

Table S1. Summary of survey questions sent to the principal investigators of the FALCON and CHEETAH randomised clinical trials

No.	Question	Definitions
1.	Name of hospital	
2.	What is the name and full address of your hospital	
3.	Are you a tertiary referral centre	No / Yes
4.	How far is your centre from the nearest tertiary referral centre	(miles / kilometres)
5.	How many surgical procedures (excluding caesarian sections) are performed annually under spinal or general anesthesia at your hospital?	<200 / 200 - 500 / >500
6.	How many full-time surgeons are on staff (excluding trainees)?	
7.	Do you have a medical trained anaesthetist (MD)?	No / Yes
8.	Do you have an anaesthetic technician/nurse?	No / Yes
9.	Do you have a blood bank or blood storage unit in your hospital	No / Yes
10.	Do you have a laboratory service for 24 hours blood/urine testing	No / Yes
11.	Do you have ventilated beds outside of the operating theatre	No / Yes

Table S2. Summary of patients included in the study across FALCON and CHEETAH by country

	CHEETAH	FALCON
Benin	746 (6.3%)	144 (3.8%)
Ghana	1,930 (16%)	1,282 (34%)
India	3,081 (26%)	418 (11%)
Mexico	670 (5.6%)	105 (2.8%)
Nigeria	2,676 (23%)	1,476 (39%)
Rwanda	2,763 (23%)	366 (9.7%)

Table S3. Core metrics in all centres involved in FALCON and CHEETAH

Characteristic	Surgical Site Infection		p-value ²	Postoperative mortality		p-value ²
	No, N = 11848 (81%)	Yes, N = 2797 (19%)		No, N = 14421 (93%) ¹	Yes, N = 1081 (7.0%) ¹	
Number of surgical procedures, n (%)			<0.001			<0.001
< 200	85 (0.7%)	34 (1.2%)		116 (0.8%)	17 (1.6%)	
200-500	2,356 (19.9%)	446 (15.9%)		2,777 (19.3%)	128 (11.8%)	
>500	9,407 (79.4%)	2,317 (82.8%)		11,528 (79.9%)	936 (86.6%)	
How many full-time surgeons are on staff			<0.001			0.010
Median (IQR)	16(4.0, 39.0)	22(5.0, 40.0)		16(4.0, 39.0)	18(4.0, 36.0)	
Do you have a medical trained anaesthetist			<0.001			0.002
No	2,454 (20.7%)	412 (14.7%)		2,844 (19.7%)	172 (15.9%)	
Yes	9,394 (79.3%)	2,385 (85.3%)		11,577 (80.3%)	909 (84.1%)	
Do you have an anaesthetic technician/nurse			0.008			0.2
No	449 (3.8%)	77 (2.8%)		516 (3.6%)	31 (2.9%)	
Yes	11,399 (96.2%)	2,720 (97.2%)		13,905 (96.4%)	1,050 (97.1%)	
Do you have a blood bank or blood storage unit in your hospital, n (%)			<0.001			<0.001
No	1,239 (10.5%)	179 (6.4%)		1,397 (9.7%)	63 (5.8%)	
Yes	10,609 (89.5%)	2,618 (93.6%)		13,024 (90.3%)	1,018 (94.2%)	
Do you have ventilated beds outside of the operating theatre, n (%)			0.15			0.3
No	2,012 (17.0%)	443 (15.8%)		2,416 (16.8%)	168 (15.5%)	
Yes	9,836 (83.0%)	2,354 (84.2%)		12,005 (83.2%)	913 (84.5%)	

Table S4. Core metrics in all by type of centres involved in FALCON and CHEETAH

Characteristic	Surgical Site Infection		Postoperative mortality	
	Referral, N = 2315 (21%) ¹	Non - Referral, N = 482 (14%) ¹	Referral, N = 916 (7.6%) ¹	Non - Referral, N = 165 (4.6%) ¹
Number of surgical procedures, n (%)				
< 200	2 (6.3%)	32 (37%)	2 (5.7%)	15 (14%)
200-500	224 (21%)	222 (13%)	65 (5.7%)	63 (3.5%)
>500	2,089 (21%)	228 (14%)	849 (7.8%)	87 (5.2%)
How many full-time surgeons are on staff				
Median (IQR)	31 (15, 40)	2.00 (2.00, 4.00)	30 (10, 40)	2.00 (2.00, 3.00)
Do you have a medical trained anaesthetist				
No	191 (18%)	221 (12%)	82 (7.4%)	90 (4.7%)
Yes	2,124 (21%)	261 (16%)	834 (7.6%)	75 (4.6%)
Do you have an anaesthetic technician/nurse				
No	55 (14%)	22 (15%)	27 (6.8%)	4 (2.6%)
Yes	2,260 (21%)	460 (14%)	889 (7.7%)	161 (4.7%)
Do you have a blood bank or blood storage unit in your hospital, n (%)				
No	7 (30%)	172 (12%)	4 (15%)	59 (4.1%)
Yes	2,308 (21%)	310 (15%)	912 (7.6%)	106 (5.0%)
Do you have ventilated beds outside of the operating theatre, n (%)				
No	203 (17%)	240 (19%)	61 (5.0%)	107 (7.7%)
Yes	2,112 (21%)	242 (11%)	855 (7.9%)	58 (2.7%)
Distance from referral Centre				
less than 50km	-	36 (11%)	-	6 (1.8%)
between 50km to 120km	-	90 (14%)	-	35 (5.1%)
between 120km to 218km	-	113 (14%)	-	58 (6.8%)
More than 218km	-	89 (10%)	-	19 (2.2%)

Table S5. Core metrics in First referral centres involved in FALCON and CHEETAH

Characteristic	Surgical Site Infection		Postoperative mortality	
	No, N = 2933 (86%)	Yes, N = 482 (14%)	No, N = 3396 (95%) ¹	Yes, N = 165 (4.6%) ¹
Number of surgical procedures, n (%)				
< 200	1,508(51.4%)	222(46.1%)	1,714(50.7%)	63(38.2%)
200-500	55(1.9%)	32(6.6%)	84(2.5%)	15(9.1%)
>500	1,370(46.7%)	228(47.3%)	1,580(46.8%)	87(52.7%)
How many full-time surgeons are on staff				
Median (IQR)	2(1.0, 3.0)	2(2.0, 4.0)	2(1.0, 3.0)	2(2.0, 3.0)
Do you have a medical trained anaesthetist				
No	1,610(54.9%)	221(45.9%)	1,817(53.8%)	90(54.5%)
Yes	1,323(45.1%)	261(54.1%)	1,561(46.2%)	75(45.5%)
Do you have an anaesthetic technician/nurse				
No	124(4.2%)	22(4.6%)	146(4.3%)	4(2.4%)
Yes	2,809(95.8%)	460(95.4%)	3,232(95.7%)	161(97.6%)
Do you have a blood bank or blood storage unit in your hospital, n (%)				
No	1,223(41.7%)	172(35.7%)	1,376(40.7%)	59(35.8%)
Yes	1,710(58.3%)	310(64.3%)	2,002(59.3%)	106(64.2%)
Do you have ventilated beds outside of the operating theatre, n (%)				
No	1,054(35.9%)	240(49.8%)	1,274(37.7%)	107(64.8%)
Yes	1,879(64.1%)	242(50.2%)	2,104(62.3%)	58(35.2%)
Distance from referral Centre				
less than 50km	293(12.6%)	36(11.0%)	323(12.3%)	6(5.1%)
between 50km to 120km	573(24.6%)	90(27.4%)	651(24.8%)	35(29.7%)
between 120km to 218km	689(29.6%)	113(34.5%)	790(30.2%)	58(49.2%)
More than 218km	773(33.2%)	89(27.1%)	856(32.7%)	19(16.1%)
Missing	605	154	758	47

Table S6. Summary of hospital-, patient-, and operative level characteristics of patients undergoing major abdominal surgery by **postoperative mortality**

Characteristic	No, N = 14421 (93%)¹	Yes, N = 1081 (7.0%)¹	p-value²
Hospital level			
Are you a tertiary referral centre			<0.001
Non- referral centre	3,378 (23%)	165 (15%)	
Referral centre	11,043 (77%)	916 (85%)	
Patient characteristics			
Age band			<0.001
Child	2,025 (14%)	103 (9.5%)	
Adult	12,396 (86%)	978 (90%)	
Sex			<0.001
Male	6,613 (46%)	654 (60%)	
Female	7,808 (54%)	427 (40%)	
What is the patients smoking status?			<0.001
Ex-smoker (stopped more than 6 weeks ago)	671 (4.7%)	102 (9.4%)	
Current smoker or stopped smoking less than 6 weeks ago	530 (3.7%)	86 (8.0%)	
Never smoked	13,220 (92%)	893 (83%)	
American Society of Anesthesiologists grade			<0.001
Grade I	7,079 (49%)	198 (18%)	
Grade II	4,929 (34%)	302 (28%)	
Grade III	1,999 (14%)	388 (36%)	
Grade IV / V	413 (2.8%)	188 (17.3%)	
(Missing)	1	8	
Does the patient have known diabetes?			<0.001
No	13,622 (94%)	983 (91%)	
Yes	798 (5.5%)	98 (9.1%)	
(Missing)	1	0	
Does the patient have known HIV status?			0.002
Known negative	7,632 (53%)	529 (49%)	
Known positive	233 (1.6%)	30 (2.8%)	
Status not known	6,556 (45%)	522 (48%)	
Operative characteristics			
Timing of surgery			<0.001
Elective (planned admission)	6,169 (43%)	274 (25%)	
Emergency (unplanned admission)	8,252 (57%)	807 (75%)	
Indication for surgery			<0.001
Malignant disease	2,009 (14%)	263 (25%)	
Benign disease	11,741 (81%)	744 (69%)	
Trauma	601 (4.2%)	64 (6.0%)	
Obstetric	68 (0.5%)	2 (0.2%)	
(Missing)	2	8	
Malignant disease*			<0.001
No	12,410 (86%)	810 (75%)	
Yes	2,009 (14%)	263 (25%)	
(Missing)	2	8	
Operation Type*			<0.001
GI tract	6,400 (47%)	528 (57%)	
Non GI tract	7,218 (53%)	399 (43%)	
(Missing)	803	154	
Operation			
Appendectomy	2,725 (19%)	32 (3.0%)	
Colorectal	1,659 (12%)	193 (18%)	
Gynaecology	3,198 (22%)	26 (2.4%)	
HPB	739 (5.1%)	40 (3.7%)	
Other	3,229 (22%)	362 (33%)	
Small bowel	1,209 (8.4%)	208 (19%)	
Upper GI	863 (6.0%)	200 (19%)	
Urology	791 (5.5%)	11 (1.0%)	

Characteristic	No, N = 14421 (93%) ¹	Yes, N = 1081 (7.0%) ¹	p-value ²
Missing	8 (<0.1%)	9 (0.8%)	
Actual intra-operative contamination			<0.001
Clean	87 (0.6%)	7 (0.7%)	
Clean-contaminated	8,070 (56%)	325 (30%)	
Contaminated	3,247 (23%)	280 (26%)	
Dirty	3,013 (21%)	461 (43%)	
(Missing)	4	8	
Contamination*			<0.001
Clean-contaminated	8,157 (57%)	332 (31%)	
Contaminated	3,247 (23%)	280 (26%)	
Dirty	3,013 (21%)	461 (43%)	
(Missing)	4	8	
What was the operative approach?			<0.001
Open midline	8,641 (60%)	973 (91%)	
Open non-midline	5,498 (38%)	95 (8.9%)	
Laparoscopic	121 (0.8%)	0 (0%)	
Laparoscopic converted to open	158 (1.1%)	5 (0.5%)	
(Missing)	3	8	
Operation Approach*			<0.001
Open midline	8,641 (60%)	973 (91%)	
Laparoscopic	279 (1.9%)	5 (0.5%)	
Open non-midline	5,498 (38%)	95 (8.9%)	
(Missing)	3	8	
Was WHO Surgical safety checklist used?			>0.9
Yes	13,657 (95%)	1,016 (95%)	
No	763 (5.3%)	57 (5.3%)	
(Missing)	1	8	
Was intraoperative pulse oximetry used?			0.5
No	89 (0.6%)	5 (0.5%)	
Yes	14,332 (99%)	1,068 (100%)	
(Missing)	0	8	
Up to 60 minutes prior to incision, were prophylactic antibiotics given?			>0.9
No	393 (2.7%)	29 (2.7%)	
Yes	14,027 (97%)	1,044 (97%)	
(Missing)	1	8	
Hair removal at site of wound ?			0.009
No hair at site of wound	6,517 (45%)	510 (48%)	
In theatre, electric	550 (3.8%)	35 (3.3%)	
In theatre, razor/blade	1,355 (9.4%)	120 (11%)	
Before theatre arrival	4,531 (31%)	287 (27%)	
Not done	1,464 (10%)	121 (11%)	
(Missing)	4	8	
Glove and instrument change			0.2
No	9,504 (66%)	732 (68%)	
Yes	4,917 (34%)	349 (32%)	

¹n (%)

²Pearson's Chi-squared test; Fisher's exact test

Table S7. Summary of hospital-, patient-, and operative level characteristics of patients undergoing major abdominal surgery by **surgical site infection**

Characteristic	No, N = 11848 (81%)	Yes, N = 2797 (19%)	p-value²
Hospital level			
Are you a tertiary referral centre			<0.001
Non- referral centre	2,933 (25%)	482 (17%)	
Referral centre	8,915 (75%)	2,315 (83%)	
Patient characteristics			0.014
Age band			
Child	1,602 (14%)	428 (15%)	
Adult	10,246 (86%)	2,369 (85%)	<0.001
Sex			
Male	5,291 (45%)	1,463 (52%)	
Female	6,557 (55%)	1,334 (48%)	<0.001
What is the patients smoking status?			
Ex-smoker (stopped more than 6 weeks ago)	550 (4.6%)	150 (5.4%)	
Current smoker or stopped smoking less than 6 weeks ago	394 (3.3%)	160 (5.7%)	
Never smoked	10,904 (92%)	2,487 (89%)	<0.001
American Society of Anesthesiologists grade			
Grade I	6,135 (52%)	980 (35%)	
Grade II	4,030 (34%)	973 (35%)	
Grade III	1,404 (12%)	679 (24%)	
Grade IV / V	211 (1.8%)	133 (4.8%)	
(Missing)	68 (0.6%)	32 (1.1%)	0.002
Does the patient have known diabetes?			
No	11,215 (95%)	2,605 (93%)	
Yes	632 (5.3%)	192 (6.9%)	
(Missing)	1	0	0.3
Does the patient have known HIV status?			
Known negative	6,314 (53%)	1,442 (52%)	
Known positive	196 (1.7%)	47 (1.7%)	
Status not known	5,338 (45%)	1,308 (47%)	<0.001
Operative characteristics			
Timing of surgery			
Elective (planned admission)	5,287 (45%)	949 (34%)	
Emergency (unplanned admission)	6,561 (55%)	1,848 (66%)	0.14
Indication for surgery			
Malignant disease	1,657 (14%)	403 (14%)	
Benign disease	487 (4.1%)	121 (4.3%)	
Trauma	48 (0.4%)	20 (0.7%)	
Obstetric	1	2	0.6
(Missing)	10,190 (86%)	2,392 (86%)	
Malignant disease*			
No	1,657 (14%)	403 (14%)	
Yes	1	2	<0.001
(Missing)	5,204 (46%)	1,291 (51%)	

Characteristic	No, N = 11848 (81%)	Yes, N = 2797 (19%)	p-value²
Operation Type*	6,087 (54%)	1,216 (49%)	
GI tract	557	290	
Non-GI tract			<0.001
(Missing)	2,933 (25%)	482 (17%)	
Operation			
Appendectomy	2,360 (20%)	359 (13%)	
Colorectal	1,252 (11%)	452 (16%)	
Gynaecology	2,853 (24%)	345 (12%)	
HPB	634 (5.4%)	116 (4.1%)	
Other	2,551 (22%)	760 (27%)	
Small bowel	809 (6.8%)	451 (16%)	
Upper GI	701 (5.9%)	200 (7.2%)	
Urology	683 (5.8%)	111 (4.0%)	
Missing	5 (<0.1%)	3 (0.1%)	
Actual intra-operative contamination			<0.001
Clean	79 (0.7%)	11 (0.4%)	
Clean-contaminated	7,107 (60%)	1,025 (37%)	
Contaminated	2,634 (22%)	672 (24%)	
Dirty	2,027 (17%)	1,087 (39%)	
(Missing)	1	2	
Contamination*			<0.001
Clean-contaminated	7,186 (61%)	1,036 (37%)	
Contaminated	2,634 (22%)	672 (24%)	
Dirty	2,027 (17%)	1,087 (39%)	
(Missing)	1	2	
What was the operative approach?			<0.001
Open midline	6,739 (57%)	2,121 (76%)	
Open non-midline	4,869 (41%)	632 (23%)	
Laparoscopic	102 (0.9%)	19 (0.7%)	
Laparoscopic converted to open	137 (1.2%)	23 (0.8%)	
(Missing)	1	2	
Operation Approach*			<0.001
Open midline	6,739 (57%)	2,121 (76%)	
Laparoscopic	239 (2.0%)	42 (1.5%)	
Open non-midline	4,869 (41%)	632 (23%)	
(Missing)	1	2	
Was WHO Surgical safety checklist used?			<0.001
Yes	11,289 (95%)	2,579 (92%)	
No	558 (4.7%)	218 (7.8%)	
(Missing)	1	0	
Was intraoperative pulse oximetry used?			0.4
No	70 (0.6%)	20 (0.7%)	
Yes	11,778 (99%)	2,777 (99%)	
Up to 60 minutes prior to incision, were prophylactic antibiotics given?			<0.001
No	346 (2.9%)	50 (1.8%)	
Yes	11,501 (97%)	2,747 (98%)	
(Missing)	1	0	

Characteristic	No, N = 11848 (81%)	Yes, N = 2797 (19%)	p-value²
Hair removal at site of wound ?			<0.001
No hair at site of wound	5,351 (45%)	1,267 (45%)	
In theatre, electric	438 (3.7%)	126 (4.5%)	
In theatre, razor/blade	1,067 (9.0%)	313 (11%)	
Before theatre arrival	3,750 (32%)	847 (30%)	
Not done	1,239 (10%)	243 (8.7%)	
(Missing)	3	1	
Glove and instrument change			<0.001
No	7,583 (64%)	2,083 (74%)	
Yes	4,265 (36%)	714 (26%)	

¹n (%)

²Pearson's Chi-squared test; Fisher's exact test

Supplementary Figure 1. Multilevel adjusted regression model on association between referral status and postoperative surgical site infection within 30-days in patients undergoing major abdominal surgery

