussions regarding prognosis with intervention need to be had with older adult surgical patients and their families. We set out to establish if the NELA risk scores we use routinely for risk assessment were in fact misleading in instances of mesenteric and colonic ischaemia in order to facilitate better prognostication for this largely frail patient cohort, in which aggressive surgical management is not always suitable.

## Methods

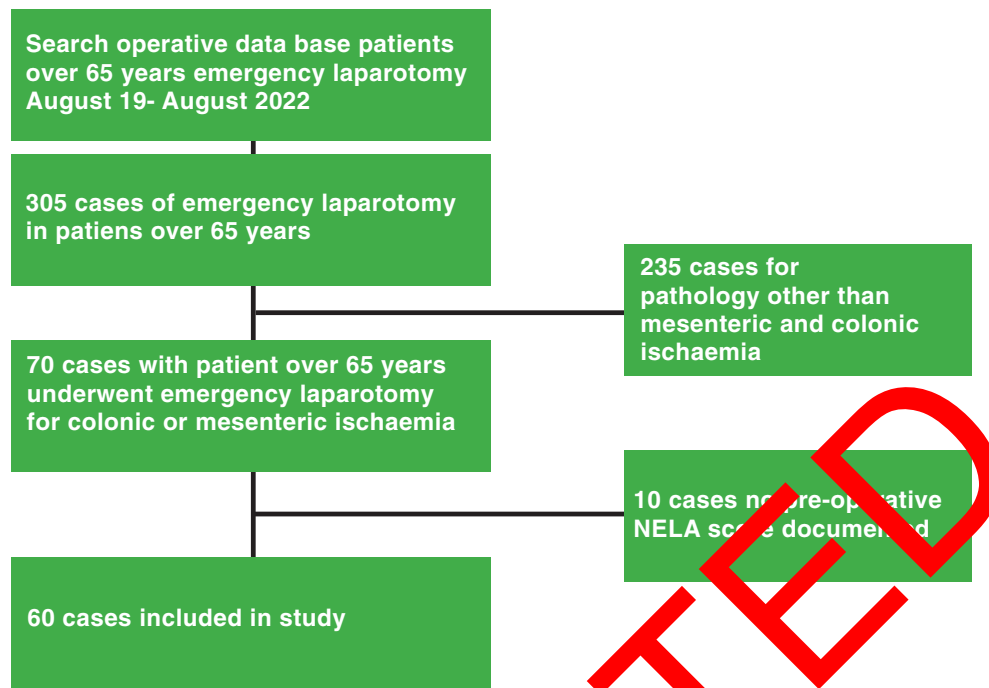
A retrospective search was performed of the hospital operative database from two tertiary centres to identify all cases of emergency laparotomy on patients aged 65 years or older from August 2019 to August 2022. A total of 305 cases were identified, and reviews of the operative records were undertaken to identify all cases where colonic or mesenteric ischaemia was recorded as the primary pathology. Cases with combined small-bowel and colonic ischaemia were included in the mesenteric ischaemia group. Cases where other pathology was recorded that may have lead to ischaemia, such as band, volvulus, intussusception, obstruction, and malignancy, were excluded. From the identified cases, a majority had an NELA score entered preoperatively; however, 10 cases without a preoperative NELA score documented were excluded (Figure 1). Hence, all patients had a NELA score calculated by the treating team as opposed to a retrospective calculation, which may have introduced bias. These scores were calculated by treating teams using the web-based NELA risk calculator.<sup>10</sup> A review was conducted of the interhospital-linked medical records for 30-day postoperative mortality. Secondary outcomes recorded were in-hospital total and intensive care unit length of stay. Baseline demographic data, anatomical distribution of ischaemia, methods of revascularisation, number of operations, and use of temporary abdominal closure were also included in our review. Comparisons were made between the number of expected mortalities (mean NELA score multiplied by total number of patients) versus the observed 30-day mortality rate. *P*-values were calculated using Fisher's exact *t*-test on GraphPad Prism 9.4.1.

## Ethics Statement

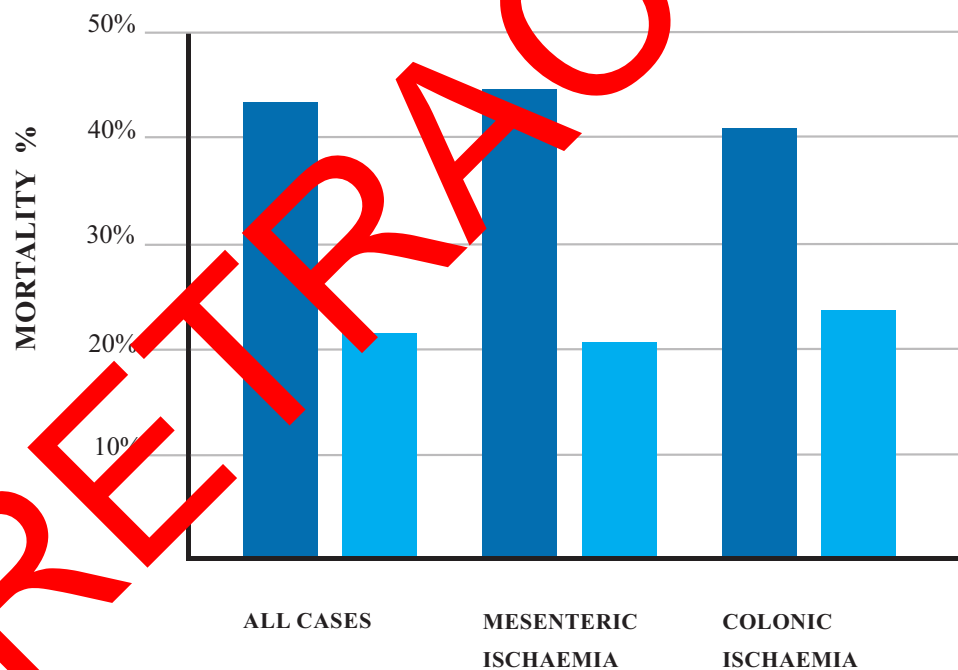
Local ethical approvals were given for this retrospective study through the GEKO ethics committee at Sir Charles Gairdner Hospital (approval 47811). As patient data were de-identified, no informed consent was required from individual patients. The current study was performed in accordance with the Institutional Committee for the Protection of Human Subjects, which was adopted by the 18th World Medical Assembly, Helsinki, Finland, and its later amendments.

## Results

Overall, the observed 30-day mortality rate was 43.3%, while the mean NELA score was 21.9% (range 2%–71%). There was little difference in NELA risk and mortality when looking separately at the colonic and mesenteric ischaemia subgroups. Amongst patients with colonic ischaemia alone, the average NELA score was 23.5%, while the actual mortality rate was 40.7% (*p*=0.1205). For mesenteric ischaemia, the predicted mortality rate was 20.6%, while the actual mortality rate was 45.5% (*p*=0.0332, Figure 2). The mean number of operations overall was 1.8. The overall median mortality following initial operation was 8 days. Amongst survivors, the mean NELA score was 12.2%, while amongst



**Figure 1** Inclusion/exclusion flow chart.



**Figure 2** Predicted versus actual mortality.

**Notes:** Dark blue, actual 30-day mortality; light blue, mean NELA score (predicted 30-day mortality).

patients with 30-day mortality the mean NELA score was 34.5%. Mean length of stay amongst survivors was 27 days (range 7–99), with a mean ICU length of stay of 9.3 days (range 0–48). Overall, 20% of patients underwent surgical revascularisation, and 75% of these were open superior mesenteric artery embolectomy. Temporary abdominal closure was used in 48% of cases. The distribution of ischaemia across all cases and patient characteristics is given in Table 1.

**Table I** Baseline characteristics and outcomes

All cases		
	Total, n	60
	Mean age, years	77.4
	Female, %	55
	Mean NELA score	21.9
	Mortality (30 days), %	43.3
	Mean Operations	1.8
	Mean LOS (survivors), days	27
	Mean ICU LOS (survivors), days	9.3
Mesenteric ischaemia		
	Total, n	33
	Mean age, years	77.1
	Female, %	58
	Mean NELA score	21.4
	Mortality (30 days), %	12
	Mean operations	1.7
	Mean LOS (survivors), days	27
	Mean ICU LOS (survivors), days	4.4
	Underwent revascularisation, %	33.3
	Use of temporary abdominal closure, %	58
Region of ischaemia, %		
	Total small bowel	12
	Distal small bowel	48.5
	Distal small bowel and colon	15
	Middle small bowel	24
Colonic ischaemia		
	Total, n	27
	Mean age, years	79.9
	Female, %	57.5%
	Mean NELA score	20.6
	Mortality (30 days), %	45.5
	Mean operations	1.9
	Mean LOS (survivors), days	39
	Mean ICU LOS (survivors), days	14
	Underwent revascularisation, %	3.7
	Use of temporary abdominal closure, %	33.3

(Continued)

Table 1 (Continued).

Region of ischaemia, %		
	Total colon + rectum	7.4
	Total colon	40.7
	Right colon	37
	Left colon	3.7
	Sigmoid colon	7.4
	Transverse colon	3.7

## Discussion

Our results demonstrate a mortality rate double the predicted 30-day mortality using the NELA risk calculator in patients who underwent a laparotomy for mesenteric and colonic ischaemia. The observed 30-day mortality rate was 43.3%, while the mean NELA score was 21.9% (range 2%–71%). From the NELA score we would predict a total mortality rate in our cohort of 13 of 60; however, the actual figure was 26 of 60. Comparing these totals as categorical data,  $p=0.009$ , demonstrating a statically significant deviation between predicted and observed mortality figures.

The mortality rate of our cohort compares favourably with reported mortality rates in the literature over many studies of 60%–70%, but is in line with recent publications demonstrating mortality rates of approximately 40% and is consistent with the lower end of published mortality rates.<sup>5,7</sup> The congruence of our study results with the lower end of published mortality figures is important, as it demonstrates that the mortality figures are not higher than the NELA risk score because of undertreatment or treatment withdrawal for our patients. This is supported further by the average time to mortality in this study being 8 days postoperatively, indicating a majority of the patients had a prolonged active treatment course before further treatment was deemed futile.

Risk assessment is important for surgeons, intensive care specialists, and patients alike. Older-adult surgical patients value quality of life over prolonged life and carefully consider the risk:benefit ratio of pursuing active treatment for major illnesses.<sup>11</sup> As well as the mortality risk, our results demonstrate an average in patient length of stay for survivors of 27 days (range 7–99) and average 9 days in intensive care (range 0–48). This is as important, as the mortality risk needs to be communicated to patients and their families so that they understand the expected treatment course. While the NELA scores in our cohort underestimated mortality, they were still correlated with mortality rate. The mean NELA score of survivors was 12.2%, while amongst non-survivors the mean NELA score was 34.5%.

Looking to alternative means of prognostication in mesenteric ischaemia, Grotelüschen et al conducted a single-centre retrospective study of 302 cases of mesenteric ischaemia from 2003 to 2014.<sup>12</sup> Through multivariate analysis, they demonstrated a significant association between preoperative lactate level  $>3$  mmol/L, C-reactive protein level  $>100$  mg/L, and ICU admission prior to diagnosis of mesenteric ischaemia with mortality risk.<sup>12</sup> None of these parameters is part of the NELA score, raising the prospect of inclusion in a modified score specific to mesenteric ischaemia risk.

Serum lactate levels were also demonstrated to be strongly associated with a poor prognosis in a retrospective study by Caluwaert et al of outcomes in patients who developed mesenteric ischaemia whilst admitted in the intensive care unit.<sup>13</sup> Other predictive factors identified were the maximal dose of vasopressors and anticoagulation.<sup>13</sup> Future studies should examine the use of NELA scoring systems modified to risk assessment in mesenteric and colonic ischaemia or use of alternative prognostication tools with greater accuracy for patients with ischaemic pathology.

There are several limitations of this study. Our cohort was only 60 patients, which limited the analysis to a simple comparison of NELA score risk with mortality rate. A larger-cohort study would allow multivariate analysis of risk and may identify patient subgroups where NELA scores are more accurate. Despite the small number of patients, the  $p$ -values from Fisher's exact test still demonstrated a statically significant result overall for discordance between expected and observed mortality. This study is also limited in that it was across two tertiary centres in a well-developed health system. Studies in alternative healthcare settings may yield different results. A further limitation of this study was that we did not examine

morbidity functional outcomes in patients. Decline in functional status is considered more important than other outcomes for older adults, especially where it leads to loss of independence, and this is an important outcome that needs to be examined by future studies in colonic and mesenteric ischaemia.<sup>11</sup> We did not examine cases of mesenteric ischaemia in patients under the age of 65 years; however, a majority of cases will be in older adults, and younger adults will almost always be suitable candidates for intensive management, hence the value of preoperative prognostication is less.

Overall, further work is required from general surgeons to develop on the risk-assessment tools we have and further improve them. This is particularly important for such conditions as mesenteric ischaemia, where the population at risk is elderly, frail, and in some cases may be suitable for comfort care rather than aggressive surgical management.

## Conclusion

In older adults with colonic or mesenteric ischaemia requiring emergency laparotomy, the NELA risk score underestimates mortality by approximately a factor of two. Given the high mortality of this condition and its association with frailty, it is important for surgeons to improve the risk-assessment tools available for older adults with mesenteric and colonic ischaemia.

## Disclosure

The author reports no conflicts of interest in this work.

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