



Advanced Colon Surgery Bundle Resource Guide

	RESOURCE	SUMMARY	FINDINGS	COMMENTS
Bundled Elements (2B)	Reducing Colorectal Surgical Site Infections (The Joint Commission Center for Transforming Health Care)	Collaborative to reduce the rate of colorectal surgical site infections using data derived from the American College of Surgeons' National Surgical Quality Improvement Program (NSQIP) across seven tertiary care academic hospital systems.	<ul style="list-style-type: none"> • After implementation of all solutions identified in the Collaborative, SSIs were reduced by 32% and the number of observed SSI was less than expected after adjusting for age, sex, BMI, and other factors. • Superficial incisional SSIs were reduced by 45%. • Reductions in average length of stay and costs were also noted. 	<ul style="list-style-type: none"> • Large number of interventions that achieved sustained change in a number of academic tertiary centers. • Single Collaborative combining multiple evidence-based practices.
	Colorectal Surgery Surgical Site Infection Reduction Program: A National Surgical Quality Improvement Program Driven Multidisciplinary Single-Institution Experience (Cima R., et al.)	Implementation of: <ul style="list-style-type: none"> • patient Cleansing with Hibiclens • antibiotic administration • closing protocols • patient and staff hand hygiene • weight-based intra-operative dosing and re-dosing of cefazolin • discharge instruction on wound care and post-discharge follow-up phone calls 	Significant decline in SSI rate—overall SSI rate dropped from 9.8% to 4.0%, and superficial SSI declined 1.5%.	<ul style="list-style-type: none"> • Results from single academic tertiary care center. • Sustained decline in SSI after bundle implementation. • Interventions successfully built into work flow. • Mechanical bowel preparation use was mixed among the participating surgeons. Pre-operative oral antibiotics were not used.

	RESOURCE	SUMMARY	FINDINGS	COMMENTS
Bundled Elements (2B)	The Preventive Surgical Site Infection Bundle in Colorectal Surgery: An Effective Approach to Surgical Site Infection Reduction and Health Care Cost Savings (Keenan et al.)	<p>Implementation of a bundle including the following elements:</p> <ul style="list-style-type: none"> • Pre-operative mechanical bowel preparation with oral antibiotics • Intravenous pre-operative prophylactic antibiotic • Standardized alcohol containing surgical skin preparation • Wound protector used intraoperatively for procedures with open incisions • Reduced operating room traffic • Maintained intraoperative normothermia • Maintained intraoperative euglycemia • Closing protocols: Gown and glove change, with dedicated closure tray • Patient education on SSI preventive measures and objectives of measures • Standardized removal/change of dressings post-operatively and washing of wound with chlorhexidine 	<p>Significant reduction in superficial SSIs were observed. SSI rate decreased from 19.3% to 5.7% in groups matched for confounding variables (larger reductions were seen in unmatched groups). Additionally, postoperative sepsis rates declined from 8.5% to 2.4%, (in matched groups) following implementation of the surgical bundle.</p>	<ul style="list-style-type: none"> • Results are from a single academic center. • Authors noted some concurrent changes in medical practice that could be potential confounders. Propensity match performed in the study was intended to limit the effect of the confounding variables. Statistically significant reductions in SSI were noted in both the pre- and postmatched groups.
Oral Antibiotic Prophylaxis/Mechanical Bowel Prep (MBP) (2B)	World Health Organization: Global Guidelines for the Prevention of Surgical Site Infection (World Health Organization)	<ul style="list-style-type: none"> • The World Health Organization Guidelines on evidence-based best practices to reduce surgical site infections. • Recommendations based on systematic review to assess available evidence on the effectiveness of preoperative oral antibiotics and MBP for prevention of SSI. 	<p>Strong recommendation for use of preoperative oral antibiotics in combination with MBP to reduce the risk of surgical site infection. Oral antibiotics should be used in addition to routine standard intravenous antibiotic prophylaxis for patients undergoing colon procedures.</p>	<ul style="list-style-type: none"> • Oral antibiotics with MBP is for preoperative use only and should not be continued postoperatively. • MBP alone has no benefit in reducing the SSI rate and should not be used for patients undergoing colorectal surgery. • SHEA/IDSA guidelines (2014) also recommend combined use of oral and parenteral antimicrobial agents to reduce the risk of SSI following colorectal procedures.

	RESOURCE	SUMMARY	FINDINGS	COMMENTS
Oral Antibiotic Prophylaxis/Mechanical Bowel Prep (MBP) (2B)	Benefits of Bowel Preparation Beyond Surgical Site Infection (Althumairi, A.A.et al.)	Retrospective review of 19, 686 elective colectomy cases in the National Surgical Quality Improvement Program (NSQIP) Colectomy Targeted Participant Use data file for 2012-2013. Postoperative outcomes were compared based on type of bowel preparation; no bowel preparation, MBP only, oral antibiotic bowel preparation (OABP) only and OABP and MBP	SSI rate differed significantly by type of bowel preparation 14.9% with no preparation, 12.0% with MBP, and 6.5% with OABP and MPB. OABP with MBP was associated with a slightly lower, but not statistically significant lower SSI rate than OABP alone (6.3% vs. 9.4%).	<ul style="list-style-type: none"> All analyses reported for OABP with or without documented MBP. OABP (±MBP) associated with lower SSI rate, lower readmission rate and lower rate of anastomotic leak, sepsis, and re-operation. Minimally invasive approach to surgery was associated with a significant reduction in SSI for all type of bowel preparation. Retrospective data review may be subject to bias. Bowel preparation data is extracted from medical records and reflects what surgeons prescribed, but not what patients actually received. NSQIP database does not allow extraction of oral antibiotic regimen and no specific regimens can therefore be recommended on the data included from the study.
	A Statewide Assessment of Surgical Site Infection Following Colectomy: The Role of Oral Antibiotics (Englesbe, M.J., et al.)	Michigan Surgical Quality Collaborative Colectomy Best Practices Project.	The evidence suggests the combination of oral antimicrobials with MBP reduces the rate of post-operative infections.	<ul style="list-style-type: none"> surveillance. Observational study to evaluate clinical practice and related outcomes with respect to mechanical bowel prep with or without oral antibiotic regimen. Note: Cochrane review (Guenaga, K.F., et al. [2011]) is equivocal about use of MBP and ability of MBP to reduce wound infection and anastomotic leakage rate

	RESOURCE	SUMMARY	FINDINGS	COMMENTS
Antimicrobial Prophylaxis (1B)	Clinical Practice Guidelines for Antimicrobial Prophylaxis in Surgery (Bratzler, D.W., et al.)	The American Society of Health-System Pharmacists' Therapeutic Guidelines on Antimicrobial Prophylaxis in Surgery.	Optimal prophylaxis ensures that adequate concentrations of an appropriate antimicrobial are present in the serum, tissue, and wound during the entire time that the incision is open and at risk for bacterial contamination.	<ul style="list-style-type: none"> Weight-based dosing of antimicrobial prophylaxis with re-dosing based on length of surgery as compared to half-life of the agent used from timing of initial dose or if there is significant blood loss. Generally, antimicrobial prophylaxis should be continued for no more than 24 hours and can typically be stopped when the procedure is completed and the surgical site is closed. For most patients, a mechanical bowel preparation combined with oral neomycin sulfate plus oral erythromycin base, or with oral neomycin sulfate plus oral metronidazole, should be given in addition to IV prophylaxis.
Skin Preparation (1A)	Chlorhexadine-Alcohol Versus Povidone-Iodine for Surgical-Site Antisepsis (Darouiche R., et al.)	Prospective RCT at six hospitals. Total of 849 patients undergoing clean contaminated surgery were assigned to have skin pre-operatively scrubbed with CHG Alcohol or povidone-iodine.	<ul style="list-style-type: none"> Rate of superficial and deep incisional SSIs were significantly lower in the chlorhexadine-alcohol group. 	<ul style="list-style-type: none"> Standard of care practices, such as prophylactic antibiotics and clipping of hair enforced at all hospitals. However, hospitals were allowed to continue with practices without proven efficacy, such as pre-operative showering, effects of these practices were controlled for using hospital-stratified randomization to match the study groups.
	Effects of Preoperative Skin Preparation on Post-operative Wound Infection Rates: A Prospective Study of Three Skin Preparation Protocols. (Swenson, B.R., et al.)	Three skin preparations were compared by means of sequential implementation. Each agent was used as the preferred modality for a six-month period for all general surgical cases. Solutions compared were: <ul style="list-style-type: none"> povidone iodine scrub with isopropyl alcohol application in between chlorhexadine and isopropyl alcohol (Chlorprep) iodine povacrylex isopropyl alcohol (duraprep) 	<ul style="list-style-type: none"> Lowest infection rates were seen with iodine-povacrylex in isopropyl alcohol. No differences in SSI rate were seen between patients prepared with povidone-iodine scrub and iodine povacrylex. Highest SSI rate seen in patients prepared with chlorhexadine-isopropyl alcohol. 	Large sample size in a single large academic medical center.

	RESOURCE	SUMMARY	FINDINGS	COMMENTS
Normothermia (1A)	World Health Organization: Global Guidelines for the Prevention of Surgical Site Infection (World Health Organization)	<ul style="list-style-type: none"> The World Health Organization Guidelines on evidence-based best practices to reduce surgical site infections. Recommendations based on systematic review to assess available evidence on the effectiveness of normothermia to reduce the risk of SSI. 	Use warming devices in the OR and during the surgical procedure for patient body warming.	The guideline notes that there is a lack of evidence to identify optimal warming devices. Additionally, more research into the proper timing and duration of warming to reduce risk of SSI is needed.
	Perioperative Normothermia to Reduce the Incidence of Surgical Wound Infection and Shorten Hospitalization (Kurz, A., et al.)	Double-blind RCT demonstrating triple the incidence of SSI and prolonged hospitalization in patients undergoing colectomy with intraoperative hypothermia	Surgical site infection in 19% of patients with intra-operative hypothermia and 6% of patients with intra-operative normothermia	Standard pre-operative prep; cases risk-adjusted for smoking, BMI, wound class, length of surgery. Clinical diagnosis of SSI.
Glucose Control (1B)	World Health Organization: Global Guidelines for the Prevention of Surgical Site Infection (World Health Organization)	<ul style="list-style-type: none"> The World Health Organization Guidelines on evidence-based best practices to reduce surgical site infections. Recommendations based on systematic review to assess available evidence on the effectiveness of glucose control to reduce the risk of SSI. 	<ul style="list-style-type: none"> Intensive perioperative blood glucose control for both diabetic and non-diabetic patients undergoing surgical procedures to reduce the risk of SSI. The report notes several observational studies have showed that hyperglycemia is associated with an increased risk of SSI. 	The guideline notes that the available evidence does not allow definition of an optimal target level of blood glucose, though it does also note that the SHEA/ IDSA guidelines and the American College of Physicians recommend target glucose levels between 140-200mg/dL or upper limits of 180 mf/dL.
	Scientific Principles and Clinical Implications of Perioperative Glucose Regulation and Control (Akhtar, S., et al.)	Review article evaluating glucose control in the pre-operative, intra-operative, and post-operative periods.	Though there are unresolved questions regarding appropriate control, it is prudent to maintain glucose levels < 180 mg /dL.	The authors cite heterogeneity in many of the included studies as a limitation to the analysis; post-operative control appears to have the most significant effect on post-operative complications.
	Risk Factors for Surgical Site Infections After Colorectal Resection in Diabetic Patients (Sehgal, R., et al.)	Retrospective review of 183 patients with DM analyzing risk factors associated with SSI.	Higher-than-normal glucose control at all post-operative time intervals was associated with SSI. The data suggests glucose < 200 may not be low enough.	Other risk factors for SSI in diabetic patients were identified, including stoma placement, obesity, and prolonged postoperative antibiotics.

	RESOURCE	SUMMARY	FINDINGS	COMMENTS
Glucose Control (1B)	Hyperglycemia Is Associated with Increased Risk of Morbidity and Mortality After Colectomy for Cancer (Jackson, R.S., et al.)	Retrospective review of 9,638 colectomies with recorded blood glucose levels; relationship of blood glucose to post-operative outcomes was assessed with multivariable logistic regression.	Operative day mild hyperglycemia was associated with surgical site infection. Study suggests a perioperative blood glucose target of 80–120 mg/dl might be appropriate.	Diabetics had higher incidence and increased severity of hyperglycemia compared with non-diabetics. However, for both diabetics and non-diabetics, the majority of patients experienced both operative and post-operative day one hyperglycemia. Hyperglycemia also associated with increased risk of respiratory complications, MI, and operative re-intervention.
Oxygenation (1A)	World Health Organization: Global Guidelines for the Prevention of Surgical Site Infection (World Health Organization)	The World Health Organization Guidelines on evidence-based best practices to reduce surgical site infections. Recommendations based on systematic review to assess available evidence on the effectiveness of hyperoxia to reduce the risk of SSI.	Strong recommendation that adult patients undergoing general anesthesia with endotracheal intubation for surgical procedures should receive an 80% fraction of inspired oxygen (FiO ₂), both intraoperatively and, if feasible, in the immediate postoperative period for 2-6 hours.	<ul style="list-style-type: none"> • Benefits of hyperoxygenation were greater in open colorectal surgery than other types of surgery. • The benefits of hyperoxygenation are maximized when normothermia and normovolemia are maintained.
	Effect of Intra-operative high inspired oxygen fraction on surgical site infection: a meta-analysis of randomized controlled trials (Yang et al.)	Meta-analysis of randomized controlled trials examining impact of hyperoxia with sub-group analysis based on surgery type.	Hyperoxia or use of high FiO ₂ does not significantly reduce the SSI rate, except for in colorectal surgery.	<ul style="list-style-type: none"> • Meta-analysis was unable to adjust for variability in antibiotic drug prophylaxis, length of follow up for SSI, and risk stratification of patients.
	Perioperative Supplemental Oxygen Therapy and Surgical Site Infection: A Meta-Analysis of Randomized Controlled Trials (Qadan M., et al.)	<ul style="list-style-type: none"> • Meta-analysis of five RCTs. • Control FiO₂ .30–.35; Study FiO₂ .80 for two to six hours postoperatively. • 30-day follow-up. • Three studies colorectal; two studies multispecialty. 	<ul style="list-style-type: none"> • Surgical site infection rates 12% control; 9% hyperoxic. • Relative risk reduction. • Greater benefit in colorectal procedures. 	<ul style="list-style-type: none"> • Variable use of antibiotics and blood loss among studies. • No standard definition of infection. • Significant improvement in all but one study, where SSI rate increased.

	RESOURCE	SUMMARY	FINDINGS	COMMENTS
Standardized Wound Closing Procedures (2B)	World Health Organization: Global Guidelines for the Prevention of Surgical Site Infection (World Health Organization)	<ul style="list-style-type: none"> The World Health Organization Guidelines on evidence-based best practices to reduce surgical site infections. Recommendations based on systematic review of whether employing new clean surgical instruments are more effective in reducing SSI than wound closure with previously used surgical instruments. 	The guidelines do not offer a recommendation on changing of instruments at closure due to lack of evidence and note more research into this area is required.	The guideline notes that changing instruments for wound closure in contaminated surgery is a common practice and appears logical, particularly after colorectal surgery. However, no evidence currently exists to support this practice.
	Reducing Colorectal Surgical Site Infections (The Joint Commission Center for Transforming Health Care)	Standardized wound closing across all surgical teams with new closing trays, instruments, and gloves at time of wound closure.	Inconsistent surgical site closing process, particularly if dirty instruments or contaminated gloves and gowns were used at time of wound closure, were found to be strongly associated with the occurrence of SSI at all seven hospitals in the collaborative.	Collaborative conducted in seven academic hospital systems.
Wound Management (2B)	Reducing Colorectal Surgical Site Infections (The Joint Commission Center for Transforming Health Care)	<ul style="list-style-type: none"> Standardize intra-operative application of wound dressing to reduce risk of contamination and maximize wound healing. Standardize orders for post-operative wound dressing, such as continuation of wound dressing for 48 hours and dressing removal on POD 2. 	Standardization of wound management for different surgical wounds was shown to affect the rate of colon SSI in six of seven centers.	<ul style="list-style-type: none"> Few good studies available to demonstrate how impact of timing will affect SSI rate. However, practices advocated in The Joint Commission Collaborative are in line with many best practices guidelines. Additionally, a Cochrane review (Dumville et al., 2011) of wound dressings indicates there is insufficient evidence to recommend one type of dressing over another, but notes that current accepted practice for surgical wounds healing by primary intention involves placing a dressing over the closed wound before the patient leaves the OR. This assumes the risk of SSI will be reduced by providing a barrier to environmental contamination and managing wound exudates, protecting the wound and their staples and sutures.

	RESOURCE	SUMMARY	FINDINGS	COMMENTS
Hand Hygiene (1A)	World Health Organization: Global Guidelines for the Prevention of Surgical Site Infection (World Health Organization)	<ul style="list-style-type: none"> The World Health Organization Guidelines on evidence-based best practices to reduce surgical site infections. Recommendations based on WHO Guidelines on Hand Hygiene in Healthcare issued in 2009. 	<ul style="list-style-type: none"> Guidelines recommend that surgical hand preparation be performed either by scrubbing with suitable antimicrobial soap and water or using a suitable alcohol-based hand rub The hands of the surgical team should be clean upon entering the OR by washing with a non-medicated soap. Once in the operating area, repeated hand rubbing or scrubbing without an additional prior hand wash is recommended before switching to the next procedure. 	Guidelines note that the activity of the alcohol-based hand rub can be impaired if hands are not completely dry before applying the product or by the handwashing itself. Hence surgical hand scrub and surgical hand rub should not be combined sequentially.
	Guidelines on Hand Hygiene in Health care (World Health Organization) Guidelines for Hand Hygiene in Health Care (Centers for Disease Control and Prevention)	Strict adherence to hand hygiene between each patient care task for staff, patient, and family	Adherence to hand hygiene guidelines prevents micro-organism transmission and cross contamination.	Hand Hygiene required between patient tasks and/or contact with equipment or surfaces, even if tasks are on same patient.
Environmental Cleanliness (1B)	Guidelines for Environmental Infection Control in Health-Care Facilities (Sehulster, L., et al.)	Standardize infection control and ventilation measures for operating rooms (ORs).	<ul style="list-style-type: none"> Guidelines recommend that OR doors remain closed except for passage of equipment, personnel, and patients and entry be limited to essential personnel. UV light should not be used to sterilize equipment. Flash sterilization is not recommended as a routine method of sterilization. 	<ul style="list-style-type: none"> Prevent contamination from outside the OR, organize needed equipment with prevention of contamination in mind. Encourage closed aseptic OR environment by reducing traffic and equipment from outside OR.

References

- Akhtar, S., Barash, P.G., Inzucchi, S.E. "Scientific Principles and Clinical Implications of Perioperative Glucose Regulation and Control." *Anesthesia and Analgesia*, (2010); 110 (2B): 478-497.
- Althumairi, A.A., Canner, J.K., Pawlik, T.M., Schneider, E., Nagarajan, N., Safar, B, Efron, J.E., "Benefits of Bowel Preparation Beyond Surgical Site Infection: A Retrospective Study." *Annals of Surgery* (2016);264:1051-1057.
- Bratzler, D.W., Dellinger, E.P., Olsen, K.M., Perl, T.M., Auwaerter, P.G., Bolon, M.K., Fish, D.N., Napolitano, L.M., Sawyer, R.G., Slain, D., Steinbert, J.P., Weinstein, R.A. "Clinical Practice Guidelines for Antimicrobial Prophylaxis in Surgery." *American Journal of Health-System Pharmacists* (2013); 70: 195-283.
- Burton, M., Cobb, E., Donachie, P., Judah, G., Curtis, V., Schmidt, W.P. "The Effect of Handwashing with Water or Soap on Bacterial Contamination of Hands." <http://www.cdc.gov/Other/disclaimer.html>. *International Journal of Environmental Research and Public Health* (January 2011); 8 (1): 97-104.
- Cima, R., Dankbar, E., Lovely, J., Pendlimari, R., Aronhalt, K., Nehring, S., Hyke, R., Tyndalee, D., Rogers, J., Quast, L. "Colorectal Surgery Surgical Site Infection Reduction Program: A National Surgical Quality Improvement Program-Driven Multidisciplinary Single-Institution Experience." *Journal of the American College of Surgeons* (2013); 216: 23-33.
- Centers for Disease Control and Prevention. "Guideline for Hand Hygiene in Health-Care Settings: Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force." *Morbidity and Mortality Weekly Report* (2002); 51 (No. RR-16).

- Darouiche, R., Wall, M.J., Itani, K.M.F., Otterson, M.F., Webb, A.L., Carrick, M.M., Miller, H.J., Aswad, S.S., Crosby, C.T., Mosier, M.C., Al Sharif, A., Berger, D.H. "Chlorhexadine-Alcohol Versus Povidone-Iodine for Surgical Site Antisepsis." *New England Journal of Medicine* (2010); 362: 9–17.
- Dumville, J.C., Walter, C.J., Sharp, C.A., Page, T. "Dressings for the Prevention of Surgical Site Infection." *Cochrane Database of Systematic Reviews* (2011); Issue 7.
- Englesbe, M.J., Brooks, L., Kubus, J., Luchtefeld, M., Lynch, J., Senagor, A., Eggenberger, J.C., Velanovich, V., Campbell, D.A. "A Statewide Assessment of Surgical Site Infection Following Colectomy: The Role of Oral Antibiotics." *Annals of Surgery* (2010); 252: 514–520.
- Günaga, K.F., Matos, D., Wille-Jørgensen, P. "Mechanical Bowel Preparation for Elective Colorectal Surgery." *Cochrane Database of Systematic Reviews* (2011); Issue 9.
- Jackson, R. S., Amdur, R.L., White, J.C., Mascata, R.A. "Hyperglycemia Is Associated with Increased Risk of Morbidity and Mortality after Colectomy for Cancer." *Journal of the American College of Surgeons* (2012); 214: 68–80.
- Keenan, J.E., Speicher, P.J., Thacker, J.K., Kuchibhatia, M., Mantyh, C.R. "The preventive surgical site infection bundle in colorectal surgery: an effective approach to surgical site infection reduction and health care cost savings." *JAMA Surgery* (2014); 149(10):1045-1052.
- Kurz, A., Sessler, D., Lenhardt, R. "Perioperative Normothermia to Reduce the Incidence of Surgical-Wound Infection and Shorten Hospitalization. *New England Journal of Medicine* 334 (19): 1209–1215.
- Loftus, R.W., Muffly, M.K., Brown, J.R., Beach, M.L., Koff, M.D., Corwin, H.L., Surgenor, S.D., Kirkland, K.B., Yeager, M.P. "Hand Contamination of Anesthesia Providers Is an Important Risk Factor for Intraoperative Bacterial Transmission." *Anesthesia & Analgesia* (January 2011); 112 (1): 98–105.
- Mc Ginley, K.J., Larson, E.L., Leyden, J.J. "Composition and Density of Microflora in the Subungual Space of the Hand." *Journal of Clinical Microbiology* (May 1988); 26 (5): 950–953.
- Morris, M.S., Graham, L.A., Chu, D.I., Cannon, J.A., Hawn, M.T. "Oral Antibiotic Bowel Preparation Significantly Reduces Surgical Site Infection Rates and Readmission Rates in Elective Colorectal Surgery." *Annals of Surgery* (2015); 261:1034-1040.
- Munoz-Price, L.S., Birnbach, D.J. "Handwashing and Anesthesia." *International Anesthesiology Clinics* (Winter 2013); 51 (1): 79–92.
- Qadan, M., Akça, O., Mahid, S.S., Hornung, C.A., Polk, H.C., Jr. "Perioperative Supplemental Oxygen Therapy and Surgical Site Infection: A Meta-Analysis of Randomized Controlled Trials." *JAMA Surgery* (April 2009); 144(4): 359–66; discussion 366–7. Review.
- Sehgal, R., Berg, A., Figueroa, R., Proits, L.S., McKenna, K.J., Stewart, D.B., Koltun, W.A. "Risk Factors for Surgical Site Infections After Colorectal Resection in Diabetic Patients." *Journal of the American College of Surgeons* (2011); 212: 29–34.
- Sehulster, L., Chinn, R.Y.W. "Guidelines for Environmental Infection Control in Health Care Facilities. Recommendations of CDC and Healthcare Infection Control Practices Advisory Committee (HICPAC)" (2003).
- Swenson, B.R., Hendrick, T.L., Metzger, R., Bonatti, H., Pruett, T.L., Sawyer, R.G. "Effects of Preoperative Skin Preparation on Postoperative Wound Infection Rates: A Prospective Study of Three Skin Preparation Protocols." *Infection Control and Hospital Epidemiology* (2009); 30 (10): 964–71.
- World Health Organization. 2009. *WHO Guidelines on Hand Hygiene in Health Care*. Geneva, Switzerland, WHO Press. http://whqlibdoc.who.int/publications/2009/9789241597906_eng.pdf
- World Health Organization. 2016. *Global Guidelines for the Prevention of Surgical Site Infection*. Geneva, Switzerland, WHO Press. <http://www.who.int/gpsc/ssi-prevention-guidelines/en/>
- Yang, W., Liu, Y., Zhang, Y., Zhao, Q.H., He, S.F. "Effect of intra-operative high inspired oxygen fraction on surgical site infection: a meta-analysis of randomized controlled trials." *Journal of Hospital Infection* (2016); 93:329-338.

Key to Grading of Evidence

- 1a. Systematic reviews (with homogeneity) of randomized controlled trials
- 1b. Individual randomized controlled trials (with narrow confidence interval)
- 1c. All or none randomized controlled trials
- 2a. Systematic reviews (with homogeneity) of cohort studies
- 2b. Individual cohort study or low quality randomized controlled trials (e.g. <80% follow-up)
- 2c. "Outcomes" research; ecological studies
- 3a. Systematic review (with homogeneity) of case-control studies
- 3b. Individual case-control study
4. Case-series (and poor quality cohort and case-control studies)
5. Expert opinion without explicit critical appraisal, or based on physiology, bench research or "first principles"

Disclaimer: The information contained in the Advanced Colon Bundle is provided by the NYS Partnership for Patients (NYSPPF) for informational purposes only. NYSPPF makes no representations, guarantees or warranties of any kind, express or implied, about the completeness, accuracy, reliability or suitability with respect to any of the information above. NYSPPF disclaims any liability for any and all damages or losses arising from use of this information. The Advanced Colon Bundle is not meant to provide medical advice and is not a substitute for professional medical or clinical judgement.