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Timing of surgical site infection and pulmonary complications after laparotomy

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TIMING OF SURGICAL SITE INFECTION AND PULMONARY COMPLICATIONS AFTER LAPAROTOMY

Running title

TIMING OF POSTOPERATIVE COMPLICATIONS

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Ethical approval

The Danish Medicines Agency and the regional Ethics Committee approved the trial, which adhered to the International Conference on Harmonisation Good Clinical Practice standards.

Trial registration number

Clinicaltrials.gov Identifier: NCT00364741

Conflict of interest statement

Christian. S. Meyhoff: Head of Research at Department of Anaesthesiology and Intensive Care Medicine, Bispebjerg and Frederiksberg Hospital. The department directly and indirectly receives research funding from Ferring Pharmaceuticals, Merck Sharp & Dohme Corp., and Boehringer Ingelheim.

Other authors' conflict of interest: none

Keywords

Surgical site infection

Pulmonary complications

Laparotomy

Surgery

Diagnosis

Highlights

- Surgical site infection (SSI) or pulmonary complications occurred in 24% of patients undergoing laparotomy.
- Median times from surgery to diagnosis of SSI or a pulmonary complication were 10 and 4 days, respectively
- Perioperative hyperoxia did not affect when postoperative complications were diagnosed.

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Abstract

Background: Surgical site infection (SSI) and other postoperative complications are associated with high costs, morbidity, secondary surgery, and mortality. Many studies have identified factors that may prevent SSI and pulmonary complications, but it is important to know when they in fact occur. The aim of this study was to investigate the diagnostic timing of surgical site infections and pulmonary complications after laparotomy.

Material and Methods: This is a secondary analysis of the PROXI trial which was a randomized clinical trial conducted in 1,400 patients undergoing elective or emergent laparotomy. Patients were randomly allocated to either 80% or 30% perioperative inspiratory oxygen fraction.

Results: SSI or pulmonary complications were diagnosed in 24.2% (95% CI: 22.0% - 26.5%) of the patients at a median of 9 days [IQR: 5-15] after surgery. Most common was surgical site infection (19.6%); median time 10 days after surgery [IQR: 7-18]. The corresponding figures for anastomotic leakage was 5.7%, 8 days [IQR: 6-10]; pneumonia 3.5%, 5 days [IQR: 3-9]; and respiratory failure 2.3%, 3 days [IQR: 1-8]. The oxygen allocation was not significantly related to time of diagnosis for postoperative surgical site infections or pulmonary complications.

Conclusion: A high percentage of patients undergoing laparotomy develop a postoperative complication. This study adds new knowledge by identifying time intervals within which medical professionals should be aware of surgical site infections and pulmonary complications in order to initiate appropriate treatment of the patients.

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1. Introduction

A number of complications may occur after abdominal surgery [1]. Among the most serious complications are surgical site infection (SSI) including anastomotic leakage, pneumonia, and respiratory failure, which are associated with increased hospital stay [2–4], morbidity, mortality [3–6], and costs for health care systems [2]. Moreover, SSI often require secondary surgery [3–5,7]. Early diagnosis and treatment of these conditions are therefore of great importance to reduce the clinical consequences of SSI and pulmonary complications.

Previous studies have focused on identification of pre- [8–12] and intraoperative [13–15] risk factors related to postoperative complications, but it has only been scarcely described when the SSI and pulmonary complications actually are occurs and are diagnosed [12,16]. The PROXI trial [15] investigated if an inspiratory oxygen fraction (FiO_2) of 0.80 as compared to 0.30 could prevent SSI, defined accordingly to Center for Disease Control and Prevention (CDC) criteria. The trial found no significant difference, but it has not yet been investigated if oxygen administration is related to the timing of SSI.

Recently, 80% oxygen was recommended by the WHO to prevent SSI [17]. If FiO_2 in fact has a role in reducing SSI, this may be detected in the time to development of SSI. Information about timing of surgical site infection and pulmonary complications after surgery would therefore not only inform clinicians about the most important period to be aware of these complications, it also has the potential to validate important international guidelines.

The primary aim of this new post hoc analysis of the PROXI trial was to assess the time to development of SSI, anastomotic leakage, pneumonia, and respiratory failure. The secondary aims were to describe the influence of 80% versus 30% oxygen on time to postoperative SSI and pulmonary complications, and to evaluate the time from diagnosis of SSI to a secondary surgical intervention.

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2. Material and methods

This study used existing data from the PROXI trial [15], a blinded multicentre randomized trial conducted in 14 Danish hospitals between October 8, 2006, and October 6, 2008. Written informed consent was obtained from all patients prior to inclusion. Inclusion criteria were elective or emergent laparotomy and age ≥ 18 years. We excluded patients who had undergone surgery under general anaesthesia within the previous 30 days, had received chemotherapy for malignancy within the last three months, were unable to provide informed consent, or had an arterial oxygen saturation below 90% without supplemental oxygen. The patients were assessed clinically every postoperative day during their hospital admission including a follow-up visit 14 days after surgery (range: 13–30 days). Pre-, per- and postoperative data were collected, including the two risk indexes, the National Nosocomial Infection Surveillance (NNIS) index and the Study on the Efficacy of Nosocomial Infection Control (SENIC) score [15]. The PROXI trial investigated the effect of per- and postoperative FiO_2 (0.80 vs 0.30) on the frequency of SSI, including anastomotic leakage as well as the frequency of pneumonia and respiratory failure. Surgical investigators assessed patients daily on the wards and performed an office follow-up after discharge on the 13^{th} – 30^{th} postoperative day. If study patients could not meet for office follow-up, the investigators contacted them or their general practitioner per telephone, and this ensured 100% follow-up [15]. The date for diagnosing a SSI, pneumonia, or respiratory failure was registered. If the patients underwent secondary surgery because of a SSI, the date and time of this procedure were registered.

2.1. Definitions

SSI was defined according to CDC criteria [18] and categorized into superficial, deep, or organ/space infection. If a patient had a combination of superficial, deep, or organ/space infections, we reported the deepest infection, except from organ/space infections that drain through the incision, which according to CDC is a deep surgical site infection. Any occurrence of organ/space infection after a surgical procedure with a primary small bowel, colonic, or rectal anastomosis were evaluated for diagnosis of anastomotic leakage. This involved review of the medical record, laboratory data, and images by a surgical specialist that verified all cases of anastomotic leakage. Respiratory failure was defined as the need for mechanical ventilation or arterial oxygen saturation below 90% despite supplemental oxygen. Pneumonia was defined according to the CDC criteria [19]. The attending physician examined all patients with pulmonary symptoms according to the clinical guidelines [15].

2.2. Outcome

The primary analysis focused on the number of days between surgery and the diagnosis of a complication. We calculated the median time from operation to the patient was diagnosed with SSI, pneumonia, or respiratory failure. We also analysed the association between oxygen fraction and time from operation to diagnosis of complication.

2.3. Statistical Analysis

The number of patients with a complication was described and the median time with interquartile range (IQR) was calculated for time between surgery and the diagnosis of: any SSI or pulmonary complication, SSI, anastomotic leakage, pneumonia, and respiratory failure. We also examined the time between diagnosis of SSI and secondary surgical intervention.

A Cox regression analysis was performed to evaluate the time to diagnosis of postoperative SSI and time to diagnosis of pulmonary complications in the 80% and 30% oxygen groups. The analysis was adjusted for multiple predictive factors including: duration of surgery, daily smoking, and obesity (body mass index above 30 kg/m^2) in the analysis of SSI, and duration of surgery and chronic obstructive pulmonary disease (COPD) in the analysis of pneumonia. Adjustment for duration of surgery, COPD, and emergent surgery was undertaken in the analysis of respiratory failure. SPSS version 22 for Mac was used for the statistical analyses.

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3. Results

All of the 1,386 patients included in the PROXI trial were followed-up and 335 (24.2%, 95% CI 22.0-26.5%) developed at least one of the defined postoperative complications, postoperative SSI or pulmonary complications. Male sex and colorectal surgery was associated with the occurrence of postoperative complications (table 1).

The median time to diagnosis of the first complication, regardless of type, was 9 days after surgery [IQR: 5-15] (table 2). There were 272 (19.6%) patients who developed SSI. The median time from surgery to SSI was 10 days [IQR: 7-18]. Forty-eight (3.5%) patients developed pneumonia, with a median time to diagnosis of 5 days [IQR: 3-9], and 32 (2.3%) developed respiratory failure, with a median time to diagnosis of 3 days [IQR: 1-8]. There were 37 (2.7%) patients who developed pneumonia followed by respiratory failure or vice versa, the median time from surgery to complication was 4 days [IQR: 2-6] (table 2).

A total of 543 (39.2% of the 1,386 included patients) underwent a primary intestinal anastomosis. Among these 31 (5.7%) developed anastomotic leakage. The median time to diagnosis of anastomotic leakage was 8 days [IQR: 6-10]. Anastomotic leakage after small bowel resection was uncommon but diagnosed very late.

A total of 203 patients (14.6%) underwent 262 secondary surgical interventions. The median time from diagnosis of SSI (superficial, deep, and organ/space infection) to secondary surgical procedure was 1 day [IQR: 0-6].

There were no statistically significant differences between the 80% and 30% oxygen groups in time to diagnosis of the first complication (Figures 1-3 and table 3). In the 80% oxygen group, the median time was 8 days [IQR: 5-15], whereas in the 30% oxygen group, the median time was 9 days [IQR: 5-16].

4. Discussion

This new study found that at least one major infectious or respiratory complication occurred in 24% of laparotomy patients within 30 days of surgery. The median time from surgery to diagnosis of SSI was 10 days, and the time was 8 days for anastomotic leakage, 5 days for pneumonia, and 3 days for respiratory failure.

Very few studies have reported time intervals from surgical procedure to postoperative SSI and pulmonary complications, especially for SSI. In patients who underwent upper or lower gastrointestinal surgery the frequency and median time from surgery to diagnosis of SSI was 15.5% and 7.3 days [20], and 13.4% and 6.5 days, respectively [21]. Patients undergoing vascular surgery below the aortic arch had a lower frequency (5.4%) and SSI was found at a mean of 17 days postoperatively [16]. Our study showed that there was a postoperative SSI frequency of 19.6% with a median time from surgery to diagnosis of 10 days. This difference probably reflects differences in skin flora and exposure to intestinal flora [22].

A study on gastrointestinal surgery showed that 6.2% of the patient developed pneumonia and respiratory failure [23]. We found a much higher frequency of SSI (19.6%) and pulmonary complications (9.7%) in this new analysis. This emphasises that the frequency of SSI and pulmonary complications could be underestimated as it is clearly related to completeness of follow-up and applied methods for detection, as patients may be discharged before a complication is diagnosed. It is remarkable that 25% of SSI in the PROXI trial were diagnosed after 18 days as a vast majority of patients had been discharged from hospital at that time point. These data have not previously been described.

The effect of a high inspiratory oxygen fraction on SSI is under intense investigation. Some studies have found a benefit with 80% oxygen, which was also recently included in a WHO recommendation [17]. The PROXI trial and a subsequent Cochrane systematic review did, however, not detect a significant benefit in terms of a lower frequency of SSI [15,24]. Still, there may be a minor, but clinically relevant benefit but also safety concerns with 80% oxygen as regards to cardiovascular and pulmonary complications [25]. We found no differences in time to diagnosis of SSI and pulmonary complications between the two levels of oxygen fraction in the PROXI trial.

Risk assessment and prevention of postoperative SSI have been investigated in previous studies. Antibiotic prophylaxis reduce the development of postoperative SSI in contaminated surgery [26], but timing of this prophylaxis is also important. Cohort studies have now demonstrated that administration between 45 and 59-60 min prior to surgery is preferable [27]. Of the patients included in the PROXI trial, 64% received antimicrobial prophylaxis before skin incision, and 84% received antimicrobial prophylaxis that was adequate for the perioperative contamination, with no difference between the 80% and 30% oxygen groups [15].

Compared to other studies investigating SSI in patients undergoing gastrointestinal surgery, this new study presents a much larger population. Furthermore, the follow-up rate was 100%, allowing complete registration of surgical site infections and pulmonary complications. The patients were assessed daily by investigators for the first 14 follow-up days, but it must be acknowledged that postoperative SSI and pulmonary complications still could have been overlooked, especially in the late phase after discharge from hospital. A later diagnosis is more likely in discharged patients who may have waited one or more days to see their general practitioner.

4.1. Perspective

This new analysis of the PROXI trial data and the above studies show that a high number of patients develop postoperative SSI and pulmonary complications after laparotomy, and that there are both pre- and perioperative factors that can influence the rate of postoperative SSI and pulmonary complications.

5. Conclusion

One in four patient undergoing laparotomy developed a postoperative complication, and the median time from surgery to diagnosis of any SSI or pulmonary complication was 9 days. Almost one out of six patients underwent secondary surgery, and this occurred primarily on the day after diagnosis of a SSI. Medical professionals on surgical wards and departments should be aware of when the most common SSI and pulmonary complications occur, so early diagnosis is performed and initial treatment is started as early as possible. Furthermore, with this new data medical professionals could in cooperation with general practitioners make a follow-up plan to ensure that the patients complications is discovered and even prevented,

Tables 1: Baseline data for 1,386 patients undergoing laparotomy

Characteristic	***No complication n= 1,051 (76%)***	***Complication n= 335 (24%)***
Age, median (IQR) y	64 (51-73)	65 (54-74)
Men, No. (%)	402 (38.3)	177 (52.8)
BMI, median (IQR)	25 (22-28)	25 (22-29)
ASA score, No. (%)		
1	306 (29.1)	67 (20.0)
2	566 (53.9)	183 (54.6)
3	173 (16.5)	82 (24.5)
4	6 (0.6)	3 (0.9)
Acute surgery, No. (%)	288 (27.4)	95 (28.4)
Surgery type, No. (%)		
Colorectal	442 (42.1)	191 (57.0)
Gynaecological	234 (22.3)	34 (10.2)
Small bowel	119 (11.3)	39 (11.6)
Appendix	95 (9.0)	29 (8.7)
Other type[B]	161 (15.3)	42 (12.5)
Duration of surgery, median (IQR) min	123 (77-180)	155 (95-214)
Blood loss, median (IQR) mL	225 (70-600)	300 (100-900)
Comorbidity, No. (%)		
Current smoker	295 (28.1)	121 (36.1)
Alcohol consumption >48g/d	43 (4.1)	20 (6.0)
Previous abdominal surgery	465 (44.3)	142 (42.5)
Diabetes mellitus	73 (7.0)	31 (9.3)
Chronic obstructive pulmonary disease	41 (3.9)	28 (8.4)
Other pulmonary disease	66 (6.3)	27 (8.1)
Hypertension	290 (27.6)	103 (30.8)
Other cardiovascular disease	162 (15.4)	58 (17.4)
Current signs of infection	99 (9.4)	41 (12.2)
Immune deficiency	44 (4.2)	12 (3.9)
Other disease	237 (22.6)	97 (29.0)
SENIC preoperative risk score, No. (%)[C]		
1	386 (36.7)	67 (20.0)
2	523 (49.8)	182 (54.3)
3	127 (12.1)	74 (22.1)
4	15 (1.4)	12 (3.6)

[A] Patients developing one or more of the investigated complications: SSI, pneumonia, or respiratory failure.
[B] Includes cholecystectomy, hernia repair, gastric or hepatobiliary resection, nephrectomy, and splenectomy.
[C] Higher scores indicate higher risk of infection. SENIC scoring system [22], 1 point is given for each of (1) presence of 3 or more diagnoses; (2) surgery lasting longer than 2 hours; (3) operation classified as contaminated or dirty-infected; (4) abdominal surgery.

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Table 2: Complications and time of occurrence in 1,386 patients undergoing laparotomy

Complication:	***No.***	***(%)***	***Time, median (IQR), days***
Any complication	335	(24.2)	9 (5-15)
SSI	272	(19.6)	10 (7-18)
Superficial SSI	212	(15.3)	12 (6-19)
Deep SSI	61	(4.4)	13 (8-21)
Organ/space infection	87	(6.3)	9 (6-12)
Anastomotic leakage	31/543	(5.7)	8 (6-10)
Small bowel	3/103	(2.9)	30 (20-30)
Colon	20/349	(5.7)	8 (6-10)
Rectal	8/91	(8.8)	7 (6-14)
Pneumonia	48	(3.5)	5 (3-9)
Respiratory failure	32	(2.3)	3 (1-8)
Either pneumonia or respiratory failure[A]	37	(2.7)	4 (2-6)

[A] Patients who developed pneumonia followed by respiratory failure or vice versa.

Table 3: Timing of surgical site infections and pulmonary complications according to perioperative oxygen therapy

	80% oxygen (n= 685)			***30% oxygen (n= 701)***		
Complication:	***No.***	***(%)***	***Time, median (IQR), days***	***No.***	***(%)***	***Time, median (IQR), days***
Any complication	162	(23.6)	8 (5-15)	173	(24.7)	9 (5-15)
SSI	131	(19.1)	10 (7-18)	141	(20.1)	11 (6-19)
Superficial SSI	109	(15.9)	11 (6-19)	103	(14.7)	12 (7-19)
Deep SSI	28	(4.1)	12 (8-22)	33	(4.7)	14 (9-20)
Organ/space infection	41	(6.0)	8 (7-10)	46	(6.6)	9 (6-13)
Anastomotic leakage	13/271	(4.8)	8 (7-13)	18/272	(6.6)	8 (5-10)
Small bowel	1/54	(1.9)	30 (30-30)	2/49	(4.0)	20 (15-25)
Colon	10/175	(5.7)	8 (6-9)	10/174	(5.7)	8 (5-10)
Rectal	2/42	(4.8)	16 (11-19)	6/49	(12.2)	6 (5.9)
Pneumonia	20	(2.9)	5 (4-9)	28	(4.0)	5 (3-8)
Respiratory failure	17	(2.5)	3 (1-5)	15	(2.1)	3 (2-9)
Either pneumonia or respiratory failure[A]	21	(3.1)	4 (2-6)	16	(2.3)	4 (4-7)

[A] Patients who developed pneumonia followed by respiratory failure or vice versa.

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Figure 1: SSI

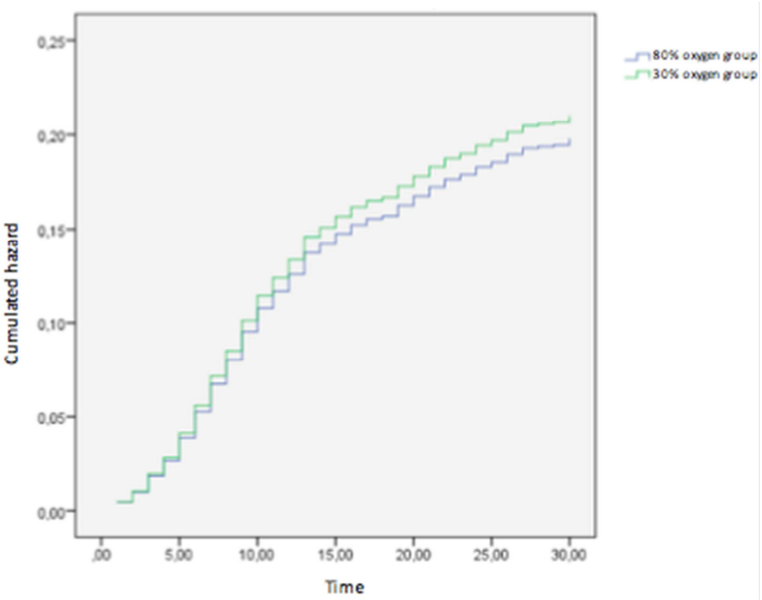


Figure 1. Cumulated hazard of diagnosis of surgical site infection over time. Adjusted hazards ratio 0.94 [95%-CI 0.74-1.20] P=0.62 for the 80% group compared to the 30% oxygen group. The analysis was adjusted for: duration of surgery, daily smoking, and obesity (body mass index above 30 kg/m^2).

Figure 2: Pneumonia

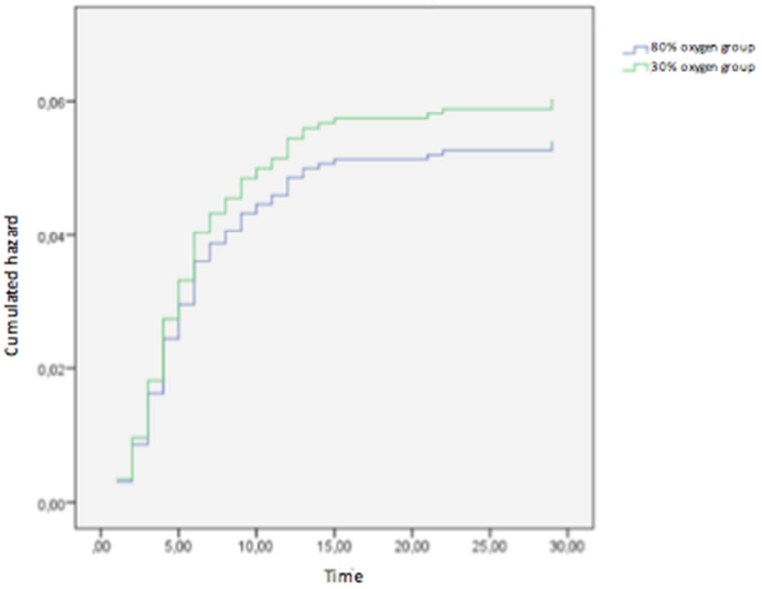


Figure 2. Cumulated hazard of diagnosis of pneumonia over time. Adjusted hazards ratio 0.89 [95%-CI 0.58-1.37] P=0.61 for the 80% group compared to the 30% oxygen group. The analysis was adjusted for: duration of surgery, and chronic obstructive pulmonary disease.

Figure 3: Respiratory failure

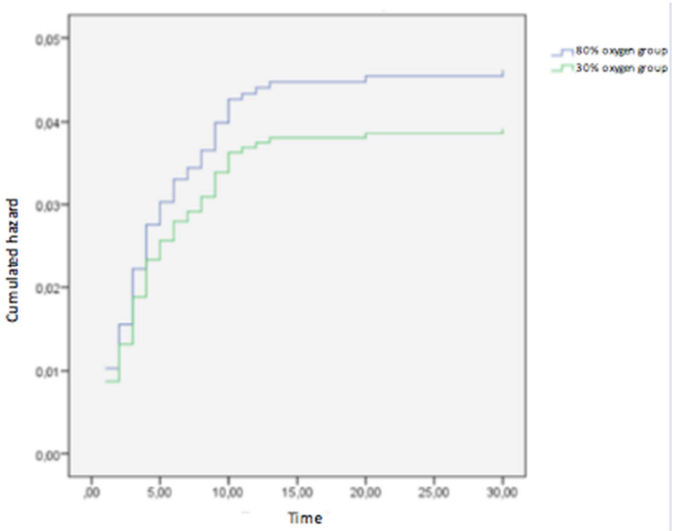


Figure 3. Cumulated hazard of diagnosis of respiratory failure over time. Adjusted hazards ratio 1.18 [95%-CI 0.73-1.90] P=0.50 for the 80% group compared to the 30% oxygen group. The analysis was adjusted for: duration of surgery, chronic obstructive pulmonary disease, and acute surgery.

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Tables 1: Baseline data for 1,386 patients undergoing laparotomy		
Characteristic	***No complication n= 1,051 (76%)***	***Complication n= 335 (24%)***
Age, median (IQR) y	64 (51-73)	65 (54-74)
Men, No. (%)	402 (38.3)	177 (52.8)
BMI, median (IQR)	25 (22-28)	25 (22-29)
ASA score, No. (%)		
1	306 (29.1)	67 (20.0)
2	566 (53.9)	183 (54.6)
3	173 (16.5)	82 (24.5)
4	6 (0.6)	3 (0.9)
Acute surgery, No. (%)	288 (27.4)	95 (28.4)
Surgery type, No. (%)		
Colorectal	442 (42.1)	191 (57.0)
Gynaecological	234 (22.3)	34 (10.2)
Small bowel	119 (11.3)	39 (11.6)
Appendix	95 (9.0)	29 (8.7)
Other type[B]	161 (15.3)	42 (12.5)
Duration of surgery, median (IQR) min	123 (77-180)	155 (95-214)
Blood loss, median (IQR) mL	225 (70-600)	300 (100-900)
Comorbidity, No. (%)		
Current smoker	295 (28.1)	121 (36.1)
Alcohol consumption >48g/d	43 (4.1)	20 (6.0)
Previous abdominal surgery	465 (44.3)	142 (42.5)
Diabetes mellitus	73 (7.0)	31 (9.3)
Chronic obstructive pulmonary disease	41 (3.9)	28 (8.4)
Other pulmonary disease	66 (6.3)	27 (8.1)
Hypertension	290 (27.6)	103 (30.8)
Other cardiovascular disease	162 (15.4)	58 (17.4)
Current signs of infection	99 (9.4)	41 (12.2)
Immune deficiency	44 (4.2)	12 (3.9)
Other disease	237 (22.6)	97 (29.0)
SENIC preoperative risk score, No. (%)[C]		
1	386 (36.7)	67 (20.0)
2	523 (49.8)	182 (54.3)
3	127 (12.1)	74 (22.1)
4	15 (1.4)	12 (3.6)

[A] Patients developing one or more of the investigated complications: SSI, pneumonia, or respiratory failure.
[B] Includes cholecystectomy, hernia repair, gastric or hepatobiliary resection, nephrectomy, and splenectomy.
[C] Higher scores indicate higher risk of infection. SENIC scoring system [22], 1 point is given for each of (1) presence of 3 or more diagnoses; (2) surgery lasting longer than 2 hours; (3) operation classified as contaminated or dirty-infected; (4) abdominal surgery.

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Table 2: Complications and time of occurrence in 1,386 patients undergoing laparotomy

Complication:	*No.*	*(%)*	*Time, median (IQR), days*
Any complication	335	(24.2)	9 (5-15)
SSI	272	(19.6)	10 (7-18)
Superficial SSI	212	(15.3)	12 (6-19)
Deep SSI	61	(4.4)	13 (8-21)
Organ/space infection	87	(6.3)	9 (6-12)
Anastomotic leakage	31/543	(5.7)	8 (6-10)
Small bowel	3/103	(2.9)	30 (20-30)
Colon	20/349	(5.7)	8 (6-10)
Rectal	8/91	(8.8)	7 (6-14)
Pneumonia	48	(3.5)	5 (3-9)
Respiratory failure	32	(2.3)	3 (1-8)
Either pneumonia or respiratory failure[A]	37	(2.7)	4 (2-6)

[A] Patients who developed pneumonia followed by respiratory failure or vice versa.

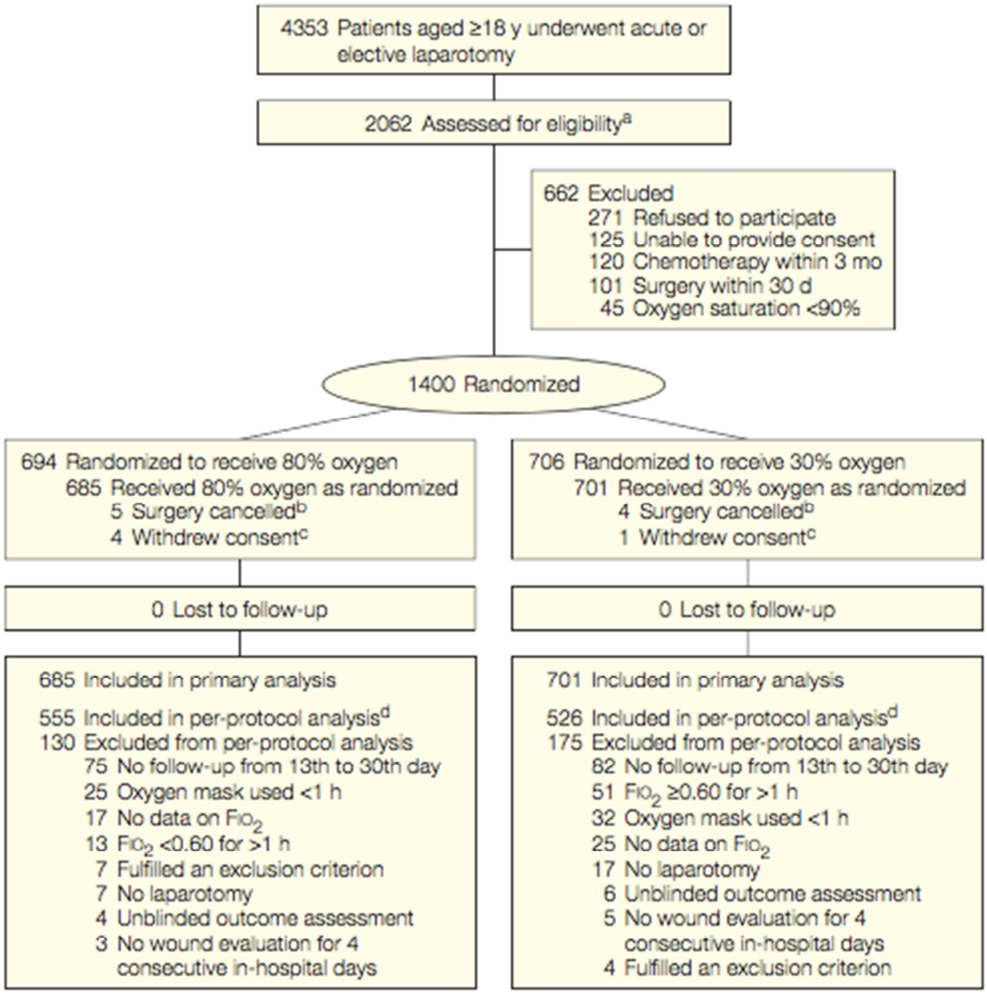
Table 3: Timing of surgical site infections and pulmonary complications according to perioperative oxygen therapy

	80% oxygen (n= 685)			*30% oxygen (n= 701)*		
Complication:	*No.*	*(%)*	*Time, median (IQR), days*	*No.*	*(%)*	*Time, median (IQR), days*
Any complication	162	(23.6)	8 (5-15)	173	(24.7)	9 (5-15)
SSI	131	(19.1)	10 (7-18)	141	(20.1)	11 (6-19)
Superficial SSI	109	(15.9)	11 (6-19)	103	(14.7)	12 (7-19)
Deep SSI	28	(4.1)	12 (8-22)	33	(4.7)	14 (9-20)
Organ/space infection	41	(6.0)	8 (7-10)	46	(6.6)	9 (6-13)
Anastomotic leakage	13/271	(4.8)	8 (7-13)	18/272	(6.6)	8 (5-10)
Small bowel	1/54	(1.9)	30 (30-30)	2/49	(4.0)	20 (15-25)
Colon	10/175	(5.7)	8 (6-9)	10/174	(5.7)	8 (5-10)
Rectal	2/42	(4.8)	16 (11-19)	6/49	(12.2)	6 (5.9)
Pneumonia	20	(2.9)	5 (4-9)	28	(4.0)	5 (3-8)
Respiratory failure	17	(2.5)	3 (1-5)	15	(2.1)	3 (2-9)
Either pneumonia or respiratory failure[A]	21	(3.1)	4 (2-6)	16	(2.3)	4 (4-7)

[A] Patients who developed pneumonia followed by respiratory failure or vice versa.

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Figure. Patient Enrollment, Randomization, and Treatment Flow



FIO_2 indicates inspiratory oxygen fraction.
[a] Underwent surgery when research staff were present.
[b] No outcome data described for these patients.
[c] No baseline or outcome data described for these patients.
[d] Patients could be excluded for more than 1 reason.

Figure 1: SSI

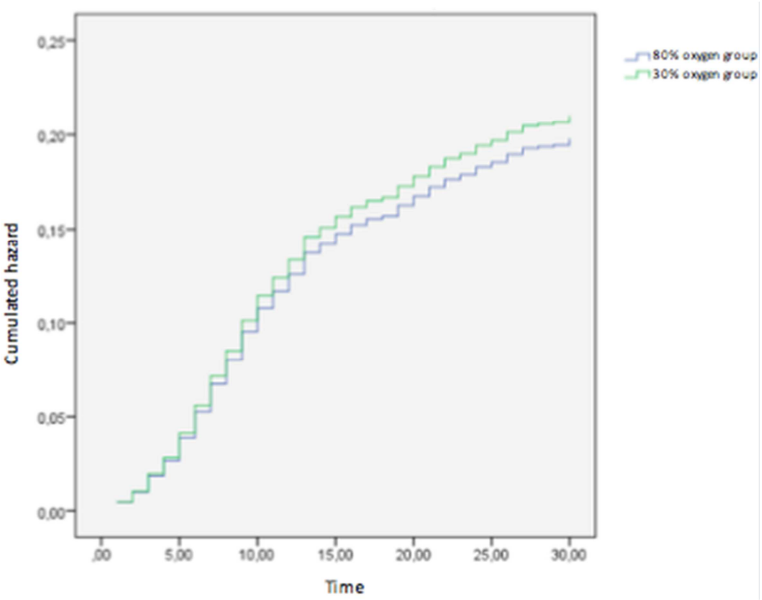


Figure 1. Cumulated hazard of diagnosis of surgical site infection over time. Adjusted hazards ratio 0.94 [95%-CI 0.74-1.20] P=0.62 for the 80% group compared to the 30% oxygen group. The analysis was adjusted for: duration of surgery, daily smoking, and obesity (body mass index above 30 kg/m^2).

Figure 2: Pneumonia

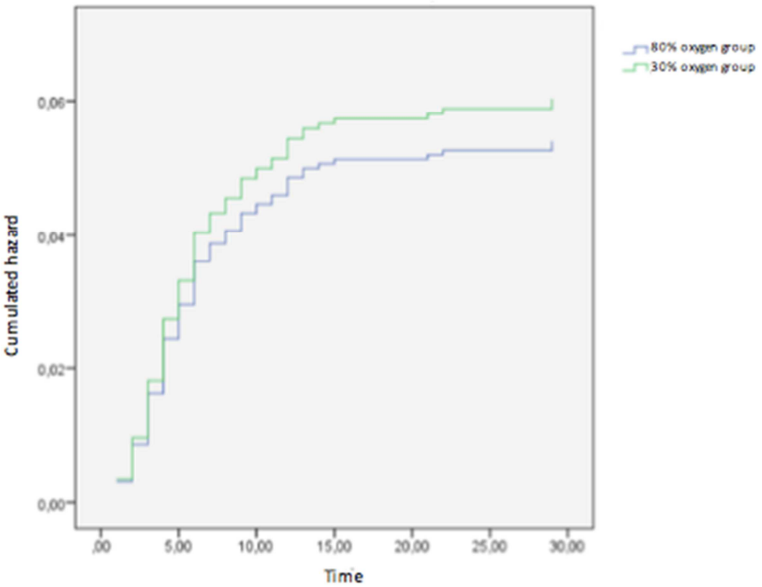


Figure 2. Cumulated hazard of diagnosis of pneumonia over time. Adjusted hazards ratio 0.89 [95%-CI 0.58-1.37] P=0.61 for the 80% group compared to the 30% oxygen group. The analysis was adjusted for: duration of surgery, and chronic obstructive pulmonary disease.

Figure 3: Respiratory failure

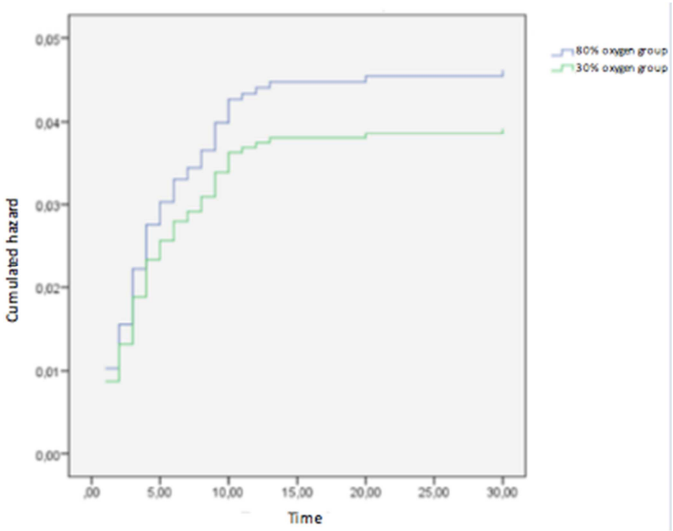


Figure 3. Cumulated hazard of diagnosis of respiratory failure over time. Adjusted hazards ratio 1.18 [95%-CI 0.73-1.90] P=0.50 for the 80% group compared to the 30% oxygen group. The analysis was adjusted for: duration of surgery, chronic obstructive pulmonary disease, and acute surgery.

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Highlights

- Surgical site infection (SSI) or pulmonary complications occurred in 24% of patients undergoing laparotomy.
- Median times from surgery to diagnosis of SSI or a pulmonary complication were 10 and 4 days, respectively
- Perioperative hyperoxia did not affect when postoperative complications were diagnosed.

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