Characteristics, Incidence, and Outcomes of Gastrointestinal Complications Post-Cardiac Surgery in A Quaternary Referral Centre: A Retrospective Study.

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Abstract

Background:

Gastrointestinal (GI) complications after cardiac surgery are associated with high morbidity and

mortality. Early identification and treatment of GI complications could improve patient outcomes. The objectives of this study were to ascertain the incidence and outcomes of GI complications following cardiac surgery and to identify clinical characteristics associated with the development of GI complications in this population.

Methods:

A retrospective single-centre cohort study of adult patients undergoing cardiac surgery in an Australian quaternary cardiothoracic surgical referral centre from November 2012 to March 2020 was conducted. Pre-operative characteristics, and intra-operative and post-operative management were compared between patients who did or did not develop GI complications. Data are presented as n (%).

Results:

A total of 4417 patients underwent cardiac surgery of whom 95 (2%) developed GI complications in the post-operative period. The most common GI complication was paralytic ileus (n=22, 22%), while mesenteric ischemia (n=16, 16%) was associated with the highest all-cause mortality (n=7, 44%). Pre-operative factors associated with GI complications included age >70 years, creatinine >200 microgram/ml, pre-operative arrhythmia, and illness severity (Acute Physiology and Chronic Health Evaluation II and III score). The intra-operative factor associated with GI complications was a cardiopulmonary bypass time >120 mins. Post-operative factors associated with GI complications included red blood cell transfusion, stroke, new-onset renal failure, cardiogenic shock, ventilation >24 hours, re-intubation, septic shock, and multiorgan failure.

Conclusions:

Multiple risk factors associated with GI complications in patients undergoing cardiac surgery were identified. These provide potential targets to support early detection and management of GI complications in order to reduce morbidity and mortality in these patients.

Background:

Patients undergoing cardiac surgery are recognised to be at risk of post-operative gastrointestinal (GI) complications. GI complications occur in approximately 3% of cardiac surgery cases [1, 2] and are thought to arise from non-pulsatile perfusion during cardiac bypass, disordered coagulation, physiological stress, and haemodynamic instability during and after surgery, use of opioids, and co-existing vascular disease [1]. GI complications range from minor GI bleeding or ileus to life-threatening

bowel infarction and, although infrequent [1, 2], can be associated with significant mortality and morbidity [3, 4, 5].

The majority of patients undergoing cardiac surgery require post-operative mechanical ventilation and analgesia which may impede timely recognition of GI complications. Delayed identification may lead to significant deterioration and higher risk of poor outcome in these patients. As surgical and post-operative care have matured, and the surgical population have become older and with greater co-morbidities, there is a need to ascertain the current incidence of GI complications following cardiac surgery and associated risk factors to inform targeted monitoring and expedite research into interventions aimed at preventing or reducing the severity of complications. The aims of this study were to: (1) identify the incidence and nature of GI complications; (2) identify factors associated with the development of GI complications; and (3) report differences in outcomes in patients with or without a GI complication following cardiac surgery in a single Australian centre in the current era. This study will help understand the risk factors associated with GI complications in the cardiac surgery population.

Methods:

A retrospective review of data collected for the Australian and New Zealand Society of Cardiac and Thoracic Surgeons (ANZSCTS) database project was conducted. Patients were eligible if they: (1) were aged ≥ 18 years; and (2) had undergone cardiac surgery under cardiopulmonary bypass (CPB) between November 2012 and March 2020 at the Royal Adelaide Hospital. Eligible patients were categorised into those with and without a GI complication. Based upon ANZSCTS data definition manual, GI complications were defined as: GI bleeding requiring transfusion; pancreatitis with abnormal amylase/lipase requiring nasogastric suction therapy; cholecystitis requiring cholecystectomy or drainage; mesenteric ischemia; hepatitis; perforation; and paralytic ileus. For this study, hepatitis was defined as liver function tests twice the upper normal limits based on the affiliated pathology laboratory. A manual case note review of all eligible patients in the GI complications group was performed to confirm diagnoses. Data was collected as part of an audit of clinical practice and as such consent was not sought from participants; ethical approval for publication was obtained from the Central Adelaide Local Health Network Research Ethics Committee (Approval number 14927).

The following data were extracted from the ANZSCTS database: patient demographics; pre-operative risk factors; intra-operative techniques; post-operative hospital course; and clinical outcomes including 30-day and in-hospital mortality and morbidity. Pre-operative variables included: smoking history; illness severity using APACHE (Acute Physiology and Chronic Health Evaluation) II and III scores on ICU admission; the need for renal dialysis; degree of heart failure using the New York Heart Association (NYHA) classification; and the presence of hypercholesterolemia, cerebrovascular diseases, diabetes mellitus, renal dialysis, cardiogenic shock, infective endocarditis, or respiratory diseases prior to surgery. Any cardiac surgery previously performed was also noted. Intra-operative variables included: the type of surgery performed; cardiac bypass time; cross clamp time; and number of blood products used. Post-operative variables included: return to the operating theatre in the same admission; new renal failure

(NRF); post-operative myocardial infarction (MI); new onset atrial fibrillation requiring treatment; stroke; transient ischaemic attack (TIA); prolonged invasive mechanical ventilation (greater than 24 h); septicaemia; and multiorgan failure. NRF was defined using two criteria: a serum creatinine of > 200 micromol/L and an increase in serum creatinine to double the preoperative value; or a new requirement for renal replacement therapy. MI was defined as at least two of the following: cardiac enzyme elevation (creatine kinase-myocardial band > 30 U/L or troponin > 20 mg/L); new wall motion abnormalities; and new Q waves on at least two serial electrocardiograms.

Patients with a GI complication were compared to those without for all pre-operative, intra-operative, and post-operative risk factors using the chi-square test, Fisher's exact test, and Students t-test as appropriate. Pre-operative and intra-operative risk factors were identified by univariate logistic regression analysis. Mortality at day 30 and post-operative complications were also compared between groups. A p-value of less than 0.05 was considered statistically significant. No sample size calculation was performed given the retrospective nature of the study design.

Results:

Over the 8-year study period, 4417 patients underwent cardiac surgery, of whom 114 patients had a GI complication as documented in the ANZSCTS database. Following case note adjudication, six patients were excluded as their case notes were unavailable and a further 13 patients were excluded as they had no identifiable GI complication documented in their case notes (Fig. 1).

The recorded incidence of GI complications was 2.16%. The most common GI complication included GI bleeding in 32 (32%) patients, followed by paralytic ileus (n = 22; 22%), hepatitis (n = 21; 21%), mesenteric ischemia (n = 16; 16%), perforation (n = 5; 5%), and acute cholecystitis (n = 4; 4%). Of the 32 patients with GI bleeding, 11 (34%) had upper GI bleeding and 21 (66%) had lower GI bleeding (Table 1). Eight of the 11 (72%) patients with upper GI bleeding required endoscopy compared to six of the 21 (28%) patients with lower GI bleeding. While mesenteric ischemia was the fourth most common complication (n = 16; 16%) it had the highest mortality (n = 7/16; 44%). Laparotomies were performed in 95% of patients (n = 15/16) with mesenteric ischemia and 100% (n = 5/5) of patients with a GI perforation. In-hospital mortality was higher in those with GI complications compared to those without (odds ratio 10.87 (95% CI 5.41–21.84), $p < 0.0001$).

Table 1
Types and characteristics of major GI complications after cardiac surgery

	Number of complications	Number requiring surgery	Number undergoing endoscopy	Number of deaths within 30 days
Upper GI bleeding	11	0	8	1
Lower GI bleeding	21	0	6	1
Perforation	5	5	0	1
Mesenteric ischemia	16	15	0	7
Hepatitis	21	0	0	3
Acute cholecystitis	4	2	0	0
Paralytic ileus	22	0	0	3
GI: Gastrointestinal				

A number of pre-operative factors were associated with the development of GI complications. Patients with a GI complication were more likely to have an age > 70 years (GI complication vs no GI complication: 56 vs 38%); pre-existing diabetes (50 vs 35%); pre-existing arrhythmia (30 vs 14%); higher APACHE II score (18 vs 15); and a creatinine greater than 200 microgram/ml (12 vs 4%) (Table 2). Intra-operative factors associated with the presence of GI complications included patients who had previous coronary artery bypass graft (CABG) (GI complication vs no GI complication: 5 vs 17%) and bypass time of > 120 min (28 vs 16%) (Table 3). When bypass time was adjusted for the type of surgery (CABG or valve with or without CABG), the difference remained significant.

Table 2
Pre-operative risk factors for development of gastrointestinal complications after cardiac surgery.

	GI complication N = 95	No GI complication N = 4303	*P*-value
Age > 70	53/95 (55.80)	1619/4303 (37.60)	0.000
Male	63/95 (66.30)	3212/4303 (74.60)	0.066
Hypercholesterolemia	69/95 (72.60)	2986/4303 (69.40)	0.498
Diabetes mellitus	47/95 (49.50)	1483/4303 (34.50)	0.002
Smoker - current	21/93 (22.60)	634/2148 (29.50)	0.150
Smoker - history	55/95 (57.90)	2134/4303 (49.60)	0.109
Creatinine > 200 ug/L	11/95 (11.60)	159/4303 (3.70)	0.000
Renal dialysis	6/95 (6.30)	137/4303 (3.20)	0.089
Renal transplant	0/95 (0.00)	40/4303 (0.90)	1.000
Cardiogenic shock	5/95 (5.30)	70/4303 (1.60)	0.022
NYHA 3–4	39/95 (41.10)	1302/4303 (30.30)	0.024
Arrythmia	28/95 (29.50)	615/4303 (14.30)	0.000
Infective endocarditis	5/95 (5.30)	123/4303 (2.90)	0.201
Peripheral vascular disease	12/95 (12.60)	326/4303 (7.60)	0.067
Ejection fraction	95	4176	0.250
EF: <30	4 (4.21)	122 (2.90)	
EF: 30–50	24 (25.26)	751 (18.00)	
EF: >50	67 (70.52)	3303 (79.10)	
Age (years), median [IQR]	72.00 [60.00, 78.00]	67.00 [58.00, 74.00]	0.001
BMI (kg/m^2), median [IQR]	27.73 [24.45, 32.02]	28.73 [25.31, 32.65]	0.111
APACHE II score, median [IQR]	18.00 [14.00, 20.50]	15.00 [13.00, 18.00]	0.000
APACHE III score, median [IQR]	57.50 [48.00, 69.50]	49.00 [40.00, 60.00]	0.000
Preoperative haemoglobin (g/L), median [IQR]	130.00 [113.00, 138.00]	135.00 [118.00, 146.00]	0.040

Data are n (%) unless otherwise stated.

APACHE: Acute Physiology and Chronic Health Evaluation; BMI: body mass index; EF: ejection fraction; IQR: interquartile range; NYHA: New York Heart Association

	GI complication N = 95	No GI complication N = 4303	*P*-value
Pre-operative creatinine (ug/L), median [IQR]	95.00 [76.00, 123.00]	85.00 [72.00, 104.00]	0.003
Data are n (%) unless otherwise stated.			
APACHE: Acute Physiology and Chronic Health Evaluation; BMI: body mass index; EF: ejection fraction; IQR: interquartile range; NYHA: New York Heart Association			

Table 3
Intra-operative risk factors for the development of gastrointestinal complications after surgery.

	GI complication	No GI complication	*P*-value
Prior CABG	5/92 (5.43)	87/503 (17.30)	0.002
Bypass time	26/92 (28.20)	659/4259 (15.50)	0.001
>120 min	11/95 (11.50)	303/4259 (7.10)	0.096
>150 min			
Surgical group	92	4303	0.016
Valvular heart	18 (20.00)	796 (18.50)	
Coronary artery	36 (38.90)	1890 (43.90)	
Other cardiovascular	22 (23.20)	1240 (28.80)	
CABG with valve	16 (17.90)	377 (8.80)	
CPB time	92	4259	0.008
<120 mins	66 (71.60)	3559 (83.60)	
120–150 mins	15 (15.80)	386 (9.10)	
>150 mins	11 (12.60)	314 (7.40)	
Data are n (%) unless otherwise stated.			
CABG: coronary artery bypass graft; CPB: cardiopulmonary bypass			

Patients with a GI complication received greater medical intervention post-operatively than those without a GI complication (Table 4). Patients with a GI complication were more likely to return to theatre (37 vs 14%), receive reintubation (17 vs 3%), had a higher incidence of stroke (11 vs 2%), and receive > 24 hours of mechanical ventilation (36 vs 6%). Patients with a GI complication also had poorer post-operative outcomes than those without a GI complication, including a higher ICU and hospital mortality (6 vs 1%, and 18 vs 1%, respectively), and greater duration of ICU and hospital stay (133 vs 55 hours, and 575 vs

248 hours, respectively). The administration of inotropes and vasopressors occurred more frequently in patients with a GI complication compared to those without (25 vs 10% and 6 vs 2%, respectively). Patients with a GI complication had a higher incidence of septicaemia (14 vs 1%), pneumonia (29 vs 10%), new renal failure (23 vs 5%), and multiorgan failure (11 vs 1%). The median post-operative creatinine level was higher in patients with a GI complication compared to those without (142 vs 93 microgram/litre).

Table 4
Post-operative risk factors for the development of a GI complication after cardiac surgery

	GI complication N = 95	No GI complication N = 4303	*P*-value
Died in ICU	6/95(6.31)	36/3298 (1.10)	0.000
Died in hospital	17/95(17.89)	47/3298 (1.40)	0.000
Returned to theatre	35/95 (36.80)	597/4292 (13.90)	0.000
Reintubation	16/95 (16.80)	121/4293 (2.80)	0.000
Stroke- permanent	11/94 (11.70)	67/4075 (1.60)	0.000
Blood products used	65/94 (69.10)	1387/4029 (34.40)	0.000
New renal failure	22/94 (23.40)	208/4049 (5.10)	0.000
Post-op MI	4/95 (4.20)	301/4292 (7.00)	0.412
Post-operative cardiogenic shock	9/95 (9.50)	52/4292 (1.20)	0.000
Cardiac inotrope use for low CO	24/95 (25.30)	440/4292 (10.30)	0.000
Cardiac vasopressor use for low SVR	6/95 (6.30)	74/4292 (1.70)	0.001
New arrythmia	34/95 (35.80)	958/4292 (22.30)	0.002
Ventilation > 24 hours	34/95 (35.80)	262/4292 (6.10)	0.000
Pulmonary embolism	3/95 (3.20)	37/4292 (0.90)	0.055
Pneumonia	28/95 (29.50)	451/4292 (10.50)	0.000
Septicemia	13/95 (13.70)	25/4292 (0.60)	0.000
Multiorgan failure	11/95 (11.60)	28/4292 (0.70)	0.000
ICU length of stay (hours), median [IQR]	132.92 [64.78, 258.75]	55.09 [39.75, 96.32]	0.000
Hospital length of stay (hours), median [IQR]	575.00 [306.58, 784.78]	248.40 [175.77, 389.67]	0.000
Ventilation > 24 hrs, median [IQR]	18.75 [7.88, 41.92]	10.17 [5.83, 18.00]	0.000
Number of RBC unit's median [IQR]	4.00 [2.00, 6.00]	2.00 [1.00, 4.00]	0.000
Platelet units received, median [IQR]	1.00 [1.00, 2.00]	1.00 [1.00, 2.00]	0.894

Data are n (%) unless otherwise stated. IQR: Interquartile range

CO: cardiac output; FFP: fresh frozen plasma; ICU: intensive care unit; IQR: interquartile range; MI: myocardial infarction; RBC: red blood cell; SVR: surgical ventricular restoration

	GI complication N = 95	No GI complication N = 4303	*P*-value
FFP units received, median [IQR]	2.00 [1.00, 4.00]	2.00 [0.00, 3.00]	0.112
Post-operative creatinine (ug/L), median [IQR]	142.50 [92.00, 285.00]	93.00 [77.00, 126.00]	0.000
Data are n (%) unless otherwise stated. IQR: Interquartile range			
CO: cardiac output; FFP: fresh frozen plasma; ICU: intensive care unit; IQR: interquartile range; MI: myocardial infarction; RBC: red blood cell; SVR: surgical ventricular restoration			

Discussion:

Incidence of GI complications

The incidence of GI complications following cardiac surgery in our study was 2.16%. Previous studies have reported rates of GI complications post-cardiac surgery, between 0.41–3.7% [3, 4, 5, 6, 7, 8]. In an Australian cohort, Saxena *et al* reported an incidence of GI complications following aortic valve replacement of 1.3% in patients aged < 80 years and 3% in patients aged 80–89 years. Furthermore, Viana et al reported an incidence of GI complications of 1.1% following cardiac surgery conducted between 2001–2011 [8]. The higher incidence of GI complications in those aged 18 years and over in our study may be due to a higher prevalence of co-morbidities and increased complexity in patients receiving cardiac surgery.

GI bleeding

In our study, the most common GI complication was GI bleeding, with lower GI bleeding occurring most frequently, and no patients experiencing both upper and lower GI bleeding. These results confirm data from previous studies with similar numbers of patients and incidence of GI complications which have shown GI bleeding to be the most common GI complication observed following cardiac surgery [9, 10, 11, 12]. However, these results differ from Vianna *et al* who observed 3 of 21 patients to have both upper and lower GI bleeding [8]. Gastro-duodenal ulcer and erosive gastritis are the two most common aetiologies of upper GI bleeding [13]. At our hospital, 40 milligram pantoprazole once daily is used as routine care post-operatively in all cardiac surgical patients. In the absence of the routine pantoprazole, the incidence if GI bleeding complication may be higher, explaining the conflicting data from prior studies.

Mesenteric ischemia

Mesenteric ischemia occurred in just 16% of patients with a GI complication in our cohort (equivalent to 0.03% of the total cardiac surgical population) but had a higher mortality (n = 7/16; 43.7%) and greater operative intervention (n = 15/16; 94%) as compared to other GI complications. In other studies, the incidence of acute mesenteric ischemia ranges from 0.06–0.2% of all cardiac surgical patients and is

similarly associated with significant mortality 46–100% [14–16]. In a systematic review of 3692 patients Schoots *et al* reported the overall mortality in non-surgically treated patients to be almost 95% [15]. While the mechanism for increased mortality following mesenteric ischemia in a cardiac surgery population is poorly understood, it has been postulated that the presence of coronary artery disease is associated with vasculopathy in the mesenteric bed [16, 17], which predisposes the patient to ischemia in a peri-operative period. In addition, the signs and symptoms for mesenteric ischemia are non-specific or may be obscured by sedation or analgesia, which may increase the incidence of mesenteric ischemia following cardiac surgery when compared to a non-surgical population.

Acute cholecystitis

In our study, 4% of patients with a GI complication exhibited acute cholecystitis. This is similar to previous reports in which acute cholecystitis accounts for 3–8% of GI complications following cardiac surgery [13, 18, 19]. The precise pathophysiology of the cholecystitis is not known, although several mechanisms have been suggested which include visceral hypoperfusion of the gallbladder, increased viscosity of bile because of the stasis, endotoxemia and overproduction of inflammatory mediators [20]. Furthermore, diagnosis may be challenging as common symptoms of fever and right upper quadrant pain are highly non-specific following cardiac surgery.

Paralytic ileus and perforation

Nearly one quarter of patients with a GI complication in our study had a paralytic ileus, of which three died within 30 days. Paralytic ileus is a rare, poorly understood surgical complication with multifactorial origins [21]. Paralytic ileus is associated with the disturbance of the autonomic innervation of the colon [22]. In our series, we had five cases of perforation and only one death. Perforated duodenal or gastric ulcer post-cardiac surgery accounts for approximately 6% of all GI complications with a reported mortality of around 38% [23]. Existing data would suggest the use of proton pump inhibitors for prophylaxis of gastric or duodenal stress ulcers for high-risk patients may be appropriate [23].

Hepatitis

In our series, 22% of patients with a GI complication had hepatitis, of which three patients died within 30 days. The incidence of liver failure post cardiac surgery in the international literature is 2.2% of all GI complications and 0.026% of all cardiac operations [24]. Liver injury following cardiopulmonary bypass may be due to ischemia as a result of arterial hypotension and venous congestion [25]. Attention to hepatic perfusion pressure and avoidance of hepatotoxic drugs may mitigate the development of liver injury post cardiac surgery; further data regarding liver protective therapies such as N-acetyl cysteine are needed.

Pre-operative risk factor for GI complication

In our study, advanced age, higher illness severity, diabetes, renal dysfunction, and arrythmias (mostly atrial fibrillation) were associated with the presence of a GI complication. Many studies have identified

various risk factors trying to elucidate the correlation with GI complication. A few authors have used multivariate analysis, but with little concordance except for age, renal dysfunction, low EF, prolonged ventilation, and NYHA functional class [26, 27]. Aithoussa *et al* has shown that smoking, diabetes, obesity, hypertension, and hyperlipidaemia occurred more frequently in patients with a GI complication and patients with a GI complication were more likely to have a history of previous gastric ulcer, peripheral vascular disease (PVD), pre-operative renal impairment, and anaemia. Our study confirms these data.

Intra-operative risk factor for GI complications

In our study, patients with a GI complication were more likely to have a cardiopulmonary bypass time of greater than 120 min than in those with no GI complications 30% of patients with a GI complication had CPB > 120 min as compared to the 15% in cohort with no GI complication. This is in accordance with previous data [11, 13, 27, 28]. McSweeny *et al* have shown that the presence of hypotension and duration of the CPB have been implicated as the strongest predictors of an adverse GI outcome (ref). In this study, 7% of patients with GI complications had a CPB > 100 min as compared to 4% of patients with no GI complications.

Post-operative risk factors for GI complications

Post-operative factors such as need for inotropic agents, requirement of ventilation for more than 24 hours, and stroke were more common in patients with GI complications. This corresponds well with previous reports [1, 10–12]. Filsoufi *et al* has shown that age, MI, haemodynamic stability, CPB time > 120 min, PVD, renal and hepatic failure as the independent predictors of the GI complications. Aithoussa *et al* suggested that severe infection is a risk factor for GI complication in univariate analysis but not multivariate analysis [29]. Septicaemia, pneumonia and multiorgan failure were also more prevalent in patients with GI complications in our study.

Clinical outcomes

Our study also revealed that in terms of resource utilisation perspective, patients with a GI complication had a longer stay in ICU and hospital as compared to those without a GI complication. McSweeny *et al* showed that the adverse GI outcome more than doubled the mean post-surgical stay to 3.5 week and also doubled the median hospital length of stay [28]. In our study, the median length of the ICU stay was three times longer in the GI complication group when compared to those with no GI complications. Similarly, the median length of hospital stay is doubled in the GI complication group as compared to the non-GI complication group.

The strengths of this study are that data from a large number of patients collected in the recent past were analysed. The patient population is likely to be representative of the cardiac surgery population in most Australian and western cardiac surgical centres given the breath of cardiac surgery performed at this site. This study also collected data on GI complications using an established, pre-defined set of criteria ensuring consistency. This study was a retrospective review of prospectively collected data which means

any inferences are associations and not causations. In addition, while data for patients with a GI complication were cross-checked against patient case notes following data extraction, data for patients initially identified as not having a GI complication were not cross-checked which may have led to the underestimation of the percentage of GI complications in the entire cohort.

Conclusions:

GI complications following cardiac surgery are relatively uncommon but are associated with high mortality. These results provide pre-operative, intra-operative, and post-operative factors that may allow early identification of GI complications following cardiac surgery in order to facilitate pre-operative assessment and optimisation in high-risk patients, the development of a risk stratification model, and timely post-operative intervention.

Abbreviations:

GI
Gastrointestinal
APACHE
Acute Physiology and Chronic Health Evaluation
NYHA
New York Heart Association
AC
Acute Cholecystitis
RBC
Red blood cell
FFP
Fresh Frozen plasma

Declarations:

Ethical approval and consent to participate:

This study forms an audit of clinical practice which meets all of the criteria for a Quality Assurance and Evaluation Activity and as such consent was not sought from participants. The study was performed in accordance with the National Health and Medical Research Council National Statement on Ethical conduct in Human Research. The ethics committee of the Central Adelaide Local Health network (Ref no 14927) approved informed consent waiver.

Consent for publication:

Not applicable

Availability of data and materials:

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request. Data sharing requests will be considered 3 years after publication of the primary trial data on an individual basis by the trial committee (the data custodians).

Data sharing will only be considered for investigator-initiated, independent researchers who provide a written data evaluation proposal that is judged to be methodologically sound.

A data sharing agreement will be required to detail conditions under which data is shared and used. Resulting publications will require submission to the corresponding author at least 30 days prior to submission for disclosure or publication for review and comment and should appropriately cite and acknowledge the original data custodians.

Competing interests:

Not applicable

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Author Contributions:

NY, MW and KS planned and designed the study.

NY did the data collection and prepared the main manuscript.

NY and LC prepared the figures and tables

NY and BR did the statistics.

SC helped in obtaining ethics/governance approval.

All the authors reviewed the manuscript.

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Figures

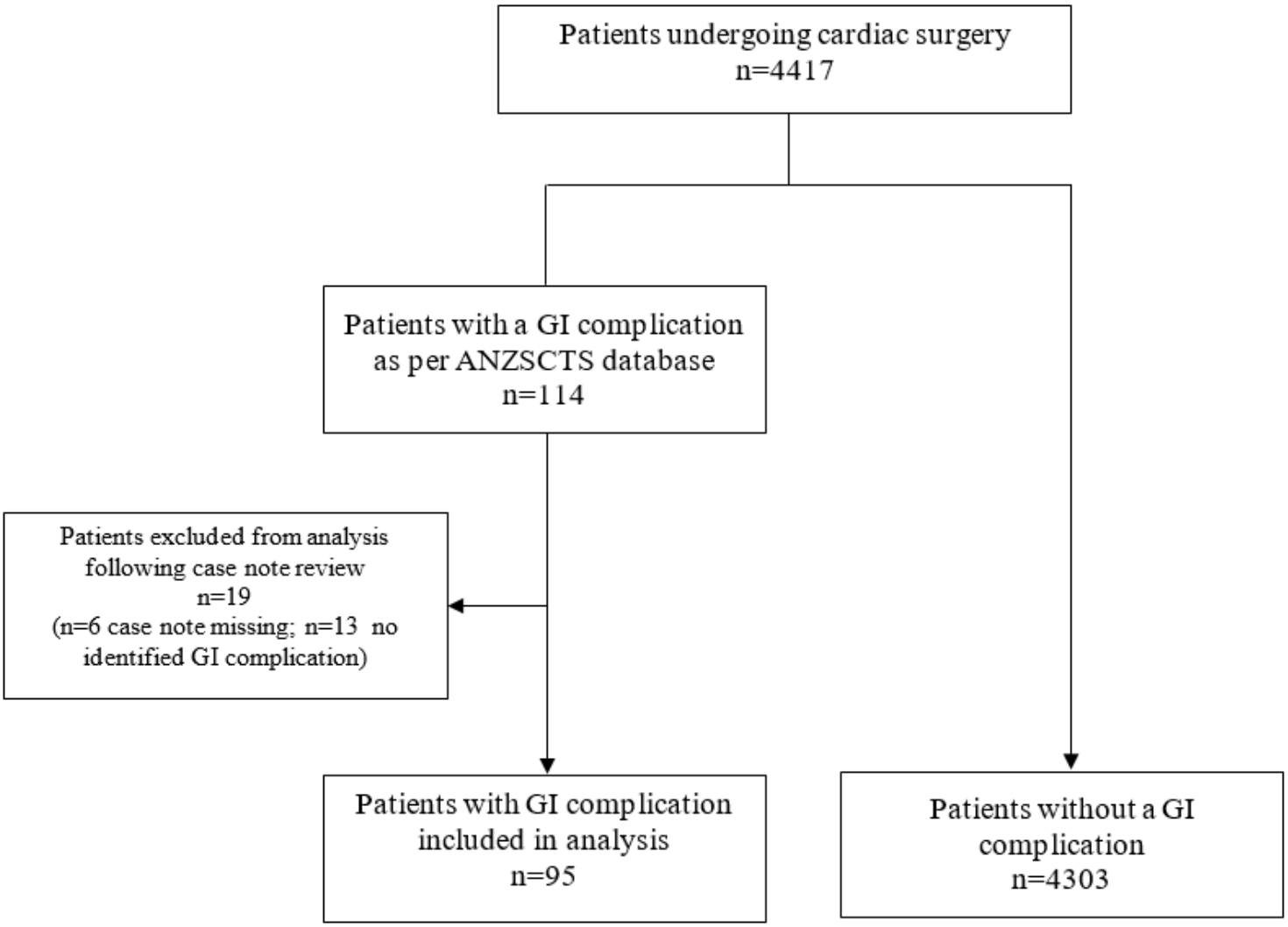

Figure 1

CONSORT diagram of patients with GI complications following cardiac surgery patients