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## **Analysis of Patients Who Died Following Hartmann's Procedure**

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### **Authors' contributions**

*This work was carried out in collaboration between all authors. Author RW analyzed the data, performed literature search and wrote the initial manuscript. Author APW collected and analyzed the data and revised the manuscript. Authors TRC and JA entered the data, analyzed the data and revised the manuscript. Author JBN analyzed the data and revised the manuscript. All authors read and approved the final manuscript.*

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### **ABSTRACT**

**Introduction:** Hartmann's procedure is typically performed for sigmoid colon obstruction or perforation. The primary aim of this study was to compare patients who died after a Hartmann's procedure for obstruction and perforation. The secondary aim was to collate opinions of surgeon reviewers of any clinical events.

**Methods:** Patients who died in Queensland, Australia after a Hartmann's procedure, between January 2009 and December 2014, were identified from the Queensland Audit of Surgical Mortality.

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**Results:** 275 patients died; of those 56% underwent surgery for perforation, 20% for obstruction and 24% for other indications. Patients with perforation were of the same age as those with obstruction ( $p = 0.178$ ) but those with perforation were more likely to be female ( $p = 0.059$ ) and have a higher ASA class ( $p = 0.001$ ). Patients with perforation underwent surgery one day earlier than those with obstruction ( $p = 0.066$ ) but had the same postoperative length of stay as those with obstruction ( $p = 0.430$ ). Surgeon reviewers identified between 1 and 7 clinical events per patient in 105 patients (38.2%).

**Conclusion:** Patients with perforation who died following a Hartmann's procedure were of a higher ASA class but had a shorter time to theatre compared to patients with obstruction. Clinical events were identified in one third of patients.

*Keywords: Hartmann's procedure; mortality; colonic obstruction; colonic perforation.*

## 1. INTRODUCTION

Henri Hartmann described two stage sigmoid resection via laparotomy, closure of the rectal stump and formation of end colostomy in 1921 (now called Hartmann's procedure). It was initially described for the treatment of recto-sigmoid cancer and given the benefits of avoiding complications of an anastomosis; its use was subsequently extended to other pathologies of the left colon such as complicated diverticular disease, sigmoid volvulus and colonic ischaemia. Recently there has been a shift away from performing a Hartmann's procedure for all emergencies of the left colon, and a sigmoid resection with primary anastomosis and covering ileostomy is increasingly being used [1-3]. Barbieux et al. conclude Hartmann's procedure is indicated where there is faecal contamination of the abdominal cavity, shock, ischaemic colitis, or the presence of numerous co-morbidities [4]. Hartmann himself described an 11% mortality rate from his initial use of this procedure. Since then morbidity rates have remained high at 36 – 65% [4-6] and mortality rates range from 11 to 27% [6-8].

The primary aim of this study was to compare the characteristics of patients who died after a Hartmann's procedure for obstruction with those who presented with perforation. The secondary aim was to determine if there are any patient-care lessons to be learned based on reviews performed by independent surgeons.

## 2. METHODS

The Australian and New Zealand Audit of Surgical Mortality (ANZASM) is run through the Royal Australasian College of Surgeons. Each Australian State and Territory manages its own audit. The functioning, governance and

objectives of ANZASM have been outlined elsewhere [9]. It is a requirement of Fellowship that all surgeons in Australia who are in operative practice in hospitals or day surgery units to participate in ANZASM.

All surgical deaths data were collected through the Queensland Audit of Surgical Mortality (QASM). Deaths are reported to QASM by the hospital if the patient was an inpatient at the time of death and under the care of a surgeon. Deaths are reported independent of the treating surgeon and whether a surgical procedure was performed or not. QASM is a protected quality assurance activity in Australia under Part VC - Quality assurance confidentiality of the Health Insurance Act 1973 (gazetted 25 July 2016). Chart reviews are not possible as part of this process.

Briefly, the treating surgeon provides the clinical data to QASM using a standard surgical case form (SCF). Every SCF is de-identified and sent for First-Line Assessment (FLA) to a surgeon of the same specialty but from a different hospital. 98% concordance between medical records and the SCF has been previously demonstrated [10]. Based on clinical judgment the assessor surgeon determines whether untoward clinical events or deficiencies in standard surgical care arose (e.g. communication issues, fluid balance issues, delays, inappropriate procedures). The case may then be closed or proceed to a non de-identified Second-Line Assessment (SLA) where a different assessor surgeon has access to the medical records for that admission and the SCF (but not the FLA). These clinical events are coded using READ codes. First and Second line assessors are Fellows of the Royal Australasian College of Surgeons who volunteered to perform reviews. Assessors are randomly allocated by the QASM Clinical Director (who is a senior consultant surgeon).

The determinations of the assessor surgeons represent their own clinical opinions rather than that of QASM or ANZASM. Check-lists and proformas are not used during FLA or SLA. Surgical Case Form and First-Line Assessment form are available on the internet. Other than demographic data, SCF includes questions about pre-operative delay, deep vein thrombosis prophylaxis and whether or not the surgeon would have done anything differently in retrospect.

For this retrospective study, data were included if the patient died in a Queensland hospital under the care of a surgeon following a Hartmann's procedure. All data were extracted from the ANZASM database and analysed using IBM SPSS Statistics 19 (Armonk, NY: IBM Corporation, 2010) and Microsoft Excel (Redmond, Washington: Microsoft, 2010). Chart review was not possible. Statistical significance was determined using the Mann-Whitney U test or a Z test as appropriate. Continuous variables are presented as means. Categorical variables are presented as frequencies. Two tailed p value < 0.05 was considered statistically significant.

### 3. RESULTS

Between January 2009 and December 2014, 275 patients died in Queensland under the care of a surgeon having had a Hartmann's procedure. Of those, 56% were for perforation, 20% for obstruction and 24% for other causes (volvulus, ischaemia, haemorrhage, fistula, non-obstructing malignancy and not stated) as shown in Table 1. Those undergoing surgery for perforation were of the same age as those with obstruction ( $p = 0.178$ ) but were more likely to be female ( $p = 0.059$ ) and have a higher ASA class ( $p = 0.001$ ). The number of patients who did not undergo reoperation ( $p = 0.641$ ) and the number of reoperations ( $p = 0.529$ ) per patient was the same in both groups. Patients with perforation underwent operation one day earlier ( $p = 0.066$ ) but had the same postoperative ( $p = 0.430$ ) and overall ( $p = 0.441$ ) length of stay as those with obstruction. Day of admission is shown in Fig. 1; – other than Thursday being a quiet day for admissions, there was little difference throughout the week.

Surgeons who operated for obstruction were equally likely as those operating for perforation to conclude that in retrospect they would manage such a patient differently: 30 / 151 (19.9%) vs 15

/ 50 (30.0%) respectively  $p = 0.136$ . For those with perforation, there was almost equal division of a retrospective preference between not operating and operating earlier. For patients with obstruction there was a mixture of retrospective preference for actions including different preoperative management, intraoperative management and postoperative care.

102 patients (37.09%) underwent at least one reoperation (mean 1.56 reoperations ranging from 1 to 10). Half were in the setting of colonic perforation (50/102), 19.61% (N=20) in the setting of obstruction, 5.88% (N=6) in setting of ischaemia with miscellaneous diagnoses in the remainder (N=26). Patients who underwent at least one reoperation were younger than those who did not (74.1 years vs 77.14 years respectively;  $p = 0.025$ ). Surgeons who reoperated for patients with perforation were three times as likely to reflect that in retrospect they would have managed the patient differently (Odds Ratio 3.35 95% CI: 1.89 to 5.94;  $P < 0.001$ ) – typically this was to operate or reoperate earlier (11/27 and 14/39 patients respectively).

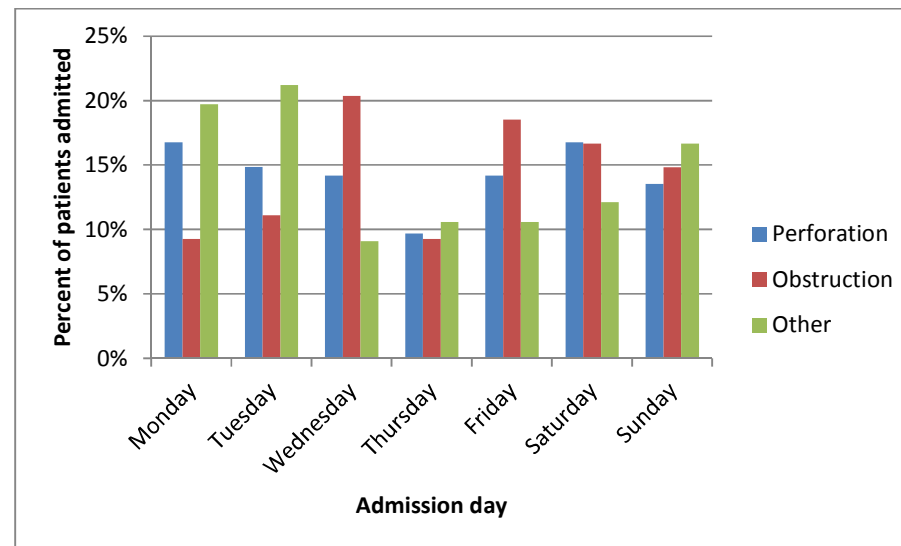
Surgeon First-Line Assessors identified 212 clinical events (between 1 and 7 per patient) in 105 patients (38.2%). Most frequent were assessment problems (72), followed by delays (39) and deficiencies in postoperative care (28). Other events included: intraoperative management, choice of intervention and not admitting the patient to Intensive Care Unit. Of patients with complete data, 95.9% (255/266) were admitted to a critical care unit.

### 4. DISCUSSION

Patients who died following a Hartmann's procedure for perforation were more likely to be female with a higher ASA class than those who underwent the procedure for obstruction. The reason for the female preponderance is not clear. Not surprisingly, over 90% of patients who died after a Hartmann's procedure had ASA class of 3 or greater and two thirds had an ASA of 4 or 5. Surgeon reviewers identified a clinical event in one third of patients (38.2%): patient assessment issues, delays to diagnosis and treatment as well as various deficiencies in postoperative care. Similarly in a recent study 70.7% of 4 816 deaths across all surgical specialties had no clinical event [11].

**Table 1. Demographics of patients who died following Hartmann’s procedure (n=275). Mean values are shown unless stated. CCU: Critical Care Unit; \* incomplete data for some patients**

Indication	Age	Female* (%)	ASA class	Admitted to CCU* (%)	Number of reoperations per patient	Patients without reoperations (%)	Preoperative inpatient days	Overall length of stay in days
Perforation N = 155	75.7 years	88 / 153 (57.5%)	3.8	145/151 (96.0%)	0.5	105 (67.7%)	3.3	17.1
Obstruction N = 54	78.1 years	23 / 54 (42.6%)	3.3	46/51 (90.2%)	0.7	34 (63.0%)	4.3	20.7
Other N = 66	75.8 years	17 / 65 (26.2%)	3.5	64/64 (100%)	0.8	34 (51.5%)	4.5	21.1
Total N = 275	76.2 years	128 / 272 (47.1%)	3.6	255/266 (95.9%)	0.6	173 (62.9%)	4.1	18.7



**Fig. 1. Admission day of the week**

ASA in our study was higher in the perforation group compared with the obstruction group. In another study of 80 patients who died following Hartmann's procedure, 17.4% of patients with ASA 3 died and 72.7% with ASA 4 died [12]. In addition, Lal et al. found a 58.33% mortality from Hartmann's procedure in those aged over 80 years ( $p < 0.05$ ). In that study, 32.5% of patients underwent surgery for malignancy and 57.5% for complicated diverticular disease. Situational awareness, preoperative assessment, involvement of a gerontologist would seem crucial in communicating operative risks with the patient and family in order to avoid futile surgery.

As would be clinically expected (e.g. extent of preoperative investigations), the perforation group underwent surgery earlier than the obstruction group. However, of the clinical events identified by reviewers, 18% (39/212) related to delay. From our dataset, it is not clear if the delays were due to a delay in diagnosis, decision to operate or access to operating theatre. The elderly population is more likely to be delayed whilst awaiting an emergency laparotomy and suffer more significantly because of delay to definitive treatment and source control [13]. Why a mean of 3.3 days elapsed between admission and operation for colonic perforation is not explained by the dataset – perhaps the perforation was thought to be contained (e.g. small gas bubbles on Computed Tomography) or the patient initially improved with non-operative management and then deteriorated. The time to theatre of 4.3 days in setting of large bowel obstruction could be due to the necessary radiological investigations, but again is not adequately explained by the dataset. Of the surgeons who would have had different actions in retrospect, 19.7% would have operated (or re-operated) earlier. For those patients who underwent a Hartmann's procedure on day 0 or 1 some surgeons would still have preferred in retrospect to operate earlier.

More than one third of patients (37.1%) in this study underwent a relaparotomy but the circumstances of this are not known. In 13 cases surgeons stated in retrospect they could have operated or re-operated earlier. Patients with colonic perforation (presence of faeculent peritonitis) had an average reoperation rate of 0.5 reoperations per patient. Uncertainty persists regarding the timing of relaparotomy in the setting of secondary peritonitis i.e. on demand when patient deteriorates or planned. A randomized trial of 232 patients found patients

undergoing planned relaparotomy (every 36 to 48 hours) had higher health care utilization and medical costs but did not have a lower rate of death or peritonitis-related morbidity [14]. In that randomized trial, more than half the on-demand patients did not require relaparotomy [14]; planned relaparotomy is currently not regarded as a conventional treatment strategy [15].

A recently developed technique to non-operatively decompress the obstructed colon is the self-expanding metallic stent. In a 2014 meta-analysis of 5 Randomized Controlled Trials comparing colonic stenting followed by semi-elective surgery to emergency surgery in malignant left sided colonic obstruction, the authors found the primary anastomotic rate, overall colostomy rate, overall complication rate, post-operative mortality within 30 days, surgical site infection rate and rate of permanent colostomy all favoured stenting [16]. Bringing the findings to the real world, a review found the technical and clinical success rates (70.7% and 69%) of stenting were lower than have been previously reported (91.9% and 71.7%) [17]. Oncological outcomes are probably not impaired following stenting [18]. Decompressing the obstruction by stenting allows adequate time for stabilization of medical co-morbidities and adequate staging before restorative resection. There will always remain patients for whom there is no option but emergency surgery due to closed loop obstruction, colonic perforation or infarction.

Almost all the patients in this dataset were admitted to a critical care unit (CCU). Non admission to CCU was identified by a surgeon reviewer as a clinical event in 9 patients (3.3%). Patients older than 65 years of age or those with shock of any cause are high risk surgical patients (Royal College of Surgeons of England defines high risk as a predicted mortality exceeding 10%) [19]. A large European cohort study found only one third of high risk surgical patients were admitted to critical care at any stage following surgery [20]. Hartmann's procedure has a reported mortality rate of 11 – 27% [5,6,8]. While only 1.1% of surgeons (3/275) commented in retrospect admission to a critical care unit may have improved outcome, this is in the context of almost uniform admission to a critical care unit.

Patients who died after a Hartmann's procedure were admitted throughout the week - there seems little day to day variation but Thursday appears relatively quiet. In a 2012 study of 31,832 patients undergoing urgent surgery for

left sided diverticulitis, patients admitted on the weekend were more likely to receive a Hartmann's procedure (64.8%) than those admitted on a weekday (53.9%  $p < 0.001$ ) [21]. The authors postulated this was due to reduced staffing and less colorectal expertise on weekends. The fact that there is less expertise available on weekends In the Australian context, Maddern's group found an association between higher odds of early surgical death and operations performed on the weekend [22]. This Weekend Effect is complex and on multivariable analysis the Confidence Intervals were broad and the finding was not statistically significant.

An inpatient death registry dataset has limitations. Inpatient medical chart review and death registry review were not possible as part of this study design. This retrospective study cannot determine why surgeons decided to perform a Hartmann's resection versus a loop colostomy or restorative anterior resection with loop ileostomy. Almost all patients were admitted to Critical Care Unit but at what time frame of their hospital stay this occurred is not known due to limitations of the dataset. Patients who survive following surgery are not reported to ANZASM – the number of patients who survived a Hartmann's procedure is not known. READ codes are used in Australia, New Zealand and United Kingdom but are cross-referenced to International Classification of Diseases, Ninth Revision (ICD-9) [23].

The average post-operative length of stay was 15.5 days. Patient assessment issues remain a key concern of the assessor surgeons and routine consultant involvement is ideal in all patients undergoing a Hartmann's procedure. This study highlights the need to carefully consider the indication for Hartmann's, the patient's age and comorbidities before embarking on such a high risk procedure. The patient and family need to be aware of the potential outcomes after Hartmann's procedure including a prolonged post-operative course. Stenting may be an important alternative to surgery in patients over 80 years of age with an ASA of 4 or 5 because a significant proportion will not survive surgery.

## 5. CONCLUSION

Despite the apparent successes of resection and primary anastomosis for left sided colonic disease, the Hartmann's procedure remains a relevant operation in modern surgical practice.

Patients who died following surgery for perforation were more likely to be female with a higher ASA class than those who underwent surgery for obstruction. Surgeon reviewers identified a clinical event in one third of patients. Avoiding surgical delay, liberal use of critical care facilities and routine consultant involvement may improve outcomes.

## CONSENT

It is not applicable.

## ETHICAL APPROVAL

Not applicable because Queensland Audit of Surgical Mortality is a protected quality assurance activity in Australia under Part VC - Quality assurance confidentiality of the Health Insurance Act 1973 (Gazetted 25 July 2016).

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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