The “weekday effect” – does it impact esophageal cancer surgery outcomes?

Sabita Jiwnani (✉ sabitajiwnani@gmail.com)
Tata Memorial Hospital
CS Pramesh
Tata Memorial Hospital
Priya Ranganathan
Tata Memorial Hospital

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Abstract

Background: Increased 30-day mortality rates have been reported in patients undergoing elective surgery later compared with earlier in the week. However, these reports have been conflicting for esophageal surgery. We conducted a study to assess the differences in outcomes of patients undergoing surgery for esophageal cancer earlier in the week (Tuesday) versus later (Friday).

Methods: This retrospective analysis of a prospectively maintained database included patients with esophageal cancer who underwent esophageal resection in a tertiary cancer centre between 1st January 2005 and 31st December 2017. We compared patients operated on Tuesdays versus Fridays. The primary outcome was a composite of major morbidity (defined as Clavien-Dindo grade 3 or more) and/or mortality. Secondary outcomes included duration of post-operative ventilation, and length of ICU and hospital stay.

Results: Among 1300 patients included, 733 were operated on Tuesday and 567 on Friday. Patient and surgery characteristics were similar in the two groups. The primary outcome (composite of major morbidity and mortality) was 23.6% in the Tuesday group versus 26.3% in the Friday group. Mortality was similar in the two groups (6.0%). Multivariable logistic regression analysis showed that the day of surgery was not a predictor of major morbidity or mortality.

Conclusions: In patients undergoing esophagectomy at tertiary care high volume cancer centre, there was no difference in major morbidity and mortality whether the surgery was performed early in the week(Tuesday) or closer to the weekend(Friday).

Background

Esophageal cancer is one of the common cancers worldwide, as well as in India. It is also a leading cause of cancer related mortality [1, 2]. Although a multimodality approach has become the standard of care for the past few decades, surgery is still the mainstay of treatment for localised and loco-regionally advanced esophageal cancer wherever feasible. [3, 4, 5] Surgery for esophageal cancer is complex, extensive and is associated with a learning curve [6]. Morbidity and mortality are more frequent after esophagectomy than most other oncological operations, and have been shown to be associated with hospital as well as surgeon volume [7]. The immediate post-operative period after esophagectomy is considered crucial and an important determinant of post-operative outcomes as well as prognosis [8].

A meta-analysis of approximately 100 studies [9] evaluated outcomes of patients hospitalised during the weekend, and found that they had significantly higher mortality – the so called “weekend effect”. This effect has also been studied in elective as well emergency surgeries [10–12]. As an extension to the weekend effect, several studies, including a meta-analysis of cohort studies looking at outcomes after both elective and emergent surgery, have shown increased post-operative mortality after elective surgery performed during the week but closer to the weekend, termed the ‘weekday effect”. [13, 14] The mechanisms suggested are surgeon and surgery team fatigue as the week progresses, along with

shortage of staff, access to imaging and other investigations. Most of these studies have been retrospective audits [14], whereas some were large nationwide [15] and international cohorts [16].

Large studies [17–19] have shown conflicting results of the impact of esophagectomy performed earlier in the week compared to that performed later in the week. Lagergren and colleagues evaluated 1748 patients undergoing esophagectomy from 1987 to 2010 with follow up till 2014 and found that there was no association between weekday of surgery (Monday or Tuesday versus Wednesday to Friday) and reoperation or mortality within 30 days of surgery. [17] However, they found a 13% increase on all cause 5-year mortality when surgery was performed later in the week compared to Monday and Tuesday. [18] Another study analysed the Netherlands Cancer Registry Database from 2005–2013 and did not find any impact of weekday on 30-day mortality, the total number of resected lymph nodes, R0 resection rates and overall long-term survival. [19]

The aim of our study was to assess the difference in the outcomes of patients undergoing esophagectomy on Tuesday versus Friday at a large volume tertiary cancer centre. We hypothesised that major morbidity and mortality would be higher in patients undergoing esophagectomy later in the week, as compared to those operated earlier in the week.

The primary objective of the study was to compare groups with respect to a composite outcome of major morbidity (as assessed by Clavien-Dindo grade 3 or more) and in-hospital mortality while the secondary objectives included comparison of post-operative length of ICU and hospital stay between the groups.

Methods

We performed a retrospective analysis of a prospectively maintained database of patients who underwent esophagectomy between1st January 2005 and 31st December 2017 in a large tertiary cancer centre. Approval was obtained from the institutional ethics committee along with a waiver of consent. We included patients who underwent esophageal resection with curative intent (both upfront and after neo-adjuvant therapy), on Tuesdays and Fridays during this period. We excluded patients who were found to have unresectable tumours and those operated on Tuesdays where the following Wednesday was a public holiday.

From the database, we extracted data on

1. Patient characteristics (age, sex, pre-operative ASA status, pre-chemotherapy, extent of disease (TNM stage), neo-adjuvant therapy received
2. Surgery characteristics: Type and approach of surgery, surgeon grade (trainee/ consultant), duration of surgery, intra-operative blood loss
3. Outcomes: The primary outcome was a composite of major morbidity (defined as Clavien-Dindo grade 3 or more) and/or mortality. Secondary outcomes included duration of post-operative ventilation, and length of ICU and hospital stay.

Data was entered into a statistical software (SPSS 20.0) for analysis. We compared outcomes between the two groups using the chi-square test for categorical variables, and the unpaired t-test or Mann Whitney test for continuous variables. A multivariable logistic regression model was used to study the association between day of surgery and primary outcome, adjusted for age, gender, ASA grade, neoadjuvant treatment, type of surgery, and extent of lymphadenectomy.

Results

Between 1st Jan 2005 and 31st Dec 2017, a total of 2269 cases of esophagectomy were performed, with the main thoracic surgical operative days being Tuesday, Thursday, and Friday. Of these, we excluded 801 cases operated on other days (not Tuesday / Friday) and 39 cases operated on Tuesdays which were followed by holidays on Wednesday.

Therefore, 1429 cases operated on Tuesday and Friday were eligible for inclusion. Of these,

118 were inoperable and 11 had missing details. 1300 were available for analysis with 733 surgeries performed on Tuesday (56%) and 567 on Friday (44%) as summarized in the Figure 1.

The mean age and sex ratio of the patients was similar in both groups. The groups were well matched with respect to pre-operative clinic-radiological stage, ASA physical status classification and neoadjuvant treatment as seen in Table 1.

Table 1: Patient, tumour and surgery characteristics		
	Tuesday (n=733)	**Friday (n=567)**
Age in years	54.3 (10.5)	54.6 (10.3)
Gender		
Men	488 (67%)	379 (67%)
Women	245 (33%)	188 (33%)
Pre-chemo tumour stage		
IIa	172 (24%)	121 (21%)
III	525 (72%)	425 (75%)
Others	36 (4%)	21 (4%)
Neoadjuvant treatment received	573 (78%)	415 (73%)
ASA grade		
I	486 (66%)	398 (70%)
II	240 (33%)	159 (28%)
III	5 (1%)	9 (2%)
Type of surgery		
Trans-thoracic esophagectomy	579 (79%)	463 (81%)
Open	385 (66%)	291 (63%)
Minimally invasive	194 (34%)	172 (37%)
Trans-hiatal esophagectomy	111 (15%)	77 (14%)
Others	43 (6%)	27 (5%)
Grade of operating surgeon		
Consultant	408 (56%)	303 (53%)
Senior resident / fellow	262 (36%)	217 (38%)
Others	63 (8%)	47 (9%)
Operative time in hours*	5 (IQR 4.2 to 6.0)	5.2 (IQR 4.3 to 6.0)
Blood loss in ml*	500 (IQR 350 to 750)	500 (331 to 750)

(Data is expressed as absolute numbers with percentages in parentheses for categorical data and mean with standard deviation in parentheses for numerical data. * indicates skewed data for which medians and interquartile ranges (IQR) have been reported)

No major differences were seen in the operative characteristics such as surgical approach, grade of the operating surgeon, operative time and blood loss. Most of the patients (approximately 80% in both groups) underwent transthoracic esophagectomy.

There was no difference between the two groups in the primary composite outcome or any of the secondary outcomes (Table 1) of major morbidity Amongst patients undergoing surgery on Tuesday, 172 patients (23.6%) experienced the primary composite endpoint of major complications or mortality compared to 149 patients (26.3%) undergoing surgery on Friday. Overall mortality was 6% in both groups. The length of post-operative ventilator support, length of ICU and hospital stay were similar in the two groups as seen in table 2.

Table 2: Outcomes after surgery

	Tuesday (n=733)	Friday (n=567)	Difference with 95% CI	p value
Primary outcome (Composite of major morbidity and/or death)	173 (23.6%)	149 (26.3%)	2.7 (-2.0 to 7.5%)	0.26
Mortality (in-hospital or 30 day, whichever earlier)	44 (6%)	34 (6%)	0 (-2.6 to 2.7%)	1.00
ICU stay in days*	1 (IQR 0 to 2)	1 (IQR 0 to 3)	-	0.31
Hospital stay in days*	12 (IQR 10 to 18)	12 (IQR 9 to 19)	-	0.38
Post-operative ventilation	22 (3.0%)	16 (2.8%)	0.2% (-1.8 to 2.0%)	0.83
Ventilator days*	0 (0; 0.5)	0 (0; 0.5)	-	0.81

(Data is expressed as absolute numbers with percentages in parentheses for categorical data and mean with standard deviation in parentheses for numerical data. * Indicates skewed data for which medians and interquartile ranges (IQR) have been reported)

On multivariate regression analysis, age, neoadjuvant treatment and transthoracic approach were independent predictors of post-operative major morbidity and/ or death but day of surgery, extent of lymphadenectomy, ASA grade did not show any association (Table 3).

Table 3: Predictors of major morbidity and/or mortality

Variable	Odds ratio	95% CI	p value
Age in years	1.02	1.01; 1.04	0.004
Neoadjuvant treatment	1.51	1.09; 2.09	0.014
Trans-thoracic approach	2.56	1.07; 6.14	0.036

Discussion

In our study, 24.8% (322 out of 1300) patients undergoing planned esophagectomy for cancer at a high-volume tertiary care cancer centre had major morbidity and/or mortality, with no difference in outcomes regardless of whether the surgery was performed early in the week or closer to the weekend. Similarly, there were no differences in any of the other outcomes studied including ICU and hospital stay.

Esophagectomy is the only curative treatment for operable esophageal cancer but is associated with significant morbidity and mortality [20–22] with an estimated 50 to 60% percent of esophagectomy patients developing a complication, and 30 and 90-day mortality rates ranging widely between 2% and 23% [23]. In surgical specialties, it has been hypothesized that procedures performed on the weekend have higher complication rates than those performed on weekdays [24]. A large part of this data comes from emergency surgeries and retrospective studies with ambivalent results [25–29].

Globally, elective surgeries are rarely performed on the weekend. However, patients operated for elective procedures at the end of the week are likely to need most of their immediate post-operative care over the weekend when resources are possibly strained. Inadequate staffing may not only be quantitative, but also qualitative, in terms of more senior and experienced medical staff being on leave during the weekend. There may be a lower nursing to patient ratio on weekends, with fewer nurses and adjunct technical staff in high intensity care areas. [14] Also, general practitioners and referring physicians may tend to refer the sick and elderly patients to a hospital setting closer to the weekend rather than caring for them in the community setting. [31] Therefore, it has been hypothesized that because of this ‘weekday effect’, patients undergoing elective surgeries towards the end of the week are likely to fare worse than those operated early in the week. [24]

But the evidence pointing towards this effect is unclear. [9, 14] Aylin et al in the UK, investigated 27,582 deaths (within 30 days) after 4,133,346 inpatient admissions for elective operating room procedures; overall crude mortality rate was 6.7 per 1000). The adjusted odds of death were 44% and 82% higher, respectively, if the procedures were carried out on a Friday (OR = 1.44, 95% CI 1.39–1.50) or a weekend (OR = 1.82, 95% CI 1.71–1.94) compared with a Monday [14]. Dubois et al [9] retrospectively evaluated 402, 899 Canadian elective surgeries performed over a period of 10 years (2002–2012) and found that although less experienced surgeons operated closer to Friday, there was no difference in 30-day mortality irrespective of the day of the week when the surgery was performed.

Cancer surgeries are major procedures with patients needing intensive care in the post-operative period and therefore, are likely to be maximally impacted by the weekday effect, if it exists. Njjolstad [32] found that surgical treatment of endometrial cancers later in the week was associated with worse outcomes. In contrast, Huijts [33] and Frostberg [34] found no evidence of weekday effect in patients undergoing elective surgery for colon or rectal cancer. Similarly, Visser [35] found no difference in immediate or long-term outcomes after gastrectomy done earlier versus later in the week. Their only significant finding was that lymph node yield was significantly lower, later in the week.

Very few previous studies [17–19] have looked at the impact of day of surgery on outcome after esophagectomy. In an analysis of a large retrospective database of patients who underwent esophagectomy, Visser and colleagues [19] found no difference in post-operative complications, lymph node yield or overall survival between patients operated on different weekdays. A paper by Lagergren showed that long-term outcomes were worse for esophagectomy patients operated later in the week than earlier; this association was strongest for patients with early-stage disease and absent for those with advanced disease. [18] However, another paper by the same group showed that day of week did not influence post-operative complications or 30-day mortality. [17]

There are several limitations with the available data on the weekday effect in general. First, there are no randomized trials evaluating the effect of weekday or weekend on short or long-term hospital outcomes; however, we feel that a randomized trial is highly unlikely. All the available data consists of analyses of large observational datasets, with their inherent biases despite statistical adjustments for known confounders.

Second, many of the studies which have demonstrated the presence of a weekend or weekday effect suffer from the problem of multiple comparisons increasing the likelihood of spurious association. [36] Third, in many of the studies, there is the possibility of inaccurate coding of diagnoses at admission. In a review examining the weekend effect in patients with stroke, Li and colleagues [37] showed that the finding of a weekend effect was seen in studies that used only administrative coding. In contrast, no weekend effect was observed in studies where clinical adjudication of stroke diagnosis was used. Finally, the findings in many of the studies have no scientific basis. For example, patients with advanced esophageal cancer are likely to have more complex surgery with a higher probability of complications. Contrary to the findings in Lagergren's study, such patients should be more affected more by the weekday effect than those with early disease.

A systematic review [38] showed that at weekends, patients who are admitted to hospital are more severely ill with differences in care pathways before and after admission. [30] This is more likely to reflect in semi-urgent and emergency indications for hospital admission. This could provide a possible explanation for the absence of the weekday effect in our study because we focused on a site-specific elective surgery where all procedures were performed at a high-volume oncology center by a small group of trained surgeons and standard well-established protocols were followed peri-operatively, irrespective of day of week.

Our study has several strengths –this was a prospectively maintained database with all the coding performed by a clinician and not by administrative staff. The database was analyzed retrospectively; therefore, the person performing the coding was not aware of the study hypothesis, thus minimizing bias. To avoid problems with multiple comparisons, we used a limited number of endpoints. To the best of our knowledge, this is the first large series to study the weekday effect in esophageal cancer surgery outside the Netherlands. Except for the fact that our study was not a randomized trial (which may be challenging to conduct), it is a robust study that adds to the limited data on the weekday effect in esophagectomy.

Conclusion

In summary, the findings of our study show no association between day of surgery and post-operative outcomes in patients undergoing esophagectomy at a high-volume tertiary care cancer center and prove that major surgery is safe and feasible throughout the week.

Declarations

Author contributions statement:

SJ and PR contributed to the study design and IEC submission.

SJ, PR and CSP contributed to the data collection.

PR did the statistical analysis.

SJ and PR prepared the initial manuscript.

CSP provided administrative support and refined the manuscript.

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References

1. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2018 Nov;68(6):394–424.-
2. Wong MCS, Hamilton W, Whiteman DC, Jiang JY, Qiao Y, Fung FDH, Wang HHX, Chiu PWY, Ng EKW, Wu JCY, Yu J, Chan FKL, Sung JJY. Global Incidence and mortality of oesophageal cancer and their correlation with socioeconomic indicators temporal patterns and trends in 41 countries. Sci Rep. 2018 Mar 14;8(1):4522.
3. Omloo JM, Lagarde SM, Hulscher JB, Reitsma JB, Fockens P, van Dekken H, Ten Kate FJ, Obertop H, Tilanus HW, van Lanschot JJ. Extended transthoracic resection compared with limited transhiatal resection for adenocarcinoma of the mid/distal esophagus: five-year survival of a randomized clinical trial. Ann Surg. 2007 Dec;246(6):992–1000; discussion 1000-1.
4. van Hagen P, Hulshof MC, van Lanschot JJ, Steyerberg EW, van Berge Henegouwen MI, Wijnhoven BP, Richel DJ, Nieuwenhuijzen GA, Hospers GA, Bonenkamp JJ, Cuesta MA, Blaisse RJ, Busch OR, ten

Kate FJ, Creemers GJ, Punt CJ, Plukker JT, Verheul HM, Spillenaar Bilgen EJ, van Dekken H, van der Sangen MJ, Rozema T, Biermann K, Beukema JC, Piet AH, van Rij CM, Reinders JG, Tilanus HW, van der Gaast A; CROSS Group. Preoperative chemoradiotherapy for esophageal or junctional cancer. N Engl J Med. 2012 May 31;366(22):2074-84.

5. Al-Batran SE, Homann N, Pauligk C, Goetze TO, Meiler J, Kasper S, Kopp HG, Mayer F, Haag GM, Luley K, Lindig U, Schmiegel W, Pohl M, Stoehlmacher J, Folprecht G, Probst S, Prasnikar N, Fischbach W, Mahlberg R, Trojan J, Koenigsmann M, Martens UM, Thuss-Patience P, Egger M, Block A, Heinemann V, Illerhaus G, Moehler M, Schenk M, Kullmann F, Behringer DM, Heike M, Pink D, Teschendorf C, Löhr C, Bernhard H, Schuch G, Rethwisch V, von Weikersthal LF, Hartmann JT, Kneba M, Daum S, Schulmann K, Weniger J, Belle S, Gaiser T, Oduncu FS, Güntner M, Hozaeel W, Reichart A, Jäger E, Kraus T, Mönig S, Bechstein WO, Schuler M, Schmalenberg H, Hofheinz RD; FLOT4-AIO Investigators. Perioperative chemotherapy with fluorouracil plus leucovorin, oxaliplatin, and docetaxel versus fluorouracil or capecitabine plus cisplatin and epirubicin for locally advanced, resectable gastric or gastrooesophageal junction adenocarcinoma (FLOT4): a randomised, phase 2/3 trial. Lancet. 2019 May 11;393(10184):1948–1957.
6. Gisbertz SS, Hagens ERC, Ruurda JP, Schneider PM, Tan LJ, Domrachev SA, Hoeppner J, van Berge Henegouwen MI. The evolution of surgical approach for esophageal cancer. Ann N Y Acad Sci. 2018 Dec;1434(1):149–155.
7. Markar SR, Lagergren J. Surgical and Surgeon-Related Factors Related to Long-Term Survival in Esophageal Cancer: A Review. Ann Surg Oncol. 2020 Mar;27(3):718–723.
8. Ashok A, Niyogi D, Ranganathan P, Tandon S, Bhaskar M, Karimundackal G, Jiwnani S, Shetmahajan M, Pramesh CS. The enhanced recovery after surgery (ERAS) protocol to promote recovery following esophageal cancer resection. Surg Today. 2020 Apr;50(4):323–334.
9. Pauls LA, Johnson-Paben R, McGready J, Murphy JD, Pronovost PJ, Wu CL. The Weekend Effect in Hospitalized Patients: A Meta-Analysis. J Hosp Med. 2017 Sep;12(9):760–766.
10. Aylin P, Yunus A, Bottle A, Majeed A, Bell D. Weekend mortality for emergency admissions. A large, multicentre study. Qual Saf Health Care. 2010 Jun;19(3):213–7.
11. Dorn SD, Shah ND, Berg BP, Naessens JM. Effect of weekend hospital admission on gastrointestinal hemorrhage outcomes. Dig Dis Sci. 2010;55(6):1658–1666.
12. Kim YY, Gauvreau K, Bacha EA, Landzberg MJ, Benavidez OJ. Resource use among adult congenital heart surgery admissions in pediatric hospitals: risk factors for high resource utilization and association with inpatient death. Circ Cardiovasc Qual Outcomes. 2011 Nov 1;4(6):634-9.
13. Dubois L, Vogt K, Vinden C, Winick-Ng J, McClure JA, Roshanov PS, Bell CM, Garg AX; Surgical Investigators Group at ICES Western. Association between day of the week of elective surgery andpostoperative mortality. CMAJ. 2017 Feb27;189(8):E303- E309.
14. Ruiz M, Bottle A, Aylin PP. Exploring the impact of consultants' experience on hospital mortality by day of the week: a retrospective analysis of hospital episode statistics. BMJ Qual Saf. 2016 May;25(5):337–44.

15. Aylin P, Alexandrescu R, Jen MH, Mayer EK, Bottle A. Day of week of procedure and 30-day mortality for elective surgery: retrospective analysis of hospital episode statistics. BMJ. 2013 May 28;346: f2424.
16. Ruiz M, Bottle A, Aylin PP. The Global Comparators project: international comparison of 30-day in-hospital mortality by day of the week. BMJ Quality & Safety 2015;24:492–504.
17. Lagergren J, Mattsson F, Lagergren P. Weekday of oesophageal cancer surgery in relation to early postoperative outcomes in a nationwide Swedish cohort study. BMJ Open. 2016 May 31;6(5):e011097
18. Lagergren J, Mattsson F, Lagergren P. Weekday of Esophageal Cancer Surgery and its Relation to Prognosis. Ann Surg. 2016 Jun;263(6):1133 – 7.19.
19. Visser E, van Rossum PSN, Verhoeven RHA, Ruurda JP, van Hillegersberg R. Impact of Weekday of Esophagectomy on Short-term and Long-term Oncological Outcomes: A Nationwide Population-based Cohort Study in the Netherlands. Ann Surg. 2017 Jul;266(1):76–81.
20. Yoshida N, Baba Y, Watanabe M, Ida S, Ishimoto T, Karashima R, Iwagami S, Imamura Y, Sakamoto Y, Miyamoto Y, Baba H. Original scoring system for predicting postoperative morbidity after esophagectomy for esophageal cancer. Surg Today. 2015;45:346–354.
21. Jiang R, Liu Y, Ward KC, Force SD, Pickens A, Sancheti MS, Javidfar J, Fernandez FG, Khullar OV. Excess Cost and Predictive Factors of Esophagectomy Complications in the SEER-Medicare Database. Ann Thorac Surg. 2018;106:1484–1491
22. Low DE, Kuppusamy MK, Alderson D, Cecconello I, Chang AC, Darling G, Davies A, D'Journo XB, Gisbertz SS, Griffin SM, Hardwick R, Hoelscher A, Hofstetter W, Jobe B, Kitagawa Y, Law S, Mariette C, Maynard N, Morse CR, Nafteux P, Pera M, Pramesh CS, Puig S, Reynolds JV, Schroeder W, Smithers M, Wijnhoven BPL. Benchmarking Complications Associated with Esophagectomy. Ann Surg. 2019;269:291–298.
23. Hodari A, Hammoud ZT, Borgi JF, Tsiouris A, Rubinfeld IS. Assessment of morbidity and mortality after esophagectomy using a modified frailty index. Ann Thorac Surg. 2013 Oct;96(4):1240–1245.
24. Smith SA, Yamamoto JM, Roberts DJ, Tang KL, Ronksley PE, Dixon E, Buie WD, James MT. Weekend Surgical Care and Postoperative Mortality: A Systematic Review and Meta-Analysis of Cohort Studies. Med Care. 2018 Feb;56(2):121–129.
25. Zapf MA, Kothari AN, Markossian T, Gupta GN, Blackwell RH, Wai PY, Weber CE, Driver J, Kuo PC. The "weekend effect" in urgent general operative procedures. Surgery. 2015 Aug;158(2):508–14.
26. Goldstein SD, Papandria DJ, Aboagye J, Salazar JH, Van Arendonk K, Al-Omar K, Ortega G, Sacco Casamassima MG, Abdullah F. The "weekend effect" in pediatricsurgery – increased mortality for children undergoing urgent surgery during the weekend. J Pediatr Surg. 2014 Jul;49(7):1087–91.
27. Ricciardi R, Nelson J, Francone TD, Roberts PL, Read TE, Hall JF, Schoetz DJ, Marcello PW. Do patient safety indicators explain increased weekend mortality? J Surg Res. 2016 Jan;200(1):164–70.
28. Smith SA, Yamamoto JM, Roberts DJ, et al. Weekend Surgical Care and Postoperative Mortality: A Systematic Review and Meta-Analysis of Cohort Studies. Med Care. 2018;56(2):121–129.

29. Worni M, Østbye T, Gandhi M, Rajgor D, Shah J, Shah A, Pietrobon R, Jacobs DO, Guller U. Laparoscopic appendectomy outcomes on the weekend and during the week are no different: a national study of 151,774 patients. World J Surg. 2012 Jul;36(7):1527–33.
30. Flynn P. Should the NHS work at weekends as it does in the week? No. BMJ. 2013 Feb 20;346:f622.
31. Glance LG, Osler T, Li Y, Lustik SJ, Eaton MP, Dutton RP, Dick AW. Outcomes are Worse in US Patients Undergoing Surgery on Weekends Compared With Weekdays. Med Care. 2016 Jun;54(6):608
32. Njølstad TS, Werner HM, Marcickiewicz J, Tingulstad S, Staff AC, Oddenes K, Bjørge L, Engh ME, Woie K, Tjugum J, Lode MS, Amant F, Salvesen HB, Trovik J. Late-week surgical treatment of endometrial cancer is associated with worse long-term outcome: Results from a prospective, multicenter study. PLoS One. 2017 Aug 3;12(8):e0182223.
33. Huijts DD, Guicherit OR, Dekker JWT, van Groningen JT, van Bodegom-Vos L, Bastiaannet E, Govaert JA, Wouters MW, Marang-van de Mheen PJ. Do Outcomes in Elective Colon and Rectal Cancer Surgery Differ by Weekday? An Observational Study Using Data From the Dutch ColoRectal Audit. J Natl ComprCancNetw. 2019Jul 1;17(7):821–828.
34. Frostberg E, Christensen RD, Rahr HB. The day of week of elective colorectal cancer surgery has no impact on mortality and morbidity. Dan Med J. 2019 Jul;66(7):A5550.
35. Visser E, Brenkman HJF, Verhoeven RHA, Ruurda JP, van Hillegersberg R. Weekday of gastrectomy for cancer in relation to mortality and oncological outcomes - A Dutch population-based cohort study. Eur J Surg Oncol. 2017 Oct;43(10):1862–1868.
36. Austin PC, Mamdani MM, Juurlink DN, Hux JE. Testing multiple statistical hypotheses resulted in spurious associations: a study of astrological signs andhealth. J Clin Epidemiol. 2006 Sep;59(9):964–9.
37. Li L, Rothwell PM; Oxford Vascular Study. Biases in detection of apparent "weekend effect" on outcome with administrative coding data: population based study of stroke. BMJ. 2016 May 16;353:i2648.
38. Chen Y, Armoiry X, Higenbottam C, Cowley N, Basra R, Watson SI, Tarrant C, Boyal A, Sutton E, Wu CW, Aldridge CP, Gosling A, Lilford R, Bion J. Magnitude and modifiers of the weekend effect in hospital admissions: a systematic review and meta-analysis. BMJ Open 2019;9:e025764.

Figures

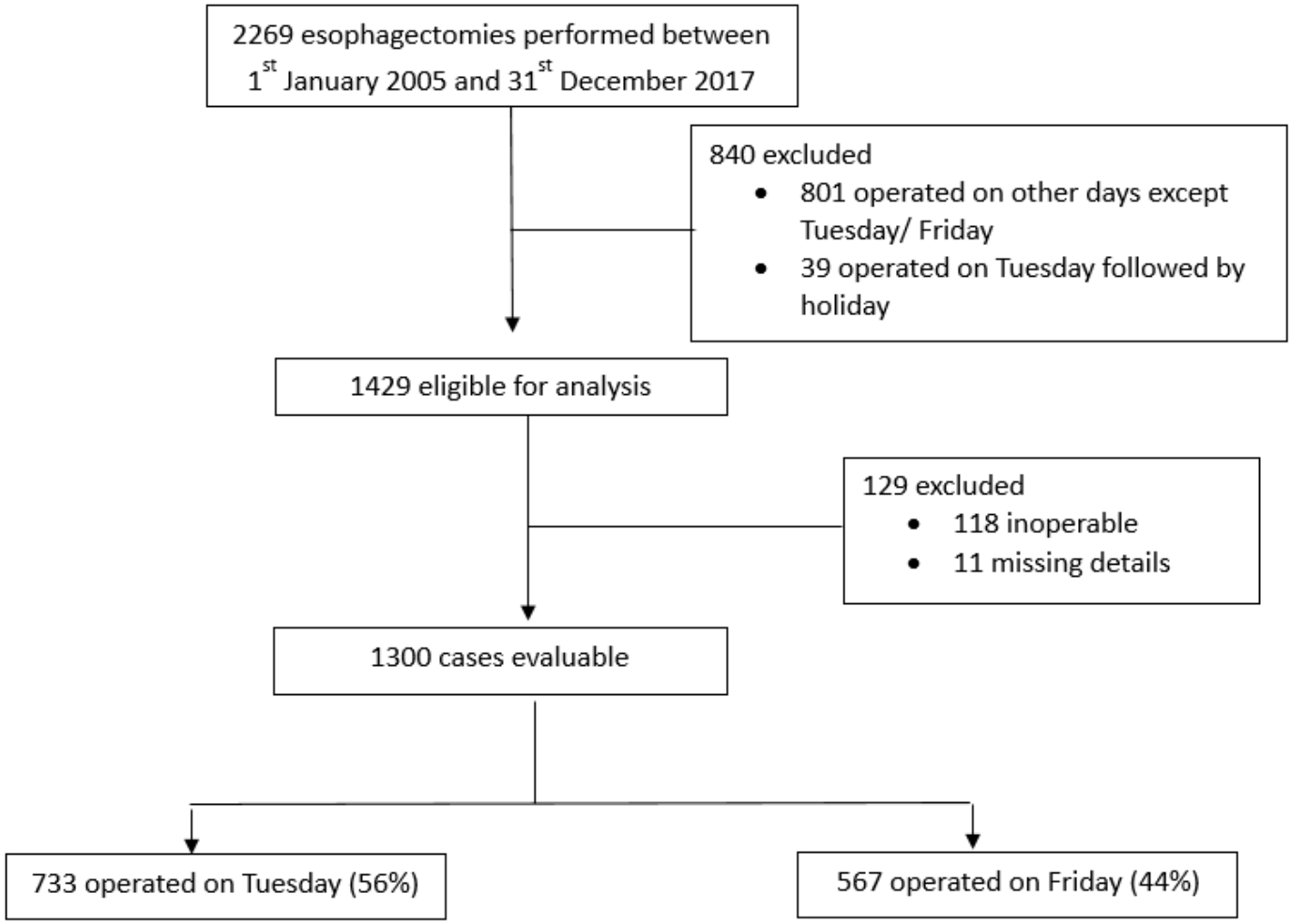

Figure 1

CONSORT flowchart