

Supplemental Online Content

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This supplemental material has been provided by the authors to give readers additional information about their work.

eMethods. Fractional Polynomial Model Assessment

The primary multivariable logistic regression model clustered at the level of the hospital was compared to the best fitting multivariable fractional polynomial model expressing the primary exposure in multiple dimensions (1 to 3) and fit terms (-3 to +3 degrees). Resulting fractional polynomial models did not yield a statistically significant improvement to model fit (1-dimension, $P=0.22$; 2-dimensions, $P=0.62$; 3-dimensions, $P=0.74$). Thus, a linear fit was retained for the primary exposure in our primary model.

eTable 1. Hospital specific American College of Surgeons surgeon availability mandate

Hospital	Trauma Center Level	Mandated Specialist Availability ^c	Bed Number	Rurality	Teaching status
1	I ^a	24-hour in-house	1601	Urban	Teaching
2	Not leveled	Not mandated	520	Urban	Teaching
3	Not leveled	Not mandated	435	Urban	Nonteaching
4	II ^b	24-hour available	423	Urban	Teaching
5	I ^a	24-hour in-house	404	Urban	Teaching
6	Not leveled	Not mandated	383	Urban	Teaching
7	II ^b	24-hour available	380	Urban	Teaching
8	Not leveled	Not mandated	312	Urban	Nonteaching
9	Not leveled	Not mandated	272	Urban	Teaching
10	Not leveled	Not mandated	249	Urban	Teaching
11	Not leveled	Not mandated	246	Urban	Nonteaching
12	Not leveled	Not mandated	165	Urban	Nonteaching
13	Not leveled	Not mandated	122	Rural	Teaching
14	Not leveled	Not mandated	49	Rural	Nonteaching

^aLevel 1 trauma centers are tertiary care facilities central to the regional trauma system capable of providing comprehensive resources and acting as a referral resource for the nearby region. Required elements include but are not limited to 24-hour in-house coverage by general surgeons and prompt availability of orthopedic, cranial, plastic, oral and maxillofacial surgeons as well as anesthesiology, emergency medicine, radiology, and critical care.

^bLevel 2 trauma centers required elements include 24-hour immediate coverage by general surgeons as well as coverage by orthopedic and cranial surgeons as well as anesthesiology, emergency medicine, radiology, and critical care

^cAmerican College of Surgeons trauma center verification

eTable 2. Source control procedures, anatomic category, and procedural stress

CPT code ^a	Procedure Stress ^b	Frequency of Code	Procedure Description
<i>Gastrointestinal and abdominal</i>			
49406	Low	363	Image-guided fluid collection drainage by catheter (eg, abscess, hematoma, seroma, lymphocele, cyst); peritoneal or retroperitoneal, percutaneous
44120	High	94	Enterectomy, resection of small intestine; single resection and anastomosis
44970	High	88	Laparoscopy, surgical, appendectomy
49000	High	77	Exploratory laparotomy, exploratory celiotomy with or without biopsy(s)
49002	High	68	Reopening of recent laparotomy
44140	High	56	Colectomy, partial; with anastomosis
44143	High	51	Colectomy, partial; with end colostomy and closure of distal segment (Hartmann type procedure)
46040	Low	43	Incision and drainage of ischiorectal and/or perirectal abscess
44160	High	33	Colectomy, partial, with removal of terminal ileum with ileocolostomy
43840	High	31	Gastrorrhaphy, suture of perforated duodenal or gastric ulcer, wound, or injury
49405	Low	31	Image-guided fluid collection drainage by catheter (eg, abscess, hematoma, seroma, lymphocele, cyst); visceral (eg, kidney, liver, spleen, lung/mediastinum), percutaneous
44141	High	27	Colectomy, partial; with skin level cecostomy or colostomy
44950	High	23	Appendectomy
49561	High	21	Repair initial incisional or ventral hernia; incarcerated or strangulated
49020	High	18	Drainage of peritoneal abscess or localized peritonitis, exclusive of appendiceal abscess, open
49422	Low	17	Removal of tunneled intraperitoneal catheter
44180	High	16	Laparoscopy, surgical, enterolysis (freeing of intestinal adhesion)
44150	High	15	Colectomy, total, abdominal, without proctectomy; with ileostomy or ileoproctostomy
44130	High	14	Enteroenterostomy, anastomosis of intestine, with or without cutaneous enterostomy
44145	High	13	Colectomy, partial; with coloproctostomy (low pelvic anastomosis)
44310	High	13	Ileostomy or jejunostomy, non-tube
44320	High	13	Colostomy or skin level cecostomy
49423	Low	13	Exchange of previously placed abscess or cyst drainage catheter under radiological guidance
44602	High	12	Suture of small intestine (enterorrhaphy) for perforated ulcer, diverticulum, wound, injury or rupture; single perforation
44050	High	11	Reduction of volvulus, intussusception, internal hernia, by laparotomy
44125	High	11	Enterectomy, resection of small intestine; with enterostomy
44187	High	10	Laparoscopy, surgical; ileostomy or jejunostomy, non-tube
49084	High	10	Peritoneal lavage, including imaging guidance, when performed
44144	High	9	Colectomy, partial; with resection, with colostomy or ileostomy and creation of mucofistula
49507	High	9	Repair initial inguinal hernia, age 5 years or older; incarcerated or strangulated

44955	High	7	Appendectomy; when done for indicated purpose at time of other major procedure (not as separate procedure)
45990	Low	7	Anorectal exam, surgical, requiring anesthesia (general, spinal, or epidural), diagnostic
49587	High	7	Repair umbilical hernia, age 5 years or older; incarcerated or strangulated
44202	High	6	Laparoscopy, surgical; enterectomy, resection of small intestine, single resection and anastomosis
49060	High	6	Drainage of retroperitoneal abscess, open
43631	High	5	Gastrectomy, partial, distal; with gastroduodenostomy
43659	High	5	Unlisted laparoscopy procedure, stomach
46060	Low	5	Incision and drainage of ischiorectal or intramural abscess, with fistulectomy or fistulotomy, submuscular, with or without placement of seton
38100	High	4	Splenectomy; total
44155	High	4	Colectomy, total, abdominal, with proctectomy; with ileostomy
44188	High	4	Laparoscopy, surgical, colostomy or skin level cecostomy
49566	High	4	Repair recurrent incisional or ventral hernia; incarcerated or strangulated
43610	High	3	Excision, local; ulcer or benign tumor of stomach
43632	High	3	Gastrectomy, partial, distal; with gastrojejunostomy
43825	High	3	Gastrojejunostomy; with vagotomy, any type
44020	High	3	Enterotomy, small intestine, other than duodenum; for exploration, biopsy(s), or foreign body removal
44121	High	3	Enterectomy, resection of small intestine; each additional resection and anastomosis
44205	High	3	Laparoscopy, surgical; colectomy, partial, with removal of terminal ileum with ileocolostomy
44346	High	3	Revision of colostomy; with repair of paracolostomy hernia
44625	High	3	Closure of enterostomy, large or small intestine; with resection and anastomosis other than colorectal
45020	High	3	Incision and drainage of deep supralevator, pelvirectal, or retrorectal abscess
49325	High	3	Laparoscopy, surgical; with revision of previously placed intraperitoneal cannula or catheter, with removal of intraluminal obstructive material if performed
43633	High	2	Gastrectomy, partial, distal; with Roux-en-Y reconstruction
43820	High	2	Gastrojejunostomy; without vagotomy
43848	High	2	Revision, open, of gastric restrictive procedure for morbid obesity, other than adjustable gastric restrictive device
44345	High	2	Revision of colostomy; complicated (reconstruction in-depth)
44603	High	2	Suture of small intestine (enterorrhaphy) for perforated ulcer, diverticulum, wound, injury or rupture; multiple perforations
44604	High	2	Suture of large intestine (colorrhaphy) for perforated ulcer, diverticulum, wound, injury or rupture (single or multiple perforations); without colostomy
45000	High	2	Transrectal drainage of pelvic abscess

45111	High	2	Proctectomy; partial resection of rectum, transabdominal approach
45393	Low	2	Colonoscopy, flexible; with decompression (for pathologic distention) (eg, volvulus, megacolon), including placement of decompression tube, when performed
45915	Low	2	Removal of fecal impaction or foreign body under anesthesia
46045	Low	2	Incision and drainage of intramural, intramuscular, or submucosal abscess, transanal, under anesthesia
49205	High	2	Excision or destruction, open, intra-abdominal tumors, cysts or endometriomas, 1 or more peritoneal, mesenteric, or retroperitoneal primary or secondary tumors; largest tumor greater than 10.0 cm diameter
49429	High	2	Removal of peritoneal-venous shunt
49521	High	2	Repair recurrent inguinal hernia, any age; incarcerated or strangulated
49553	High	2	Repair initial femoral hernia, any age; incarcerated or strangulated
49999	High	2	Unlisted procedure, abdomen, peritoneum and omentum
43635	High	1	Vagotomy when performed with partial distal gastrectomy (List separately in addition to code[s] for primary procedure)
43640	High	1	Vagotomy including pyloroplasty, with or without gastrostomy; truncal or selective
43860	High	1	Revision of gastrojejunal anastomosis (gastrojejunostomy) with reconstruction, with or without partial gastrectomy or intestine resection; without vagotomy
43870	High	1	Closure of gastrostomy, surgical
44021	High	1	Enterotomy, small intestine, other than duodenum; for decompression (eg, Baker tube)
44025	High	1	Colotomy, for exploration, biopsy(s), or foreign body removal
44110	High	1	Excision of 1 or more lesions of small or large intestine not requiring anastomosis, exteriorization, or fistulization; single enterotomy
44146	High	1	Colectomy, partial; with coloproctostomy (low pelvic anastomosis), with colostomy
44151	High	1	Colectomy, total, abdominal, without proctectomy; with continent ileostomy
44207	High	1	Laparoscopy, surgical; colectomy, partial, with anastomosis, with coloproctostomy (low pelvic anastomosis)
44210	High	1	Laparoscopy, surgical; colectomy, total, abdominal, without proctectomy, with ileostomy or ileoproctostomy
44212	High	1	Laparoscopy, surgical; colectomy, total, abdominal, with proctectomy, with ileostomy
44227	High	1	Laparoscopy, surgical, closure of enterostomy, large or small intestine, with resection and anastomosis
44314	High	1	Revision of ileostomy; complicated (reconstruction in-depth)
44605	High	1	Suture of large intestine (colorrhaphy) for perforated ulcer, diverticulum, wound, injury or rupture (single or multiple perforations); with colostomy
44620	High	1	Closure of enterostomy, large or small intestine
44640	High	1	Closure of intestinal cutaneous fistula

44701	High	1	Intraoperative colonic lavage
44800	High	1	Excision of Meckel's diverticulum (diverticulectomy) or omphalomesenteric duct
44900	High	1	Incision and drainage of appendiceal abscess, open
44960	High	1	Appendectomy; for ruptured appendix with abscess or generalized peritonitis
45005	High	1	Incision and drainage of submucosal abscess, rectum
45110	High	1	Proctectomy; complete, combined abdominoperineal, with colostomy
45337	Low	1	Sigmoidoscopy, flexible; with decompression (for pathologic distention) (eg, volvulus, megacolon), including placement of decompression tube, when performed
45347	Low	1	Sigmoidoscopy, flexible; with placement of endoscopic stent (includes pre- and post-dilation and guide wire passage, when performed)
45389	Low	1	Colonoscopy, flexible; with endoscopic stent placement (includes pre- and post-dilation and guide wire passage, when performed)
45562	Low	1	Exploration, repair, and presacral drainage for rectal injury
49010	High	1	Exploration, retroperitoneal area with or without biopsy(s)
49040	High	1	Drainage of subdiaphragmatic or subphrenic abscess, open
49250	High	1	Umbilectomy, omphalectomy, excision of umbilicus
49402	High	1	Removal of peritoneal foreign body from peritoneal cavity
49557	High	1	Repair recurrent femoral hernia; incarcerated or strangulated
49572	High	1	Repair epigastric hernia (eg, preperitoneal fat); incarcerated or strangulated
49653	High	1	Laparoscopy, surgical, repair, ventral, umbilical, spigelian or epigastric hernia (includes mesh insertion, when performed); incarcerated or strangulated
49655	High	1	Laparoscopy, surgical, repair, incisional hernia (includes mesh insertion, when performed); incarcerated or strangulated
49657	High	1	Laparoscopy, surgical, repair, recurrent incisional hernia (includes mesh insertion, when performed); incarcerated or strangulated
<i>Hepatopancreaticobiliary</i>			
47562	High	127	Laparoscopy, surgical; cholecystectomy
43264	Low	126	ERCP; with removal of calculi/debris from biliary/pancreatic duct(s)
43262	Low	122	ERCP; with sphincterotomy/papillotomy
47490	Low	104	Cholecystostomy, percutaneous, complete procedure, including imaging guidance, catheter placement, cholecystogram when performed, and radiological supervision and interpretation
43274	Low	98	ERCP; with placement of endoscopic stent into biliary or pancreatic duct, including pre- and post-dilation and guide wire passage, when performed, including sphincterotomy, when performed, each stent
47563	High	52	Laparoscopy, surgical; cholecystectomy with cholangiography
43260	Low	41	ERCP; diagnostic, including collection of specimen(s) by brushing or washing, when performed
47600	High	34	Cholecystectomy

43261	Low	30	ERCP; with biopsy, single or multiple
43276	Low	23	ERCP; with removal and exchange of stent(s), biliary or pancreatic duct, including pre- and post-dilation and guide wire passage, when performed, including sphincterotomy, when performed, each stent exchanged
47534	Low	20	Placement of biliary drainage catheter, percutaneous, including diagnostic cholangiography when performed, imaging guidance (eg, ultrasound and/or fluoroscopy), and all associated radiological supervision and interpretation; internal-external
43266	Low	19	Esophagogastroduodenoscopy, flexible, transoral; with placement of endoscopic stent (includes pre- and post-dilation and guide wire passage, when performed)
47536	Low	19	Exchange of biliary drainage catheter (eg, external, internal-external, or conversion of internal-external to external only), percutaneous, including diagnostic cholangiography when performed, imaging guidance (eg, fluoroscopy), and all associated radiological supervision and interpretation
43277	Low	13	ERCP; with trans-endoscopic balloon dilation of biliary/pancreatic duct(s) or of ampulla (sphincteroplasty), including sphincterotomy, when performed, each duct
43265	Low	11	ERCP; with destruction of calculi, any method (eg, mechanical, electrohydraulic, lithotripsy)
47605	High	10	Cholecystectomy; with cholangiography
43275	Low	8	ERCP; with removal of foreign body(s) or stent(s) from biliary/pancreatic duct(s)
47120	High	5	Hepatectomy, resection of liver; partial lobectomy
47533	Low	3	Placement of biliary drainage catheter, percutaneous, including diagnostic cholangiography when performed, imaging guidance (eg, ultrasound and/or fluoroscopy), and all associated radiological supervision and interpretation; external
47542	Low	3	Balloon dilation of biliary duct(s) or of ampulla (sphincteroplasty), percutaneous, including imaging guidance (eg, fluoroscopy), and all associated radiological supervision and interpretation, each duct
47610	High	3	Cholecystectomy with exploration of common duct
48105	High	3	Resection or debridement of pancreas and peripancreatic tissue for acute necrotizing pancreatitis
47400	High	2	Hepaticotomy or hepaticostomy with exploration, drainage, or removal of calculus
47579	High	2	Unlisted laparoscopy procedure, biliary tract
47480	High	1	Cholecystotomy or cholecystostomy, open, with exploration, drainage, or removal of calculus
47535	Low	1	Conversion of external biliary drainage catheter to internal-external biliary drainage catheter, percutaneous, including diagnostic cholangiography when performed, imaging guidance (eg, fluoroscopy), and all associated radiological supervision and interpretation
47544	Low	1	Removal of calculi/debris from biliary duct(s) and/or gallbladder, percutaneous, including destruction of calculi by any method (eg, mechanical, electrohydraulic, lithotripsy) when performed, imaging guidance (eg, fluoroscopy), and all associated radiological supervision and interpretation
47564	High	1	Laparoscopy, surgical; cholecystectomy with exploration of common duct
47711	High	1	Excision of bile duct tumor, with or without primary repair of bile duct; extrahepatic
<i>Thoracic</i>			

31645	Low	178	Bronchoscopy, rigid or flexible, including fluoroscopic guidance, when performed; with therapeutic aspiration of tracheobronchial tree, initial (eg, drainage of lung abscess)
32551	Low	53	Tube thoracostomy, includes connection to drainage system (eg, water seal), when performed, open
32651	High	15	Thoracoscopy, surgical; with partial pulmonary decortication
43281	High	12	Laparoscopy, surgical, repair of paraesophageal hernia, includes fundoplasty, when performed; without implantation of mesh
21627	High	11	Sternal debridement
43212	Low	7	Esophagoscopy, flexible, transoral; with placement of endoscopic stent (includes pre- and post-dilation and guide wire passage, when performed)
39010	High	6	Mediastinotomy with exploration, drainage, removal of foreign body, or biopsy; transthoracic approach, including either transthoracic or median sternotomy
32666	High	5	Thoracoscopy, surgical; with therapeutic wedge resection (eg, mass, nodule), initial unilateral
32225	High	4	Decortication, pulmonary ; partial
32320	High	4	Decortication and parietal pleurectomy
43124	High	4	Total or partial esophagectomy, without reconstruction (any approach), with cervical esophagostomy
32220	High	3	Decortication, pulmonary ; total
32480	High	3	Removal of lung, other than pneumonectomy; single lobe (lobectomy)
32652	High	3	Thoracoscopy, surgical; with total pulmonary decortication, including intrapleural pneumonolysis
33244	High	3	Removal of single or dual chamber implantable defibrillator electrode(s); by transvenous extraction
33980	High	3	Removal of ventricular assist device, implantable intracorporeal, single ventricle
33992	High	3	Removal of percutaneous ventricular assist device at separate and distinct session from insertion
39000	High	3	Mediastinotomy with exploration, drainage, removal of foreign body, or biopsy; cervical approach
32150	High	2	Thoracotomy; with removal of intrapleural foreign body or fibrin deposit
32653	High	2	Thoracoscopy, surgical; with removal of intrapleural foreign body or fibrin deposit
33233	High	2	Removal of permanent pacemaker pulse generator only
32552	Low	1	Removal of indwelling tunneled pleural catheter with cuff
33238	High	1	Removal of permanent transvenous electrode(s) by thoracotomy
33241	High	1	Removal of implantable defibrillator pulse generator only
33243	High	1	Removal of single or dual chamber implantable defibrillator electrode(s); by thoracotomy
33977	High	1	Removal of ventricular assist device; extracorporeal, single ventricle
43310	High	1	Esophagoplasty (plastic repair or reconstruction), thoracic approach; without repair of tracheoesophageal fistula
43352	High	1	Esophagostomy, fistulization of esophagus, external; cervical approach
43360	High	1	Gastrointestinal reconstruction for previous esophagectomy, for obstructing esophageal lesion or fistula, or for previous esophageal exclusion; with stomach, with or without pyloroplasty

43415	High	1	Suture of esophageal wound or injury; transthoracic or transabdominal approach
<i>Urologic and gynecologic</i>			
52332	Low	481	Cystourethroscopy, with insertion of indwelling ureteral stent (eg, Gibbons or double-J type)
50432	Low	55	Placement of nephrostomy catheter, percutaneous, including diagnostic nephrostogram and/or ureterogram when performed, imaging guidance (eg, ultrasound and/or fluoroscopy) and all associated radiological supervision and interpretation
52352	Low	38	Cystourethroscopy, with ureteroscopy and/or pyeloscopy; with removal or manipulation of calculus (ureteral catheterization is included)
52000	Low	32	Cystourethroscopy
50435	Low	19	Exchange nephrostomy catheter, percutaneous, including diagnostic nephrostogram and/or ureterogram when performed, imaging guidance (eg, ultrasound and/or fluoroscopy) and all associated radiological supervision and interpretation
52310	Low	11	Cystourethroscopy, with removal of foreign body, calculus, or ureteral stent from urethra or bladder ; simple
54700	Low	11	Incision and drainage of epididymis, testis and/or scrotal space (eg, abscess or hematoma)
51102	Low	10	Aspiration of bladder; with insertion of suprapubic catheter
52281	Low	9	Cystourethroscopy, with calibration and/or dilation of urethral stricture or stenosis, with or without meatotomy, with or without injection procedure for cystography, male or female
56405	Low	9	Incision and drainage of vulva or perineal abscess
51865	High	6	Cystorrhaphy, suture of bladder wound, injury or rupture; complicated
55100	Low	6	Drainage of scrotal wall abscess
51040	High	4	Cystostomy, cystotomy with drainage
51705	Low	4	Change of cystostomy tube; simple
51860	High	3	Cystorrhaphy, suture of bladder wound, injury or rupture; simple
52330	Low	3	Cystourethroscopy (including ureteral catheterization); with manipulation, without removal of ureteral calculus
50370	High	2	Removal of transplanted renal allograft
52700	Low	2	Transurethral drainage of prostatic abscess
54406	High	2	Removal of all components of a multi-component, inflatable penile prosthesis without replacement of prosthesis
50040	Low	1	Nephrostomy, nephrotomy with drainage
50395	Low	1	Introduction of guide into renal pelvis and/or ureter with dilation to establish nephrostomy tract, percutaneous
53446	High	1	Removal of inflatable urethral/bladder neck sphincter, including pump, reservoir, and cuff
53620	Low	1	Dilation of urethral stricture by passage of filiform and follower, male; initial
54015	Low	1	Incision and drainage of penis, deep

54415	High	1	Removal of non-inflatable (semi-rigid) or inflatable (self-contained) penile prosthesis, without replacement of prosthesis
57010	Low	1	Colpotomy; with drainage of pelvic abscess
<i>Orthopedic and Cranial</i>			
11044	High	82	Debridement, bone (includes epidermis, dermis, subcutaneous tissue, muscle and/or fascia, if performed); first 20 sq cm or less
28820	High	47	Amputation, toe; metatarsophalangeal joint
28810	High	40	Amputation, metatarsal, with toe, single
28805	High	34	Amputation, foot; transmetatarsal
28825	High	30	Amputation, toe; interphalangeal joint
27880	High	27	Amputation, leg, through tibia and fibula
22015	High	26	Incision and drainage, open, of deep abscess (subfascial), posterior spine; lumbar, sacral, or lumbosacral
27310	High	26	Arthroscopy, knee, with exploration, drainage, or removal of foreign body (eg, infection)
27889	High	20	Ankle disarticulation
27488	High	18	Removal of prosthesis, including total knee prosthesis, methylmethacrylate with or without insertion of spacer, knee
20680	High	17	Removal of implant; deep (eg, buried wire, pin, screw, metal band, nail, rod or plate)
27598	High	15	Disarticulation at knee
27590	High	13	Amputation, thigh, through femur, any level
62256	High	12	Removal of complete cerebrospinal fluid shunt system; without replacement
27882	High	11	Amputation, leg, through tibia and fibula; open, circular (guillotine)
61601	High	11	Resection or excision of neoplastic, vascular or infectious lesion of base of anterior cranial fossa; intradural, including dural repair, with or without graft
29871	High	10	Arthroscopy, knee, surgical; for infection, lavage and drainage
22010	High	8	Incision and drainage, open, of deep abscess (subfascial), posterior spine; cervical, thoracic, or cervicothoracic
61514	High	8	Craniectomy, trephination, bone flap craniotomy; for excision of brain abscess, supratentorial
11012	High	7	Debridement including removal of foreign material at the site of an open fracture and/or an open dislocation (eg, excisional debridement); skin, subcutaneous tissue, muscle fascia, muscle, and bone
11047	High	7	Debridement, bone (includes epidermis, dermis, subcutaneous tissue, muscle and/or fascia, if performed); each additional 20 sq cm, or part thereof
28005	High	7	Incision, bone cortex (eg, osteomyelitis or bone abscess), foot
41008	Low	7	Intraoral incision and drainage of abscess, cyst, or hematoma of tongue or floor of mouth; submandibular space
41017	Low	7	Extraoral incision and drainage of abscess, cyst, or hematoma of floor of mouth; submandibular

22852	High	6	Removal of posterior segmental instrumentation
25040	High	6	Arthrotomy, radiocarpal or midcarpal joint, with exploration, drainage, or removal of foreign body
27091	High	6	Removal of hip prosthesis; complicated, including total hip prosthesis, methylmethacrylate with or without insertion of spacer
28122	High	6	Partial excision (craterization, saucerization, sequestrectomy, or diaphysectomy) bone (eg, osteomyelitis or bossing); tarsal or metatarsal bone, except talus or calcaneus
27592	High	5	Amputation, thigh, through femur, any level; open, circular (guillotine)
28120	High	5	Partial excision (craterization, saucerization, sequestrectomy, or diaphysectomy) bone (eg, osteomyelitis or bossing); talus or calcaneus
42720	High	5	Incision and drainage abscess; retropharyngeal or parapharyngeal, intraoral approach
61320	High	5	Craniectomy or craniotomy, drainage of intracranial abscess; supratentorial
62365	High	5	Removal of subcutaneous reservoir or pump, previously implanted for intrathecal or epidural infusion
20694	High	4	Removal, under anesthesia, of external fixation system
42725	High	4	Incision and drainage abscess; retropharyngeal or parapharyngeal, external approach
61607	High	4	Resection or excision of neoplastic, vascular or infectious lesion of parasellar area, cavernous sinus, clivus or midline skull base; extradural
62355	High	4	Removal of previously implanted intrathecal or epidural catheter
15937	High	3	Excision, sacral pressure ulcer, in preparation for muscle or myocutaneous flap or skin graft closure; with ostectomy
23030	High	3	Incision and drainage, shoulder area; deep abscess or hematoma
24900	High	3	Amputation, arm through humerus; with primary closure
27610	High	3	Arthrotomy, ankle, including exploration, drainage, or removal of foreign body
42700	High	3	Incision and drainage abscess; peritonsillar
61616	High	3	Resection or excision of neoplastic, vascular or infectious lesion of base of posterior cranial fossa, jugular foramen, foramen magnum, or C1-C3 vertebral bodies; intradural, including dural repair, with or without graft
63661	High	3	Removal of spinal neurostimulator electrode percutaneous array(s), including fluoroscopy, when performed
22830	High	2	Exploration of spinal fusion
23931	High	2	Incision and drainage, upper arm or elbow area; bursa
26910	Low	2	Amputation, metacarpal, with finger or thumb (ray amputation), single, with or without interosseous transfer
27596	High	2	Amputation, thigh, through femur, any level; re-amputation
28124	High	2	Partial excision (craterization, saucerization, sequestrectomy, or diaphysectomy) bone (eg, osteomyelitis or bossing); phalanx of toe
40800	Low	2	Drainage of abscess, cyst, hematoma, vestibule of mouth; simple

41000	Low	2	Intraoral incision and drainage of abscess, cyst, or hematoma of tongue or floor of mouth; lingual
41016	Low	2	Extraoral incision and drainage of abscess, cyst, or hematoma of floor of mouth; submental
41800	Low	2	Drainage of abscess, cyst, hematoma from dentoalveolar structures
11010	High	1	Debridement including removal of foreign material at the site of an open fracture and/or an open dislocation (eg, excisional debridement); skin and subcutaneous tissues
20670	Low	1	Removal of implant; superficial (eg, buried wire, pin or rod)
21025	High	1	Excision of bone (eg, for osteomyelitis or bone abscess); mandible
21502	High	1	Incision and drainage, deep abscess or hematoma, soft tissues of neck or thorax; with partial rib ostectomy
22855	High	1	Removal of anterior instrumentation
23044	High	1	Arthrotomy, acromioclavicular, sternoclavicular joint, including exploration, drainage, or removal of foreign body
23920	High	1	Disarticulation of shoulder
24000	High	1	Arthrotomy, elbow, including exploration, drainage, or removal of foreign body
24160	High	1	Removal of prosthesis, includes debridement and synovectomy when performed; humeral and ulnar components
24930	High	1	Amputation, arm through humerus; re-amputation
25900	High	1	Amputation, forearm, through radius and ulna
25905	High	1	Amputation, forearm, through radius and ulna; open, circular (guillotine)
26236	Low	1	Partial excision (craterization, saucerization, or diaphysectomy) bone (eg, osteomyelitis); distal phalanx of finger
27070	High	1	Partial excision, wing of ilium, symphysis pubis, or greater trochanter of femur, (craterization, saucerization) (eg, osteomyelitis or bone abscess); superficial
27090	High	1	Removal of hip prosthesis;
27290	High	1	Interpelviabdominal amputation (hindquarter amputation)
27295	High	1	Disarticulation of hip
27331	High	1	Arthrotomy, knee; including joint exploration, biopsy, or removal of loose or foreign bodies
27360	High	1	Partial excision (craterization, saucerization, or diaphysectomy) bone, femur, proximal tibia and/or fibula (eg, osteomyelitis or bone abscess)
27372	High	1	Removal of foreign body, deep, thigh region or knee area
27604	High	1	Incision and drainage, leg or ankle; infected bursa
27607	High	1	Incision (eg, osteomyelitis or bone abscess), leg or ankle
27620	High	1	Arthrotomy, ankle, with joint exploration, with or without biopsy, with or without removal of loose or foreign body
27886	High	1	Amputation, leg, through tibia and fibula; re-amputation
28800	High	1	Amputation, foot; midtarsal (eg, Chopart type procedure)

41005	Low	1	Intraoral incision and drainage of abscess, cyst, or hematoma of tongue or floor of mouth; sublingual, superficial
41007	Low	1	Intraoral incision and drainage of abscess, cyst, or hematoma of tongue or floor of mouth; submental space
41015	Low	1	Extraoral incision and drainage of abscess, cyst, or hematoma of floor of mouth; sublingual
42310	Low	1	Drainage of abscess; submaxillary or sublingual, intraoral
42320	Low	1	Drainage of abscess; submaxillary, external
61150	High	1	Burr hole(s) or trephine; with drainage of brain abscess or cyst
61606	High	1	Resection or excision of neoplastic, vascular or infectious lesion of infratemporal fossa, parapharyngeal space, petrous apex; intradural, including dural repair, with or without graft
63662	High	1	Removal of spinal neurostimulator electrode plate/paddle(s) placed via laminotomy or laminectomy, including fluoroscopy, when performed
63688	High	1	Revision or removal of implanted spinal neurostimulator pulse generator or receiver
<i>Soft Tissue</i>			
11042	High	251	Debridement, subcutaneous tissue (includes epidermis and dermis, if performed); first 20 sq cm or less
11043	High	155	Debridement, muscle and/or fascia (includes epidermis, dermis, and subcutaneous tissue, if performed); first 20 sq cm or less
11004	High	85	Debridement of skin, subcutaneous tissue, muscle and fascia for necrotizing soft tissue infection; external genitalia and perineum
10060	Low	55	Incision and drainage of abscess (eg, carbuncle, suppurative hidradenitis, cutaneous or subcutaneous abscess, cyst, furuncle, or paronychia); simple or single
10061	High	54	Incision and drainage of abscess (eg, carbuncle, suppurative hidradenitis, cutaneous or subcutaneous abscess, cyst, furuncle, or paronychia); complicated or multiple
10160	Low	45	Puncture aspiration of abscess, hematoma, bulla, or cyst
10030	Low	34	Image-guided fluid collection drainage by catheter (eg, abscess, hematoma, seroma, lymphocele, cyst), soft tissue (eg, extremity, abdominal wall, neck), percutaneous
11046	High	34	Debridement, muscle and/or fascia (includes epidermis, dermis, and subcutaneous tissue, if performed); each additional 20 sq cm, or part thereof
11045	High	31	Debridement, subcutaneous tissue (includes epidermis and dermis, if performed); each additional 20 sq cm, or part thereof
11005	High	29	Debridement of skin, subcutaneous tissue, muscle and fascia for necrotizing soft tissue infection; abdominal wall, with or without fascial closure
27301	High	28	Incision and drainage, deep abscess, bursa, or hematoma, thigh or knee region
36590	Low	27	Removal of tunneled central venous access device, with subcutaneous port or pump, central or peripheral insertion
35903	High	26	Excision of infected graft; extremity
21501	High	20	Incision and drainage, deep abscess or hematoma, soft tissues of neck or thorax

46050	Low	20	Incision and drainage, perianal abscess, superficial
27603	High	18	Incision and drainage, leg or ankle; deep abscess or hematoma
20005	High	16	Incision and drainage of soft tissue abscess, subfascial (ie, involves the soft tissue below the deep fascia)
25028	Low	16	Incision and drainage, forearm and/or wrist; deep abscess or hematoma
26990	High	13	Incision and drainage, pelvis or hip joint area; deep abscess or hematoma
11006	High	12	Debridement of skin, subcutaneous tissue, muscle and fascia for necrotizing soft tissue infection; external genitalia, perineum and abdominal wall, with or without fascial closure
28002	High	12	Incision and drainage below fascia, with or without tendon sheath involvement, foot; single bursal space
23930	High	7	Incision and drainage, upper arm or elbow area; deep abscess or hematoma
25025	Low	5	Decompression fasciotomy, forearm and/or wrist, flexor AND extensor compartment; with debridement of nonviable muscle and/or nerve
11000	High	4	Debridement of extensive eczematous or infected skin; up to 10% of body surface
19020	High	4	Mastotomy with exploration or drainage of abscess, deep
10120	Low	3	Incision and removal of foreign body, subcutaneous tissues; simple
10121	Low	3	Incision and removal of foreign body, subcutaneous tissues; complicated
28003	High	3	Incision and drainage below fascia, with or without tendon sheath involvement, foot; multiple areas
11770	Low	2	Excision of pilonidal cyst or sinus; simple
11771	High	2	Excision of pilonidal cyst or sinus; extensive
15940	High	2	Excision, ischial pressure ulcer, with primary suture
25023	Low	2	Decompression fasciotomy, forearm and/or wrist, flexor OR extensor compartment; with debridement of nonviable muscle and/or nerve
27892	High	2	Decompression fasciotomy, leg; anterior and/or lateral compartments only, with debridement of nonviable muscle and/or nerve
35907	High	2	Excision of infected graft; abdomen
11971	High	1	Removal of tissue expander(s) without insertion of prosthesis
15931	High	1	Excision, sacral pressure ulcer, with primary suture
27057	High	1	Decompression fasciotomy(ies), pelvic (buttock) compartment(s) (eg, gluteus medius-minimus, gluteus maximus, iliopsoas, and/or tensor fascia lata muscle) with debridement of nonviable muscle, unilateral
27497	High	1	Decompression fasciotomy, thigh and/or knee, 1 compartment (flexor or extensor or adductor); with debridement of nonviable muscle and/or nerve
27499	High	1	Decompression fasciotomy, thigh and/or knee, multiple compartments; with debridement of nonviable muscle and/or nerve

28190	Low	1	Removal of foreign body, foot; subcutaneous
28193	High	1	Removal of foreign body, foot; complicated
46020	Low	1	Placement of seton

^aIncludes only procedures defined by modified Delphi consensus methodology and validated through clinical adjudication which were identified within the primary cohort source control including.

^aThe Operative Stress Score guided the categorization of procedures as low (Operative Stress Score, 1) or high (Operative Stress Score, 2-5). Procedures not rated by the Operative Stress Score were provided a stress category which was consistent with similar procedure with a rating.

Abbreviations: CPT: Current Procedural Terminology.

eTable 3. Most common source control intervention families

CPT Code ^a	Procedure Description ^b	Count ^c
<i>Exploratory Laparotomy or Laparoscopy Intervention Family</i>		
43659	Unlisted laparoscopy procedure, stomach	12
43840	Gastrorrhaphy, suture of perforated duodenal or gastric ulcer, wound, or injury	39
44050	Reduction of volvulus, intussusception, internal hernia, by laparotomy	13
44120	Enterectomy, resection of small intestine; single resection and anastomosis	149
44125	Enterectomy, resection of small intestine; with enterostomy	15
44130	Enteroenterostomy, anastomosis of intestine, with or without cutaneous enterostomy	22
44140	Colectomy, partial; with anastomosis	92
44141	Colectomy, partial; with skin level cecostomy or colostomy	52
44143	Colectomy, partial; with end colostomy and closure of distal segment (Hartmann type procedure)	75
44144	Colectomy, partial; with resection, with colostomy or ileostomy and creation of mucofistula	15
44145	Colectomy, partial; with coloproctostomy (low pelvic anastomosis)	17
44150	Colectomy, total, abdominal, without proctectomy; with ileostomy or ileoproctostomy	25
44160	Colectomy, partial, with removal of terminal ileum with ileocolostomy	61
44180	Laparoscopy, surgical, enterolysis (freeing of intestinal adhesion)	18
44187	Laparoscopy, surgical; ileostomy or jejunostomy, non-tube	15
44310	Ileostomy or jejunostomy, non-tube	32
44320	Colostomy or skin level cecostomy	22
44602	Suture of small intestine (enterorrhaphy) for perforated ulcer, diverticulum, wound, injury or rupture; single perforation	18
49000	Exploratory laparotomy, exploratory celiotomy with or without biopsy(s)	113
49002	Reopening of recent laparotomy	100
49561	Repair initial incisional or ventral hernia; incarcerated or strangulated	34
49587	Repair umbilical hernia, age 5 years or older; incarcerated or strangulated	13
<i>Biliary Decompression Intervention Family</i>		
43260	ERCP diagnostic, including collection of specimen(s) by brushing or washing, when performed	46
43261	ERCP; biopsy, single or multiple	50
43262	ERCP; sphincterotomy/papillotomy	202
43264	ERCP; removal of calculi/debris from biliary/pancreatic duct(s)	220
43265	ERCP; destruction of calculi, any method (eg, mechanical, electrohydraulic, lithotripsy)	24
43266	Esophagogastroduodenoscopy, flexible, transoral; with placement of endoscopic stent (includes pre- and post-dilation and guide wire passage, when performed)	22
43274	ERCP; placement of endoscopic stent into biliary or pancreatic duct, including pre- and post-dilation and guide wire passage, when performed, including sphincterotomy, when performed, each stent	167
43275	ERCP; removal of foreign body(s) or stent(s) from biliary/pancreatic duct(s)	15

	43276	ERCP; removal and exchange of stent(s), biliary or pancreatic duct, including pre- and post-dilation and guide wire passage, when performed, including sphincterotomy, when performed, each stent exchanged	41
	43277	ERCP; trans-endoscopic balloon dilation of biliary/pancreatic duct(s) or of ampulla (sphincteroplasty), including sphincterotomy, when performed, each duct	28
	47534	Placement of biliary drainage catheter, percutaneous, including diagnostic cholangiography when performed, imaging guidance (eg, ultrasound and/or fluoroscopy), and all associated radiological supervision and interpretation; internal-external	24
	47536	Exchange of biliary drainage catheter (eg, external, internal-external, or conversion of internal-external to external only), percutaneous, including diagnostic cholangiography when performed, imaging guidance (eg, fluoroscopy), and all associated radiological supervision and interpretation	21
<i>Urinary Decompression Intervention Family</i>			
	52000	Cystourethroscopy	39
	52281	Cystourethroscopy, with calibration and/or dilation of urethral stricture or stenosis, with or without meatotomy, with or without injection procedure for cystography, male or female	11
	52310	Cystourethroscopy, with removal of foreign body, calculus, or ureteral stent from urethra or bladder ; simple	13
	52332	Cystourethroscopy, with insertion of indwelling ureteral stent (eg, Gibbons or double-J type)	510
	52352	Cystourethroscopy, with ureteroscopy and/or pyeloscopy; with removal or manipulation of calculus (ureteral catheterization is included)	50
	50432	Placement of nephrostomy catheter, percutaneous, including diagnostic nephrostogram and/or ureterogram when performed, imaging guidance (eg, ultrasound and/or fluoroscopy) and all associated radiological supervision and interpretation	61
	50435	Exchange nephrostomy catheter, percutaneous, including diagnostic nephrostogram and/or ureterogram when performed, imaging guidance (eg, ultrasound and/or fluoroscopy) and all associated radiological supervision and interpretation	20
<i>Debridement of Soft Tissue Intervention Family</i>			
	11004	Debridement of skin, subcutaneous tissue, muscle and fascia for necrotizing soft tissue infection; external genitalia and perineum	136
	11005	Debridement of skin, subcutaneous tissue, muscle and fascia for necrotizing soft tissue infection; abdominal wall, with or without fascial closure	49
	11006	Debridement of skin, subcutaneous tissue, muscle and fascia for necrotizing soft tissue infection; external genitalia, perineum and abdominal wall, with or without fascial closure	25
	11042	Debridement, subcutaneous tissue (includes epidermis and dermis, if performed); first 20 sq cm or less	412
	11043	Debridement, muscle and/or fascia (includes epidermis, dermis, and subcutaneous tissue, if performed); first 20 sq cm or less	269
	11045	Debridement, subcutaneous tissue (includes epidermis and dermis, if performed); each additional 20 sq cm, or part thereof (List separately in addition to code for primary procedure)	71
	11046	Debridement, muscle and/or fascia (includes epidermis, dermis, and subcutaneous tissue, if performed); each additional 20 sq cm, or part thereof (List separately in addition to code for primary procedure)	85

<i>Incision and Percutaneous Drainage Intervention Family</i>		
10030	Image-guided fluid collection drainage by catheter (eg, abscess, hematoma, seroma, lymphocele, cyst), soft tissue (eg, extremity, abdominal wall, neck), percutaneous	35
10060	Incision and drainage of abscess (eg, carbuncle, suppurative hidradenitis, cutaneous or subcutaneous abscess, cyst, furuncle, or paronychia); simple or single	82
10061	Incision and drainage of abscess (eg, carbuncle, suppurative hidradenitis, cutaneous or subcutaneous abscess, cyst, furuncle, or paronychia); complicated or multiple	85
10160	Puncture aspiration of abscess, hematoma, bulla, or cyst	52
10160	Puncture aspiration of abscess, hematoma, bulla, or cyst	52
20005	Incision and drainage of soft tissue abscess, subfascial (ie, involves the soft tissue below the deep fascia)	20
21501	Incision and drainage, deep abscess or hematoma, soft tissues of neck or thorax	32
22010	Incision and drainage, open, of deep abscess (subfascial), posterior spine; cervical, thoracic, or cervicothoracic	11
22015	Incision and drainage, open, of deep abscess (subfascial), posterior spine; lumbar, sacral, or lumbosacral	33
25028	Incision and drainage, forearm and/or wrist; deep abscess or hematoma	21
26990	Incision and drainage, pelvis or hip joint area; deep abscess or hematoma	21
27301	Incision and drainage, deep abscess, bursa, or hematoma, thigh or knee region	36
27603	Incision and drainage, leg or ankle; deep abscess or hematoma	24
46040	Incision and drainage of ischiorectal and/or perirectal abscess	55
46050	Incision and drainage, perianal abscess, superficial	32
49405	Image-guided fluid collection drainage by catheter (eg, abscess, hematoma, seroma, lymphocele, cyst); visceral (eg, kidney, liver, spleen, lung/mediastinum), percutaneous	35
49406	Image-guided fluid collection drainage by catheter (eg, abscess, hematoma, seroma, lymphocele, cyst); peritoneal or retroperitoneal, percutaneous	373
49423	Exchange of previously placed abscess or cyst drainage catheter under radiological guidance	14
54700	Incision and drainage of epididymis, testis and/or scrotal space (eg, abscess or hematoma)	12
55100	Drainage of scrotal wall abscess	10
56405	Incision and drainage of vulva or perineal abscess	11

^a Eligible *Current Procedural Terminology* (CPT) codes included those that occurred >10 times in the primary cohort.

^a Eligible procedures included those that occurred >500 times in the primary cohort and therefore accounting for >10% of the primary cohort.

^c Patients may have more than once *Current Procedural Terminology* code per index source control procedure

eTable 4. Feature summary statistics before and after imputation

Feature^a	Original^b	Imputed^b	Missingness
BMI	30.9 (9.6)	30.9 (9.5)	3.9%
Heart Rate, beats/minute	98 (21)	98 (21)	5.6%
Systolic BP, mmHg	137 (30)	138 (30)	5.8%
Diastolic BP, mmHg	77 (17)	77 (18)	6.1%
O ₂ Saturation, %	94 (5)	94 (5)	6.7%
Respiratory Rate, breaths/minute	21 (6)	21 (6)	8.5%
Temperature, °C	37.1 (0.8)	37.1 (0.8)	8.5%
Hemoglobin, g/dL	12 (2)	12 (2)	38%
Potassium, mEq/L	4 (1)	4 (1)	38%
Bicarbonate, mEq/L	24 (5)	24 (4)	39%
BUN, mg/dL	26 (21)	27 (22)	39%
Chloride, mEq/L	102 (6)	102 (6)	39%
Creatinine, mg/dL	1.6 (1.6)	1.7 (1.7)	39%
Glucose, mg/dL	158 (89)	159 (93)	39%
Platelets, x10 ⁹ /L	253 (126)	253 (126)	39%
Sodium, mEq/L	136 (5)	136 (5)	39%
WBC, x10 ³ /L	14 (9)	14 (9)	39%
Albumin, g/dL	3.1 (0.8)	3.0 (0.7)	56%
ALT, U/L	77 (228)	76 (206)	56%
AST, U/L	99 (436)	92 (334)	56%
Bilirubin, mg/dL	1.9 (3.4)	2.0 (3.5)	56%
INR	1.5 (1.1)	1.5 (1.2)	58%
Serum Lactate, mmol/L	2.7 (2.7)	2.1 (2.2)	76%

^a Age, race, gender, SOFA, and Elixhauser included in imputation, but had 0% missing
^b Mean (SD) presented for all values for worst values measured prior to sepsis onset

Abbreviations: ALT: alanine transaminase; AST: aspartate transaminase; BMI: body mass index; BP: blood pressure; BUN: blood urea nitrogen; INR: international normalized ratio; SD: standard deviation; SOFA: sequential organ failure assessment score; WBC: white blood cell count

eTable 5. Cohort characteristics by anatomic location of source control

Feature	Overall	GI and Abdominal	HPB	Thoracic	Urologic and Gynecologic	Orthopedic and Cranial	Soft Tissue
N	4,962	1,372 (28%)	883 (18%)	347 (7%)	714 (14%)	616 (12%)	1,030 (21%)
<i>Patient Characteristics</i>							
Age, years, mean (SD)	62 (16)	61 (16)	67 (16)	61 (15)	64 (16)	61 (15)	57 (16)
Sex, male, no. (%)	2,604 (52%)	681 (50%)	459 (52%)	220 (63%)	317 (44%)	371 (60%)	556 (54%)
Race, no. (%) ^a							
White	4,226 (85%)	1,164 (85%)	752 (85%)	305 (88%)	647 (91%)	495 (80%)	863 (84%)
Black	422 (9%)	118 (9%)	54 (6%)	16 (5%)	50 (7%)	91 (15%)	93 (9%)
Other	314 (6%)	90 (7%)	77 (9%)	26 (7%)	17 (2%)	30 (5%)	74 (7%)
BMI, mean (SD)	30.9 (9.6)	29.5 (8.8)	29.6 (8.1)	29.2 (10.3)	32.0 (9.7)	31.3 (9.2)	33.3 (10.9)
SOFA, max within 6hrs, mean (SD) ^b	3.8 (2.5)	4.3 (2.7)	3.7 (2.2)	4.5 (2.9)	3.5 (1.9)	3.2 (2.3)	3.7 (2.4)
Elixhauser, mean (SD) ^c	4.0 (2.4)	4.2 (2.4)	3.4 (2.2)	4.5 (2.2)	3.5 (2.2)	4.5 (2.4)	4.1 (2.4)
<i>Selected Vitals and Labs^d</i>							
Heart rate, beats/minute, mean (SD)	98 (21)	101 (23)	93 (20)	101 (21)	97 (21)	94 (20)	99 (21)
Respiratory rate, breaths/minute, mean (SD)	21 (6)	21 (6)	20 (5)	24 (7)	21 (5)	20 (5)	20 (4)
Serum lactate, mmol/L, mean (SD)	2.7 (2.7)	3.0 (3.0)	2.3 (1.9)	2.4 (2.5)	2.5 (2.0)	3.0 (3.5)	2.4 (2.1)
INR, mean (SD)	1.5 (1.1)	1.6 (1.2)	1.5 (1.2)	1.4 (0.7)	1.5 (1.4)	1.5 (1.3)	1.5 (0.8)
Creatinine, mg/dL, mean (SD)	1.6 (1.6)	1.7 (1.7)	1.3 (1.0)	1.2 (0.9)	2.1 (2.1)	1.7 (1.8)	1.6 (1.7)
Bilirubin, mg/dL, mean (SD)	1.9 (3.4)	1.7 (3.3)	3.7 (4.9)	1.2 (2.1)	0.8 (0.7)	0.9 (1.5)	1.1 (1.7)
<i>Hospital and Source Control Characteristics</i>							
Mandated Surgeon Availability, no. (%)							
In-house 24-hours	2503 (50.4%)	736 (53.6%)	467 (52.9%)	235 (67.7%)	188 (26.3%)	328 (53.2%)	549 (53.3%)
Available 24-hours	252 (5.1%)	97 (7.1%)	40 (4.5%)	9 (2.6%)	54 (7.6%)	12 (1.9%)	40 (3.9%)
Not Mandated	2207 (44.5%)	539 (39.3%)	376 (42.6%)	103 (29.7%)	472 (66.1%)	276 (44.8%)	441 (42.8%)
Transfer Status, no. (%)							
Not transfer	4219 (85.0%)	1174 (85.6%)	749 (84.8%)	279 (80.4%)	665 (93.1%)	496 (80.5%)	856 (83.1%)
Transfer	743 (15.0%)	198 (14.4%)	134 (15.2%)	68 (19.6%)	49 (6.9%)	120 (19.5%)	174 (16.9%)
Time to Antibiotics, hours, mean (SD)	1.5 (0.2, 3.7)	1.1 (0.1, 3.8)	2.1 (0.5, 4.4)	0.6 (-0.2, 2.9)	1.9 (0.6, 4.4)	1.5 (0.2, 4.0)	1.1 (0.2, 2.7)

Time to Source Control, hours, mean (SD)	15.4 (5.5, 21.7)	11.9 (3.5, 19.5)	17.9 (13.0, 23.5)	11.0 (1.6, 21.1)	16.7 (9.3, 22.2)	17.5 (9.1, 23.0)	14.8 (3.8, 21.6)
Procedural Stress ^e , no. (%)							
Less stressful	2568 (52%)	489 (36%)	642 (73%)	239 (69%)	695 (97%)	31 (5%)	214 (21%)
More stressful	2394 (48%)	883 (64%)	241 (27%)	108 (31%)	19 (3%)	585 (95%)	816 (79%)
Hospital Utilization and Outcomes							
Mechanical Ventilation, any, no. (%)	1,493 (30%)	573 (42%)	138 (16%)	272 (78%)	92 (13%)	132 (21%)	286 (28%)
Vasopressors, any, no. (%)	1,010 (20%)	397 (29%)	115 (13%)	159 (46%)	92 (13%)	83 (13%)	164 (16%)
Admitted to ICU, no. (%)	2,219 (45%)	765 (56%)	268 (30%)	301 (87%)	221 (31%)	232 (38%)	432 (42%)
Hospital LOS, days, mean (SD)	11.8 (12.3)	13.0 (11.2)	7.9 (7.3)	21.0 (24.9)	7.4 (8.0)	12.0 (9.5)	13.2 (12.3)
In-hospital Mortality, no. (%)	287 (5.8%)	129 (9.4%)	36 (4.1%)	44 (12.7%)	16 (2.2%)	29 (4.7%)	33 (3.2%)
90-Day Mortality, no. (%)	706 (14.2%)	278 (20.3%)	123 (13.9%)	74 (21.3%)	67 (9.4%)	68 (11.0%)	96 (9.3%)
^a Other race corresponds to Chinese, Filipino, Hawaiian, American Indian/Alaskan, Asian, Hawaiian/Other Pacific Islander, Middle Eastern, Native American, or Pacific Islander							
^b SOFA score corresponds to the severity of organ dysfunction, reflecting six organ systems each with a score range of 0 to 4 points (cardiovascular, hepatic, hematologic, respiratory, cranial, renal), with a total score range of 0 to 24 points							
^c Elixhauser is a method of categorizing comorbidities of patients based on the International Classification of Diseases (ICD) diagnosis codes found in administrative data, ranging from 0 to 31							
^d Missing data imputed via random forest models (eTable 3)							
^e Physiologic stress was guided by the Operative Stress Score (Low<1; High 2-5). Procedures without an Operative Stress Score rating were assigned a physiologic stress level based the rating of similar procedures.							
<i>Abbreviations:</i> BMI: body mass index; GI: gastrointestinal; HPB: Hepatopancreatobiliary; ICU: intensive care unit; INR: international normalized ratio; IQR: interquartile range; LOS: length of stay; SD: standard deviation; SOFA: sequential organ failure assessment score							

eTable 6. Logistic Regression - Primary model with all-cause 90-day mortality as outcome

Feature ^a	aOR	aOR 95% CI	P-Value
Source Control			
>6hrs after sepsis onset	Ref	-	-
≤6hrs of sepsis onset	0.71	0.63-0.80	<0.001
Age	1.03	1.02-1.04	<0.001
Race^b			
White	Ref	-	-
Black	0.79	0.66-0.94	0.01
Other	1.53	1.39-1.69	<0.001
Sex			
Female	Ref	-	-
Male	1.12	0.99-1.28	0.07
SOFA ^c	1.17	1.11-1.24	<0.001
Elixhauser ^d	1.25	1.20-1.30	<0.001
BMI Category			
Normal (18.5 to 25)	Ref	-	-
Underweight (less than 18.5)	1.45	1.02-2.07	0.039
Overweight (25 to 30)	0.68	0.57-0.81	<0.001
Obese (30 or higher)	0.63	0.43-0.92	0.018
Hospital Transfer			
Not transfer	Ref	-	-
Transfer	1.59	1.15-2.20	0.05
Surgeon Availability			
24hr on-site	Ref	-	-
24hr available	0.95	0.68-1.31	0.74
Not mandated	0.86	0.52-1.44	0.57
Anatomic Location			
GI and Abdominal	Ref	-	-
HPB	0.52	0.40-0.67	<0.001
Thoracic	0.85	0.61-1.18	0.34
Urologic and Gynecologic	0.42	0.30-0.59	<0.001
Orthopedic and Cranial	0.56	0.42-0.75	0.001
Soft tissue	0.52	0.34-0.77	<0.001
Procedural Physiologic Stress			
Low stress	Ref	-	-
High stress	0.72	0.53-0.98	0.037

^aYear of admission included as fixed effect and p>0.05 for all years, not shown

^bOther race corresponds to Chinese, Filipino, Hawaiian, American Indian/Alaskan, Asian, Hawaiian/Other Pacific Islander, Middle Eastern, Native American, or Pacific Islander

^cSOFA score corresponds to the severity of organ dysfunction, reflecting six organ systems each with a score range of 0 to 4 points (cardiovascular, hepatic, hematologic, respiratory, cranial, renal), with a total score range of 0 to 24 points

^dElixhauser is a method of categorizing comorbidities of patients based on the International Classification of Diseases (ICD) diagnosis codes found in administrative data, ranging from 0 to 31

Abbreviations: aOR: adjusted odds ratio; BMI: body mass index; CI: confidence interval; SOFA: sequential organ failure assessment

eTable 7. Logistic Regression - Primary model with all-cause in-hospital mortality as outcome

Feature ^a	aOR	aOR 95% CI	P-Value
Source Control			
>6hrs after sepsis onset	Ref	-	-
≤6hrs of sepsis onset	0.76	(0.63-0.90)	0.002
Age	1.02	(1.01-1.03)	0.001
Race^b			
White	Ref	-	-
Black	0.82	(0.73-0.93)	0.002
Other	1.72	(1.38-2.14)	<0.001
Sex			
Female	Ref	-	-
Male	1.21	(1.03-1.41)	0.018
SOFA ^c	1.18	(1.14-1.23)	<0.001
Elixhauser ^d	1.33	(1.26-1.40)	<0.001
BMI Category			
Normal (18.5 to 25)	Ref	-	-
Underweight (less than 18.5)	2.01	(1.37-2.94)	<0.001
Overweight (25 to 30)	0.99	(0.79-1.25)	0.95
Obese (30 or higher)	1.08	(0.76-1.53)	0.68
Hospital Transfer			
Not transfer	Ref	-	-
Transfer	1.92	(1.52-2.42)	0
Surgeon Availability			
24hr on-site	Ref	-	-
24hr available	1.26	(0.75-2.13)	0.38
Not mandated	0.52	(0.25-1.07)	0.077
Anatomic Location			
GI and Abdominal	Ref	-	-
HPB	0.55	(0.40-0.77)	<0.001
Thoracic	1.50	(1.11-2.01)	0.008
Urologic and Gynecologic	0.48	(0.32-0.71)	<0.001
Orthopedic and Cranial	0.48	(0.37-0.62)	<0.001
Soft tissue	0.34	(0.23-0.49)	<0.001
Procedural Physiologic Stress			
Low stress	Ref	-	-
High stress	1.50	(1.05-2.15)	0.025

^aYear of admission included as fixed effect and p>0.05 for all years, not shown

^bOther race corresponds to Chinese, Filipino, Hawaiian, American Indian/Alaskan, Asian, Hawaiian/Other Pacific Islander, Middle Eastern, Native American, or Pacific Islander

^cSOFA score corresponds to the severity of organ dysfunction, reflecting six organ systems each with a score range of 0 to 4 points (cardiovascular, hepatic, hematologic, respiratory, cranial, renal), with a total score range of 0 to 24 points

^dElixhauser is a method of categorizing comorbidities of patients based on the International Classification of Diseases (ICD) diagnosis codes found in administrative data, ranging from 0 to 31

Abbreviations: aOR: adjusted odds ratio; BMI: body mass index; CI: confidence interval; SOFA: sequential organ failure assessment

eTable 8. Logistic Regression - Primary model with all-cause 1-year mortality as outcome

Feature ^a	aOR	aOR 95% CI	P-Value
Source Control			
>6hrs after sepsis onset	Ref	-	-
≤6hrs of sepsis onset	0.66	(0.61-0.71)	<0.001
Age	1.03	(1.02-1.04)	<0.001
Race^b			
White	Ref	-	-
Black	0.94	(0.79-1.12)	0.48
Other	1.25	(1.01-1.56)	0.043
Sex			
Female	Ref	-	-
Male	1.17	(1.05-1.32)	<0.001
SOFA ^c	1.14	(1.09-1.18)	<0.001
Elixhauser ^d	1.27	(1.21-1.34)	<0.001
BMI Category			
Normal (18.5 to 25)	Ref	-	-
Underweight (less than 18.5)	2.17	(1.52-3.10)	<0.001
Overweight (25 to 30)	0.72	(0.64-0.81)	<0.001
Obese (30 or higher)	0.58	(0.41-0.81)	0.001
Hospital Transfer			
Not transfer	Ref	-	-
Transfer	1.45	(1.06-1.99)	0.021
Surgeon Availability			
24hr on-site	Ref	-	-
24hr available	1.10	(0.77-1.57)	0.59
Not mandated	1.02	(0.59-1.76)	0.95
Anatomic Location			
GI and Abdominal	Ref	-	-
HPB	0.57	(0.40-0.82)	0.002
Thoracic	0.84	(0.55-1.28)	0.42
Urologic and Gynecologic	0.41	(0.29-0.59)	<0.001
Orthopedic and Cranial	0.58	(0.41-0.83)	0.003
Soft tissue	0.66	(0.42-1.03)	0.069
Procedural Physiologic Stress			
Low stress	Ref	-	-
High stress	0.59	(0.48-0.71)	<0.001

^aYear of admission included as fixed effect and p>0.05 for all years, not shown

^bOther race corresponds to Chinese, Filipino, Hawaiian, American Indian/Alaskan, Asian, Hawaiian/Other Pacific Islander, Middle Eastern, Native American, or Pacific Islander

^cSOFA score corresponds to the severity of organ dysfunction, reflecting six organ systems each with a score range of 0 to 4 points (cardiovascular, hepatic, hematologic, respiratory, cranial, renal), with a total score range of 0 to 24 points

^dElixhauser is a method of categorizing comorbidities of patients based on the International Classification of Diseases (ICD) diagnosis codes found in administrative data, ranging from 0 to 31

Abbreviations: aOR: adjusted odds ratio; BMI: body mass index; CI: confidence interval; SOFA: sequential organ failure assessment

eTable 9. Cohort characteristics by most common intervention

Feature	All undergoing most common interventions	Exploratory laparotomy	Biliary decompression	Urinary decompression	Soft tissue debridement	Incision or percutaneous drainage
N	3309	680	535	647	704	743
<i>Patient Characteristics</i>						
Age, years, mean (SD)	63 (15)	64 (15)	68 (15)	64 (16)	56 (16)	62 (14)
Sex, male, no. (%)	1666 (50%)	335 (49%)	278 (52%)	266 (41%)	383 (54%)	404 (54%)
Race, no. (%) ^a						
White	2812 (85%)	570 (84%)	456 (85%)	587 (91%)	579 (82%)	620 (83%)
Black	280 (8%)	58 (9%)	24 (4%)	44 (7%)	61 (9%)	93 (13%)
Other	217 (7%)	52 (8%)	55 (10%)	16 (2%)	64 (9%)	30 (4%)
BMI, mean (SD)	31.1 (9.8)	29.7 (9.3)	28.9 (8.7)	32.0 (9.6)	34.3 (11.0)	30.2 (9.2)
SOFA, max within 6hrs, mean (SD) ^b	3.9 (2.5)	5.0 (3.0)	3.8 (2.2)	3.4 (1.9)	4.1 (2.7)	3.4 (2.1)
Elixhauser, mean (SD) ^c	4.1 (2.3)	4.7 (2.4)	3.5 (2.2)	3.5 (2.2)	4.3 (2.4)	4.4 (2.3)
<i>Selected Vitals and Labs^d</i>						
Heart rate, beats/minute, mean (SD)	98 (21)	106 (24)	93 (20)	96 (20)	100 (21)	94 (19)
Respiratory rate, breaths/minute, mean (SD)	21 (6)	23 (7)	20 (5)	21 (6)	20 (5)	20 (5)
GCS, mean (SD)	13.7 (2.8)	12.9 (3.6)	13.9 (2.5)	14.1 (2.1)	13.7 (2.8)	14.0 (2.3)
Serum lactate, mmol/L, mean (SD)	2.1 (2.2)	3.1 (3.2)	1.9 (1.8)	1.9 (1.7)	2.0 (2.0)	1.9 (1.7)
INR, mean (SD)	2.1 (2.2)	3.1 (3.2)	1.9 (1.8)	1.9 (1.7)	2.0 (2.0)	1.9 (1.7)
Creatinine, mg/dL, mean (SD)	1.8 (1.8)	1.9 (1.8)	1.5 (1.2)	1.9 (2.0)	1.7 (1.7)	1.9 (1.9)
Bilirubin, mg/dL, mean (SD)	1.8 (1.8)	1.9 (1.8)	1.5 (1.2)	1.9 (2.0)	1.7 (1.7)	1.9 (1.9)
<i>Hospital and Source Control Characteristics</i>						
Mandated Surgeon Availability, no. (%)						
In-house 24-hours	1724 (52.1%)	393 (57.8%)	353 (66.0%)	158 (24.4%)	440 (62.5%)	380 (51.1%)
Available 24-hours	173 (5.2%)	53 (7.8%)	18 (3.4%)	51 (7.9%)	21 (3.0%)	30 (4.0%)
Not Mandated	1412 (42.7%)	234 (34.4%)	164 (30.7%)	438 (67.7%)	243 (34.5%)	333 (44.8%)
Transfer Status, no. (%)						
Not transfer	2845 (86.0%)	573 (84.3%)	443 (82.8%)	605 (93.5%)	595 (84.5%)	629 (84.7%)
Transfer	464 (14.0%)	107 (15.7%)	92 (17.2%)	42 (6.5%)	109 (15.5%)	114 (15.3%)

Time to Antibiotics, hours, mean (SD)	1.6 (0.3, 3.8)	0.6 (-0.1, 2.9)	2.5 (0.7, 5.0)	1.9 (0.6, 4.6)	0.9 (0.1, 2.6)	1.8 (0.4, 4.4)
Time to Source Control, hours, mean (SD)	15.3 (5.6, 21.7)	6.5 (2.1, 16.4)	17.7 (13.4, 23.4)	17.0 (10.1, 22.4)	9.2 (2.9, 19.9)	18.1 (12.6, 23.1)
Procedural Stress, no. (%)						
Less stressful	1713 (52%)	13 (2%)	531 (99%)	640 (99%)	36 (5%)	493 (66%)
More stressful	1596 (48%)	667 (98%)	4 (1%)	7 (1%)	668 (95%)	250 (34%)
Hospital Utilization and Outcomes						
Mechanical Ventilation, any, no. (%)	973 (29%)	474 (70%)	75 (14%)	70 (11%)	262 (37%)	92 (12%)
Vasopressors, any, no. (%)	690 (21%)	327 (48%)	55 (10%)	77 (12%)	152 (22%)	79 (11%)
Admitted to ICU, no. (%)	1470 (44%)	562 (83%)	141 (26%)	191 (30%)	362 (51%)	214 (29%)
Hospital LOS, days, mean (SD)	7.9 (8.0)	9.8 (8.8)	6.2 (5.9)	5.1 (5.0)	7.9 (8.4)	6.6 (6.7)
In-hospital Mortality, no. (%)	199 (6.0%)	104 (15.3%)	25 (4.7%)	11 (1.7%)	26 (3.7%)	33 (4.4%)
90-Day Mortality, no. (%)	516 (15.6%)	169 (24.9%)	92 (17.2%)	53 (8.2%)	64 (9.1%)	138 (18.6%)
^a Other race corresponds to Chinese, Filipino, Hawaiian, American Indian/Alaskan, Asian, Hawaiian/Other Pacific Islander, Middle Eastern, Native American, or Pacific Islander						
^b SOFA score corresponds to the severity of organ dysfunction, reflecting six organ systems each with a score range of 0 to 4 points (cardiovascular, hepatic, hematologic, respiratory, cranial, renal), with a total score range of 0 to 24 points						
^c Elixhauser is a method of categorizing comorbidities of patients based on the International Classification of Diseases (ICD) diagnosis codes found in administrative data, ranging from 0 to 31						
^d Denotes minimum GCS and maximum of all other values prior to sepsis onset						
Abbreviations: BMI: body mass index; GI: gastrointestinal; HPB: Hepatopancreatobiliary; ICU: intensive care unit; INR: international normalized ratio; IQR: interquartile range; LOS: length of stay; SD: standard deviation; SOFA: sequential organ failure assessment score						

eTable 10. Adjusted absolute risk difference of 90-day mortality when compared to source control at 6 hours, by most common interventions

Most common intervention	No.	90-day mortality No. (%)	Adjusted mortality absolute difference from source control at 6 hours			
			3 hours	12 hours	24 hours	36 hours
All Most common interventions	3,309	516 (16%)	-0.38%	0.82%	2.76%	5.12%
Exploratory Laparotomy	681	169 (25%)	-1.25%	2.63%	8.37%	14.68%
Biliary Decompression	539	92 (17%)	-0.45%	0.93%	2.92%	5.07%
Urinary Decompression	649	53 (8%)	-0.45%	0.99%	3.38%	6.42%
Debridement of Skin, Subcutaneous Tissue, Muscle and/or Fascia	716	64 (9%)	-0.74%	1.70%	6.14%	12.16%
Incision and Percutaneous Drainage	743	138 (19%)	0.34%	-0.68%	-1.98%	-3.22%

eTable 11. Sensitivity Analyses - Modifications to Covariate Set

Sensitivity Analyses – 90-day mortality		aOR	95% CI	P Value
<i>Primary Model – Early Source Control</i>				
	Primary Cohort (N=4,962)	0.71	0.63 - 0.80	<0.001
<i>Alterative Time to Source Control</i>				
	Very early (<3 hours; N=811)	0.68	0.58 - 0.81	<0.001
<i>Expanding Cohort</i>				
	Including those who died within 2 days of sepsis onset (N=5,054)	0.74	0.65 - 0.86	<0.001
<i>Limiting Cohort</i>				
	Excluding hospital transfers (N=4,219)	0.64	0.54 - 0.77	<0.001
	Excluding pre-procedural SOFA ^a <2 (N=3,123)	0.60	0.49 - 0.75	<0.001
	Excluding time to source control >30 hours (N=4,643)	0.74	0.62 - 0.85	<0.001
	Excluding time to source control >24 hours (N=4,110)	0.73	0.62 - 0.89	<0.001
<i>Primary Model With Individual Additional Predictors</i>				
Adding sepsis specific variables				
	Primary model + time to antibiotics	0.70	0.63 - 0.79	<0.001
	Primary model + pre-procedure lactate	0.74	0.64 - 0.87	<0.001
Adding procedure specific variables				
	Primary model + Operative Stress Score ^b	0.66	0.57 - 0.76	<0.001
	Primary model + procedure time	0.67	0.59 - 0.76	<0.001
Adding disease specific variables				
	Primary model + preprocedural bilirubin, creatinine, INR ^c	0.75	0.66 - 0.86	<0.001
<i>Primary Model With All Additional Predictors</i>				
	Primary model + time to antibiotics + lactate + Operative Stress Score + procedure time + bilirubin, creatinine, INR	0.72	0.59 - 0.86	<0.001

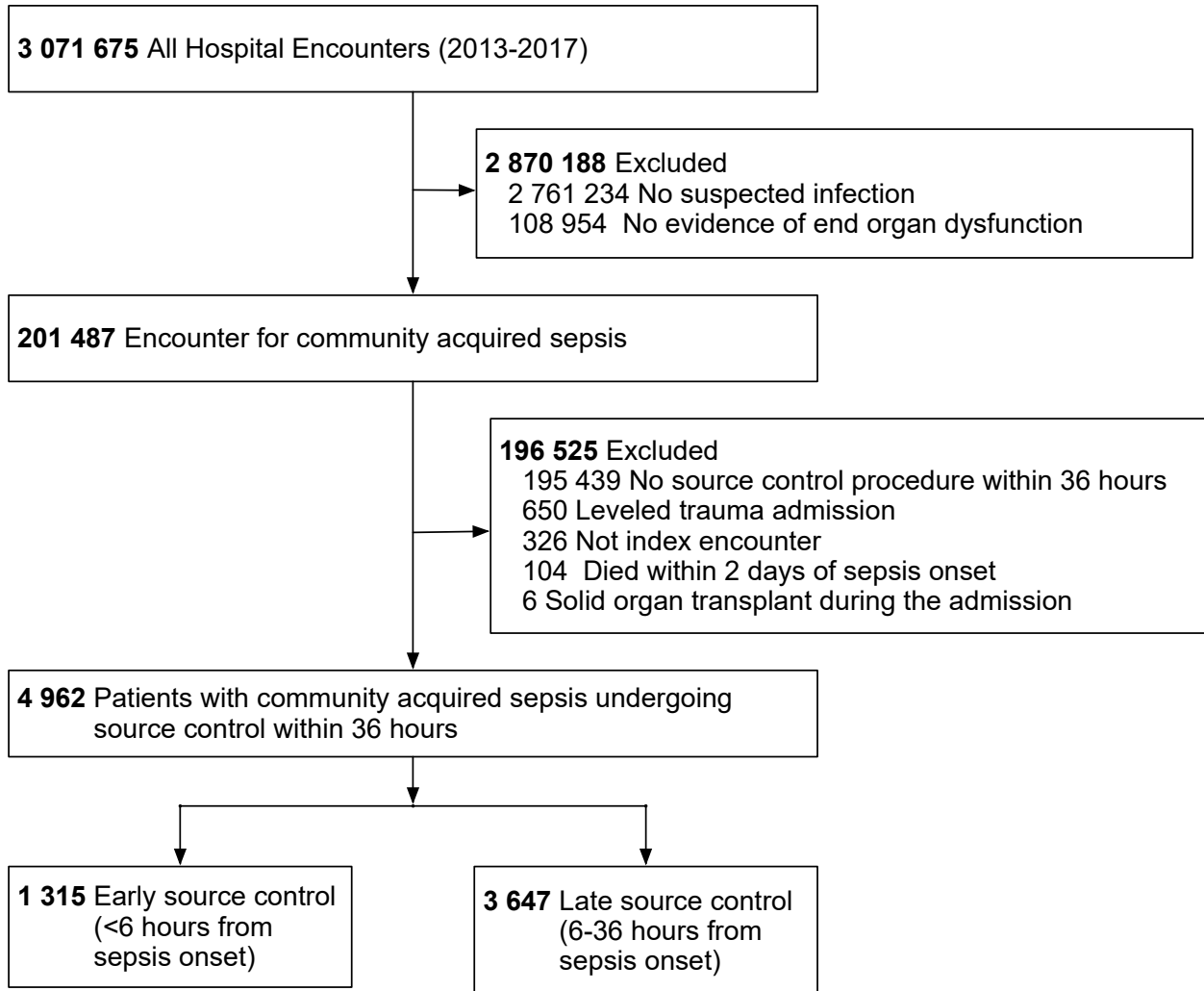
^aSOFA score corresponds to the severity of organ dysfunction, reflecting six organ systems each with a score range of 0 to 4 points (cardiovascular, hepatic, hematologic, respiratory, cranial, renal), with a total score range of 0 to 24 points

^bOperative stress score quantifies physiologic stress for surgical procedures with a score range of 1 to 5 points categorizing procedures as very low stress to very high stress, respectively

^cPreprocedural creatine [mg/dL] and bilirubin [mg/dL]

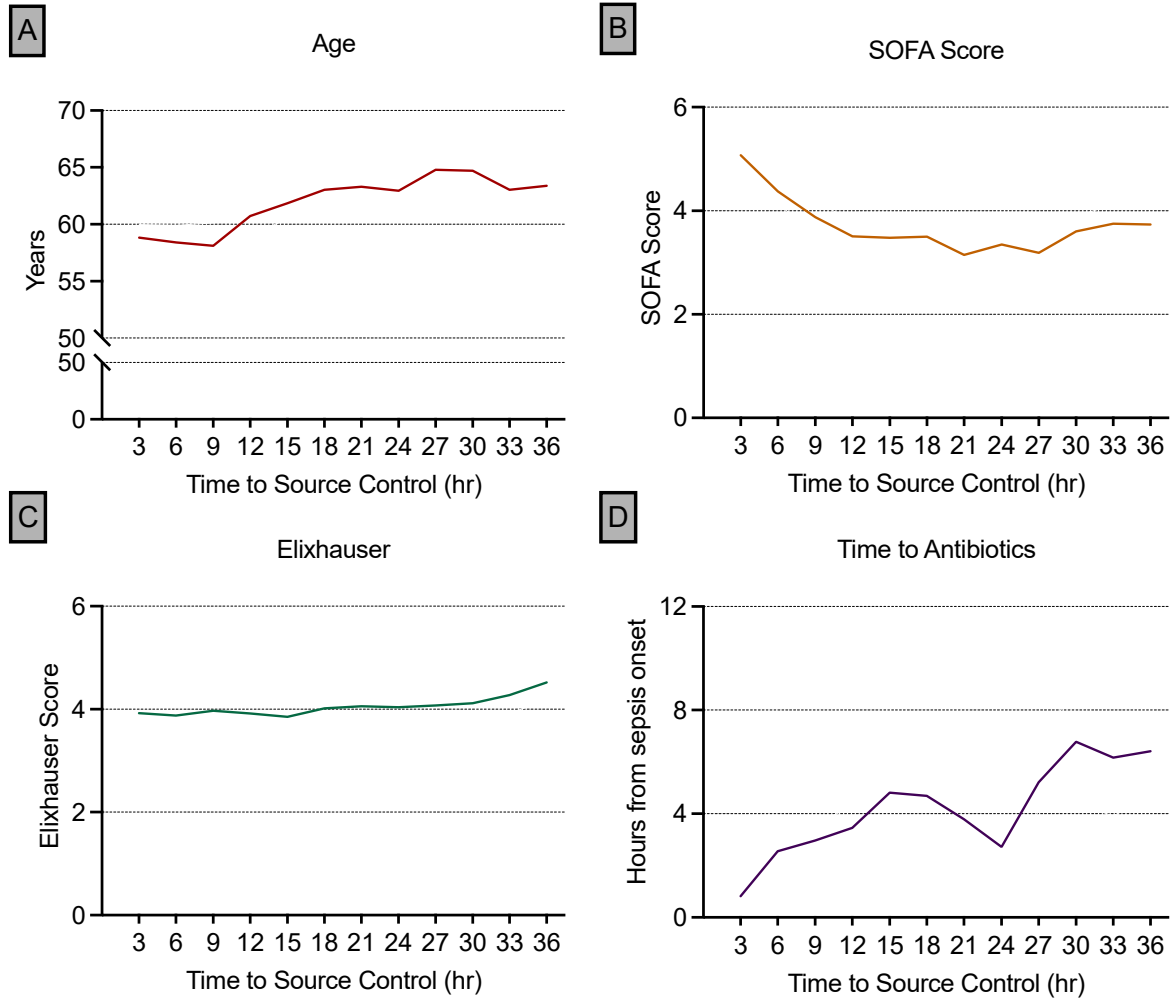
Abbreviations: aOR: adjusted odds ratio; bilirubin; CI: confidence interval; INR: international normalized ratio; SOFA, sequential organ failure assessment.

eFigure 1. Cohort accrual



Excluded encounters and patients may have meet more than one exclusion criteria.

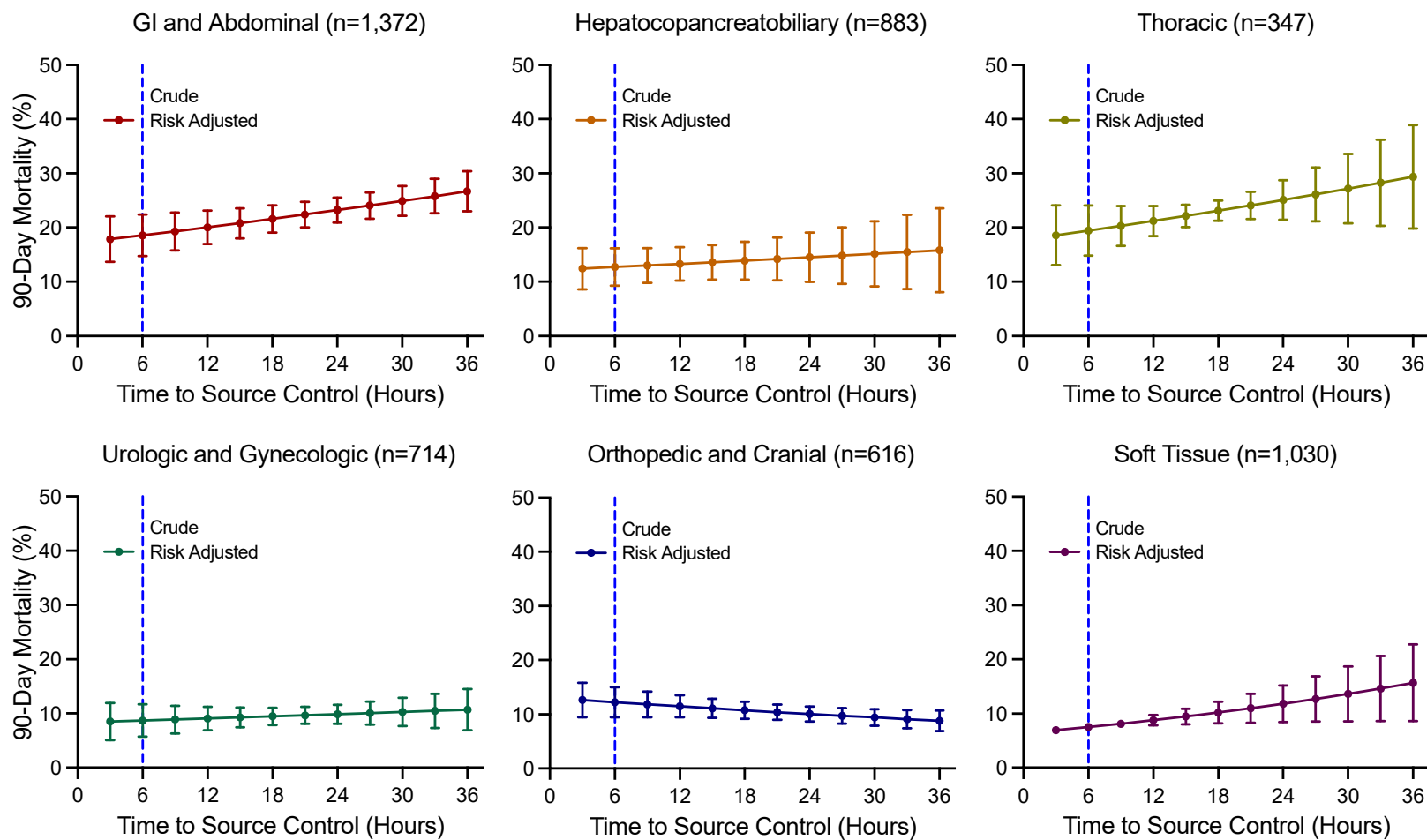
eFigure 2. Correlation between variables and time to source control



Line graphs demonstrate the variable average overtime with the error bars demonstrating 95% confidence intervals.

Abbreviations: SOFA: sequential organ failure assessment score

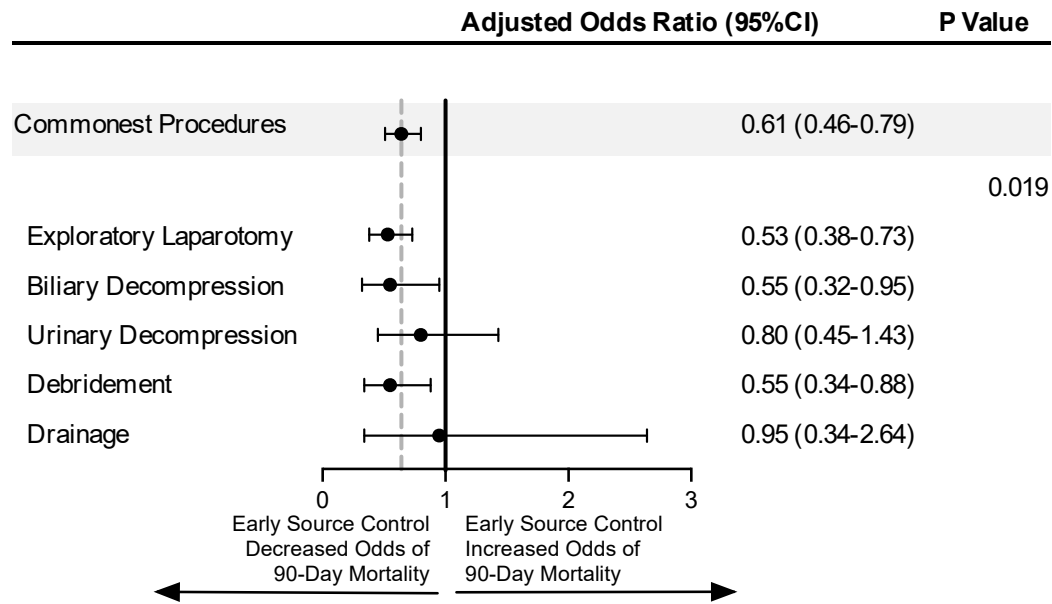
eFigure 3. Observed and adjusted risk of 90-day mortality by source control anatomic categories



Crude (box) and adjusted (dot) risk of 90-day mortality among each source control anatomic category (Panel B). Error bars correspond to 95% confidence interval of the adjusted risk.

Abbreviations: GI: gastrointestinal

eFigure 4. Association between early source control and 90-day mortality among the most common interventions



Risk-adjusted odds ratios of 90-day mortality among five most common interventions. No difference in mortality among early or late source control is indicated by a risk-adjusted odds ratio of 1.0, represented by the solid vertical black line. The overall risk-adjusted odds ratio of 90-day mortality associated with early source control is indicated by the vertical dashed gray line. All P values were calculated from the interaction between the treatment group and intervention type. .

Abbreviations: aOR: adjusted odds ratio.