ASPEN International Nutrition Guidelines for Adult Perioperative Cardiac Patients: Protocol

Introduction

Patients undergoing cardiac surgery represent an underappreciated cohort of critically ill patients, who are at increased risk of iatrogenic underfeeding during the pre- and postoperative course [1, 2]. This population frequently experiences significant delays in the initiation of medical nutrition therapy (MNT) and a lower overall total nutritional adequacy is often observed when compared to other patients in non-cardiac surgical or medical intensive care units (ICU) [1]. Acute nutritional deficiencies may be further compounded with pre-existing malnutrition and have been associated with complicated and prolonged critical illness course. This is further associated with and can result in further exacerbation of organ dysfunctions and increased risk , increased risk of infectious complications [3–11] .and reduced respiratory muscle mass. This ultimately results in delayed weaning from mechanical ventilation, increased ICU length of stay (LOS), high readmission rates, high health care related costs, and reduced quality of life after hospital discharge [12–17]. Despite growing awareness about the detrimental effects of acute and chronic malnutrition, to date there are no specific granular recommendations for cardiac surgery patients [2, 18, 19], which necessitates for this current guideline initiative.

Objective: The objective of this guideline will be to provide guidance for perioperative MNT in adult patients undergoing non-emergent (elective and urgent) cardiac surgery

Target Knowledge User: This guideline is intended for dietitians, nutrition scientists, nurses, pharmacists, physicians (e.g. cardiac surgeons, cardiologists, anesthesiologists, critical care physicians), speech language pathologists, perioperative specialists, and any other medical health professionals involved in the nutritional care of patients undergoing cardiac surgery.

The International Panel of Experts

The guideline is comprised of two panels, a Clinical Experts panel and a Bias panel. The clinical panel includes dietitians, nutrition scientists, pharmacists, physicians and scientists with a background: cardiac surgery, critical care medicine, anesthesiology, cardiology, and/or critical care nutrition/nutritional sciences. The Clinical Experts panel is comprised of an international group of subject matter experts originating from Asia, Europe, and North America.

The Bias panel of experts will be formed to perform all bias analyses and provide commentary on the direct relationship between the recommendations made and the available evidence. The Bias panel will be comprised of doctoral level researchers with a background in nutrition to limit bias. The Bias panel will be trained and closely overseen by the methodologist

and Editor-in-Chief, Liam McKeever, PhD, RDN, who will mentor the entire process and coordinate the actions of the Clinical Experts panel and the Bias panel.

Conflicts of Interest

Christian Stoppe received honorarium from BBRAUN, Fresenius, Abiomed and Baxter in the past for his role as speaker and consultant. He further received financial support for an Investigator Initiated Study from Fresenius and Pascoe Pharma.
Liam McKeever has no conflicts of interest to disclose.
Ellen Dresen has received speaker honoraria from Baxter in the past.
Gunnar Elke has received speaker honoraria from Baxter and Fresenius Kabi and advisory honoraria from Fresenius Kabi.
Aileen Hill received speaker honoraria and travel support from Fresenius Kabi and Baxter. She received financial support for an Investigator Initiated Study from Fresenius and Pascoe Pharma.
Ranna Modir has no conflicts of interest.
Nicholas Barker has no conflicts of interest.
Foong Pui Hing has no conflicts of interest.
Stephen Fremes receives support from Polypid as DSMB member and the institution receives support for clinical trial participation by Medronic, Boston and Amgen.
Rakesh C. Arora – received speaker honoraria from Edwards LifeScience and Abbott Nutrition, HLS Therapeutics and on the advisory study advisory board for Renibus Therapeutics Inc.
Salvatore Carbone – received speaker honoraria from Baxter
Alessandro Belletti has no conflicts of interest to disclose.
Wäschle Reiner has no conflict of interest to disclose.

Panel members will abstain from voting on any recommendations for which they have a conflict of interest. This includes conflicts of interest that become apparent as the guideline is being carried out. The Editor-in-Chief (L.M.) will be responsible for identifying and acting upon all known conflicts of interest.

Request for Commentary

From the time this protocol is published electronically and up to two months following electronic publication, ***the writing committee welcomes and requests commentary on any and every aspect of this protocol***. We would like to hear from all key stakeholders including but not limited to all levels of dietitians, nutrition scientists, physicians, nurses, speech language pathologists, pharmacists, epidemiologists, methodologists, public health experts, occupational therapists, etc. We also welcome all stakeholders to show the list of PICOT questions presented in this protocol to selected patients to provide guideline group with feedback from the patient perspective.

Timely comments from readers of this protocol are welcomed and requested. Any concerns, comments, or additions should be submitted using this form. Comments will be received until May 31, 2024.

PICOT Questions

Table 1 below contains the list of questions this guideline intends to answer. These are termed PICOT questions because they include the intended **P**opulation, **I**ntervention, **C**omparator or **C**ontrol, **O**utcomes, and **T**imeframe. Beside each outcome is a judgement concerning the outcome's importance. If the outcome concerns life and death or is of utmost importance in the context of the question itself, the importance is deemed 'critical'. If the outcome is not life or death, or of utmost importance, but of unquestionable importance to decision making, the outcome is deemed 'important, but not critical'. If the outcome is of questionable importance, it is deemed 'of limited importance'. These importance levels are then included in the decision-making process for which outcome variables will be most directive of our recommendations. At the bottom of each PICOT question will be a list of relevant co-interventions. These are additional interventions that occur as a byproduct of receiving the main intervention that provide an alternative explanation for the outcome. Most co-interventions are part of the natural sequelae of the intervention (part of the intervention package) and part of the big picture effect the PICOT is trying to address. These types of co-interventions will not be listed in the tables below but will be captured in each study at the data extraction phase. The co-intervention box in the tables below is reserved only for known co-interventions that may be greatly differential between studies and problematic. In most cases this box will be empty.

Table 1 Preoperative PICOT Questions

Preoperative PICOT Questions			
PICOT 1	In adult preoperative cardiac patients, does screening for nutrition risk vs not screening impact/predict clinical outcomes?		
Outcomes		**Importance**	
ICU & Hospital Length of Stay		Critical	
Time on Mechanical Ventilation		Critical	
Infection Rate		Critical	
Mortality (ICU, Hospital, 30/60/90 Day/12 months)		Critical	
Time to discharge alive		Critical	
Frailty (6-minute walk test, Frailty Index, hand grip strength)		Critical	
Acute Kidney Injury		Critical	
Hospital/ICU Readmission Rates		Critical	
Time on inotropic/vasopressor support		Critical	
Time on mechanical circulatory system support		Critical	
% of nutrition needs met		Important but not critical	
Calorie and protein delivery		Important but not critical	
Malnutrition rates		Important but not critical	
Inflammation (C-reactive protein (CRP), interleukin (IL)-6)		Important but not critical	
Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, amino-terminal pro-brain natriuretic peptide (NTproBNP))		Important but not critical	
GI adverse events (bowel ischemia, emesis, ileus, nausea, GI complications		Important but not critical	
Cointerventions	**None**	**RCT's Ethical?**	Yes
PICOT 2	In adult preoperative cardiac patients does choice of screening and nutrition assessment tools impact clinical outcomes?		
Outcomes		**Importance**	

ICU & Hospital Length of Stay			Critical
Time on Mechanical Ventilation			Critical
Infection Rate			Critical
Mortality (ICU, Hospital, 30/60/90 Day/12 months)			Critical
Frailty (6-minute walk test, Frailty Index, grip strength)			Critical
Acute Kidney Injury			Critical
Hospital/ICU Readmission Rates			Critical
Time on inotropic/vasopressor support			Critical
Time on mechanical circulatory system support			Critical
Time to discharge alive			Important but not critical
% of nutrition needs met			Important but not critical
Calorie and protein delivery			Important but not critical
Malnutrition rates			Important but not critical
Inflammation (CRP, IL-6)			Important but not critical
Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, NTproBNP)			Important but not critical
GI adverse events (bowel ischemia, emesis, ileus, nausea, GI Complications)			Important but not critical
Cointerventions	**None**	**RCT's Ethical?**	Yes
PICOT 3	In adult preoperative cardiac patients who can take oral nutrition, does nutrition supplementation (ONS, supplemental EN or PN vs no supplemental ONS; EN or PN) improve clinical outcomes?		
Outcomes		**Importance**	
ICU & Hospital Length of Stay			Critical
Time on Mechanical Ventilation			Critical
Infection Rate			Critical
Mortality (ICU, Hospital, 30/60/90 Day/12 months)			Critical
Frailty (6-minute walk test, Frailty Index, grip strength)			Critical
Acute Kidney Injury			Critical
Hospital/ICU Readmission Rates			Critical
Time on inotropic/vasopressor support			Critical
Time on mechanical circulatory system support			Critical
Time to discharge alive			Important but not critical
% of nutrition needs met			Important but not critical
Calorie and protein delivery			Important but not critical
Malnutrition rates			Important but not critical
Inflammation (CRP, IL-6)			Important but not critical
Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, NTproBNP)			Important but not critical
GI adverse events (bowel ischemia, emesis, ileus, nausea, GI Complications)			Important but not critical
Cointerventions	**None**	**RCT's Ethical?**	Yes
PICOT 4	In adult preoperative cardiac patients, does preoperative nutrition consultation vs no nutrition consultation impact clinical outcomes?		
Outcomes		**Importance**	
ICU & Hospital Length of Stay			Critical
Time on Mechanical Ventilation			Critical
Infection Rate			Critical
Mortality (ICU, Hospital, 30/60/90 Day/12 months)			Critical
Frailty (6-minute walk test, Frailty Index, grip strength)			Critical
Acute Kidney Injury			Critical
Hospital/ICU Readmission Rates			Critical
Time on inotropic/vasopressor support			Critical
Time on mechanical circulatory system support			Critical
Time to discharge alive			Important but not critical
% of nutrition needs met			Important but not critical
Calorie and protein delivery			Important but not critical
Malnutrition rates			Important but not critical

Inflammation (CRP, IL-6)		Important but not critical	
Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, NTproBNP)		Important but not critical	
GI adverse events (bowel ischemia, emesis, ileus, nausea, GI Complications)		Important but not critical	
Cointerventions	**None**	**RCT's Ethical?**	Yes
PICOT 5	In adult preoperative cardiac patients, does reducing NPO period prior to surgery vs NPO at midnight impact clinical outcomes.		
Outcomes		**Importance**	
ICU & Hospital Length of Stay		Critical	
Time on Mechanical Ventilation		Critical	
Infection Rate		Critical	
Mortality (ICU, Hospital, 30/60/90 Day/12 months)		Critical	
Frailty (6-minute walk test, Frailty Index, grip strength)		Critical	
Acute Kidney Injury		Critical	
Hospital/ICU Readmission Rates		Critical	
Time on inotropic/vasopressor support		Critical	
Time on mechanical circulatory system support		Critical	
Time to discharge alive		Important but not critical	
% of nutrition needs met		Important but not critical	
Calorie and protein delivery		Important but not critical	
Malnutrition rates		Important but not critical	
Inflammation (CRP, IL-6)		Important but not critical	
Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, NTproBNP)		Important but not critical	
GI adverse events (bowel ischemia, emesis, ileus, nausea, GI Complications)		Important but not critical	
Cointerventions	**None**	**RCT's Ethical?**	Yes
PICOT 6	In adult preoperative cardiac patients, does carbohydrate loading vs. no carbohydrate loading impact clinical outcomes?		
Outcomes		**Importance**	
ICU & Hospital Length of Stay		Critical	
Time on Mechanical Ventilation		Critical	
Infection Rate		Critical	
Mortality (ICU, Hospital, 30/60/90 Day/12 months)		Critical	
Frailty (6-minute walk test, Frailty Index, grip strength)		Critical	
Acute Kidney Injury		Critical	
Hospital/ICU Readmission Rates		Critical	
Time on inotropic/vasopressor support		Critical	
Time on mechanical circulatory system support		Critical	
Time to discharge alive		Important but not critical	
% of nutrition needs met		Important but not critical	
Calorie and protein delivery		Important but not critical	
Malnutrition rates		Important but not critical	
Inflammation (CRP, IL-6)		Important but not critical	
Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, NTproBNP)		Important but not critical	
GI adverse events (bowel ischemia, emesis, ileus, nausea, GI Complications)		Important but not critical	
Cointerventions	**None**	**RCT's Ethical?**	Yes
PICOT 7	In adult preoperative cardiac patients, does drinking clear liquids until 2 hours before surgery vs not permitting clear liquids until 2 hours before surgery impact clinical outcomes?		
Outcomes		**Importance**	
ICU & Hospital Length of Stay		Critical	
Time on Mechanical Ventilation		Critical	
Infection Rate		Critical	
Mortality (ICU, Hospital, 30/60/90 Day/12 months)		Critical	
Frailty (6-minute walk test, Frailty Index, grip strength)		Critical	
Acute Kidney Injury		Critical	
Hospital/ICU Readmission Rates		Critical	

Time on inotropic/vasopressor support		Critical	
Time on mechanical circulatory system support		Critical	
Time to discharge alive		Important but not critical	
% of nutrition needs met		Important but not critical	
Calorie and protein delivery		Important but not critical	
Malnutrition rates		Important but not critical	
Inflammation (CRP, IL-6)		Important but not critical	
Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, NTproBNP)		Important but not critical	
GI adverse events (bowel ischemia, emesis, ileus, nausea, GI Complications)		Important but not critical	
Cointerventions	**None**	**RCT's Ethical?**	Yes
PICOT 8	In adult preoperative cardiac patients who cannot take oral nutrition, does nutrition supplementation (EN or PN vs no EN or PN) impact clinical outcomes?		
Outcomes		**Importance**	
ICU & Hospital Length of Stay		Critical	
Time on Mechanical Ventilation		Critical	
Infection Rate		Critical	
Mortality (ICU, Hospital, 30/60/90 Day/12 months)		Critical	
Frailty (6-minute walk test, Frailty Index, grip strength)		Critical	
Acute Kidney Injury		Critical	
Hospital/ICU Readmission Rates		Critical	
Time on inotropic/vasopressor support		Critical	
Time on mechanical circulatory system support		Critical	
Time to discharge alive		Important but not critical	
% of nutrition needs met		Important but not critical	
Calorie and protein delivery		Important but not critical	
Malnutrition rates		Important but not critical	
Inflammation (CRP, IL-6)		Important but not critical	
Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, NTproBNP)		Important but not critical	
GI adverse events (bowel ischemia, emesis, ileus, nausea, GI Complications)		Important but not critical	
Cointerventions	**None**	**RCT's Ethical?**	Yes

Table 2 Perioperative PICOT Questions

Perioperative PICOT Questions			
PICOT 9	In adult perioperative cardiac patients, do interventions designed to provide tighter glycemic control vs more liberalized glycemic control impact clinical outcomes?		
Outcomes		**Importance**	
ICU & Hospital Length of Stay		Critical	
Time on Mechanical Ventilation		Critical	
Infection Rate		Critical	
Mortality (ICU, Hospital, 30/60/90 Day/12 months)		Critical	
Frailty (6-minute walk test, Frailty Index, grip strength)		Critical	
Acute Kidney Injury		Critical	
Hospital/ICU Readmission Rates		Critical	
Time on inotropic/vasopressor support		Critical	
Time on mechanical circulatory system support		Critical	
Time to discharge alive		Important but not critical	
% of nutrition needs met		Important but not critical	
Calorie and protein delivery		Important but not critical	
Malnutrition rates		Important but not critical	
Inflammation (CRP, IL-6)		Important but not critical	
Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, NTproBNP)		Important but not critical	
Cointerventions	**None**	**RCT's Ethical?**	Yes

PICOT 10	In adult perioperative cardiac inpatients receiving PN, does use of Omega-3 enhanced injectable lipid emulsions (ILE) vs 100%SO-ILE impact clinical outcomes		
Outcomes		**Importance**	
ICU & Hospital Length of Stay		Critical	
Time on Mechanical Ventilation		Critical	
Infection Rate		Critical	
Mortality (ICU, Hospital, 30/60/90 Day/12 months)		Critical	
Frailty (6-minute walk test, Frailty Index, grip strength)		Critical	
Acute Kidney Injury		Critical	
Hospital/ICU Readmission Rates		Critical	
Time on inotropic/vasopressor support		Critical	
Time on mechanical circulatory system support		Critical	
Time to discharge alive		Important but not critical	
% of nutrition needs met		Important but not critical	
Calorie and protein delivery		Important but not critical	
Malnutrition rates		Important but not critical	
Inflammation (CRP, IL-6)		Important but not critical	
Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, NTproBNP)		Important but not critical	
GI adverse events (bowel ischemia, emesis, ileus, nausea, GI Complications)		Important but not critical	
Cointerventions	**None**	**RCT's Ethical?**	Yes
PICOT 11	In adult perioperative cardiac patients, does antioxidant and/or anti-inflammatory nutrient administration (with or without other strategies) vs no administration lead to reduced inflammatory markers (IL-6, CRP, PCT) and/or improved clinical outcomes.		
Outcomes		**Importance**	
ICU & Hospital Length of Stay		Critical	
Time on Mechanical Ventilation		Critical	
Infection Rate		Critical	
Mortality (ICU, Hospital, 30/60/90 Day/12 months)		Critical	
Frailty (6-minute walk test, Frailty Index, grip strength)		Critical	
Acute Kidney Injury		Critical	
Hospital/ICU Readmission Rates		Critical	
Time on inotropic/vasopressor support		Critical	
Time on mechanical circulatory system support		Critical	
Time to discharge alive		Important but not critical	
Malnutrition rates		Important but not critical	
Inflammation (CRP, IL-6)		Important but not critical	
Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, NTproBNP)		Important but not critical	
GI adverse events (bowel ischemia, emesis, ileus, nausea, GI Complications)		Important but not critical	
Cointerventions	**None**	**RCT's Ethical?**	Yes
PICOT 12	In adult perioperative cardiac (out)patients, does the administration of iron vs. no administration of iron reduce anemia and blood product utilization?		
Outcomes		**Importance**	
ICU & Hospital Length of Stay		Critical	
Time on Mechanical Ventilation		Critical	
Infection Rate		Critical	
Mortality (ICU, Hospital, 30/60/90 Day/12 months)		Critical	
Frailty (6-minute walk test, Frailty Index, grip strength)		Critical	
Acute Kidney Injury		Critical	
Hospital/ICU Readmission Rates		Critical	
Time on inotropic/vasopressor support		Critical	
Time on mechanical circulatory system support		Critical	
Time to discharge alive		Important but not critical	
Malnutrition rates		Important but not critical	
Inflammation (CRP, IL-6)		Important but not critical	

Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, NTproBNP)		Important but not critical	
GI adverse events (bowel ischemia, emesis, ileus, nausea, GI Complications)		Important but not critical	
Cointerventions	**None**	**RCT's Ethical?**	Yes
PICOT 13	In adult perioperative cardiac patients, does the administration of micronutrients (e.g. iron, selenium, vitamin D) vs. no administration affect patient outcomes?		
Outcomes		**Importance**	
ICU & Hospital Length of Stay		Critical	
Time on Mechanical Ventilation		Critical	
Infection Rate		Critical	
Mortality (ICU, Hospital, 30/60/90 Day/12 months)		Critical	
Frailty (6-minute walk test, Frailty Index, grip strength)		Critical	
Acute Kidney Injury		Critical	
Hospital/ICU Readmission Rates		Critical	
Time on inotropic/vasopressor support		Critical	
Time on mechanical circulatory system support		Critical	
Time to discharge alive		Important but not critical	
Malnutrition rates		Important but not critical	
Inflammation (CRP, IL-6)		Important but not critical	
Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, NTproBNP)		Important but not critical	
GI adverse events (bowel ischemia, emesis, ileus, nausea, GI Complications)		Important but not critical	
Cointerventions	**None**	**RCT's Ethical?**	Yes

Table 3 Postoperative PICOT Questions

Postoperative PICOT Questions			
PICOT 14	In adult perioperative cardiac patients, does checking for gastric residuals vs not checking impact clinical outcomes?		
Outcomes		**Importance**	
ICU & Hospital Length of Stay		Critical	
Time on Mechanical Ventilation		Critical	
Infection Rate		Critical	
Mortality (ICU, Hospital, 30/60/90 Day/12 months)		Critical	
Frailty (6-minute walk test, Frailty Index, grip strength)		Critical	
Acute Kidney Injury		Critical	
Hospital/ICU Readmission Rates		Critical	
Time on inotropic/vasopressor support		Critical	
Time on mechanical circulatory system support		Critical	
Time to discharge alive		Important but not critical	
% of nutrition needs met		Important but not critical	
Calorie and protein delivery		Important but not critical	
Malnutrition rates		Important but not critical	
Inflammation (CRP, IL-6)		Important but not critical	
Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, NTproBNP)		Important but not critical	
GI adverse events (bowel ischemia, emesis, ileus, nausea, GI Complications)		Important but not critical	
Cointerventions	Use of prokinetics	**RCT's Ethical?**	Yes
PICOT 15	In adult postoperative cardiac patients who can take oral nutrition, does nutrition supplementation (ONS, supplemental EN or PN vs no supplemental ONS; EN or PN) impact clinical outcomes?		
Outcomes		**Importance**	
ICU & Hospital Length of Stay		Critical	
Time on Mechanical Ventilation		Critical	
Infection Rate		Critical	
Mortality (ICU, Hospital, 30/60/90 Day/12 months)		Critical	

Frailty (6-minute walk test, Frailty Index, grip strength)		Critical	
Acute Kidney Injury		Critical	
Hospital/ICU Readmission Rates		Critical	
Time on inotropic/vasopressor support		Critical	
Time on mechanical circulatory system support		Critical	
Time to discharge alive		Important but not critical	
% of nutrition needs met		Important but not critical	
Calorie and protein delivery		Important but not critical	
Malnutrition rates		Important but not critical	
Inflammation (CRP, IL-6)		Important but not critical	
Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, NTproBNP)		Important but not critical	
GI adverse events (bowel ischemia, emesis, ileus, nausea, GI Complications)		Important but not critical	
Cointerventions	**None**	**RCT's Ethical?**	Yes
PICOT 16	In adult postoperative cardiac patients who cannot take oral nutrition, does nutrition supplementation (EN or PN vs no EN or PN) impact clinical outcomes?		
Outcomes		**Importance**	
ICU & Hospital Length of Stay		Critical	
Time on Mechanical Ventilation		Critical	
Infection Rate		Critical	
Mortality (ICU, Hospital, 30/60/90 Day/12 months)		Critical	
Frailty (6-minute walk test, Frailty Index, grip strength)		Critical	
Acute Kidney Injury		Critical	
Hospital/ICU Readmission Rates		Critical	
Time on inotropic/vasopressor support		Critical	
Time on mechanical circulatory system support		Critical	
Time to discharge alive		Important but not critical	
% of nutrition needs met		Important but not critical	
Calorie and protein delivery		Important but not critical	
Malnutrition rates		Important but not critical	
Inflammation (CRP, IL-6)		Important but not critical	
Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, NTproBNP)		Important but not critical	
GI adverse events (bowel ischemia, emesis, ileus, nausea, GI Complications)		Important but not critical	
Cointerventions	**None**	**RCT's Ethical?**	Yes
PICOT 17	In adult postoperative cardiac patients, does provision of additional protein beyond standard oral diet protein intake vs no additional protein impact clinical outcomes?		
Outcomes		**Importance**	
ICU & Hospital Length of Stay		Critical	
Time on Mechanical Ventilation		Critical	
Infection Rate		Critical	
Mortality (ICU, Hospital, 30/60/90 Day/12 months)		Critical	
Frailty (6-minute walk test, Frailty Index, grip strength)		Critical	
Acute Kidney Injury		Critical	
Hospital/ICU Readmission Rates		Critical	
Time on inotropic/vasopressor support		Critical	
Time on mechanical circulatory system support		Critical	
Time to discharge alive		Important but not critical	
% of nutrition needs met		Important but not critical	
Calorie and protein delivery		Important but not critical	
Malnutrition rates		Important but not critical	
Inflammation (CRP, IL-6)		Important but not critical	
Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, NTproBNP)		Important but not critical	
GI adverse events (bowel ischemia, emesis, ileus, nausea, GI Complications)		Important but not critical	
Cointerventions	**None**	**RCT's Ethical?**	Yes

PICOT 18	In adult postoperative cardiac patients, does structured exercise in combination with a nutrition intervention vs. nutrition intervention alone impact clinical outcomes?		
Outcomes		**Importance**	
ICU & Hospital Length of Stay		Critical	
Time on Mechanical Ventilation		Critical	
Infection Rate		Critical	
Mortality (ICU, Hospital, 30/60/90 Day/12 months)		Critical	
Frailty (6-minute walk test, Frailty Index, grip strength)		Critical	
Acute Kidney Injury		Critical	
Hospital/ICU Readmission Rates		Critical	
Time on inotropic/vasopressor support		Critical	
Time on mechanical circulatory system support		Critical	
Time to discharge alive		Important but not critical	
% of nutrition needs met		Important but not critical	
Calorie and protein delivery		Important but not critical	
Malnutrition rates		Important but not critical	
Inflammation (CRP, IL-6)		Important but not critical	
Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, NTproBNP)		Important but not critical	
GI adverse events (bowel ischemia, emesis, ileus, nausea, GI Complications)		Important but not critical	
Cointerventions	**None**	**RCT's Ethical?**	Yes
PICOT 19	In adult postoperative cardiac surgery patients does waiting to feed until hemodynamic stability is achieved not waiting impact clinical outcomes?		
Outcomes		**Importance**	
ICU & Hospital Length of Stay		Critical	
Time on Mechanical Ventilation		Critical	
Infection Rate		Critical	
Mortality (ICU, Hospital, 30/60/90 Day/12 months)		Critical	
Frailty (6-minute walk test, Frailty Index, grip strength)		Critical	
Acute Kidney Injury		Critical	
Hospital/ICU Readmission Rates		Critical	
Time on inotropic/vasopressor support		Critical	
Time on mechanical circulatory system support		Critical	
Time to discharge alive		Important but not critical	
% of nutrition needs met		Important but not critical	
Calorie and protein delivery		Important but not critical	
Malnutrition rates		Important but not critical	
Inflammation (CRP, IL-6)		Important but not critical	
Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, NTproBNP)		Important but not critical	
GI adverse events (bowel ischemia, emesis, ileus, nausea, GI Complications)		Important but not critical	
Cointerventions	**None**	**RCT's Ethical?**	Yes
PICOT 20	In adult postoperative cardiac surgery patients, does slow progressive feeding to reach energy target (ramp up) vs starting at goal rate impact clinical outcomes?		
Outcomes		**Importance**	
ICU & Hospital Length of Stay		Critical	
Time on Mechanical Ventilation		Critical	
Infection Rate		Critical	
Mortality (ICU, Hospital, 30/60/90 Day/12 months)		Critical	
Frailty (6-minute walk test, Frailty Index, grip strength)		Critical	
Acute Kidney Injury		Critical	
Hospital/ICU Readmission Rates		Critical	
Time on inotropic/vasopressor support		Critical	
Time on mechanical circulatory system support		Critical	
Time to discharge alive		Important but not critical	
% of nutrition needs met		Important but not critical	

Calorie and protein delivery		Important but not critical	
Malnutrition rates		Important but not critical	
Inflammation (CRP, IL-6)		Important but not critical	
Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, NTproBNP)		Important but not critical	
GI adverse events (bowel ischemia, emesis, ileus, nausea, GI Complications)		Important but not critical	
Cointerventions	**None**	**RCT's Ethical?**	Yes
PICOT 21	In adult postoperative cardiac surgery patients who cannot meet estimated energy and protein target through enteral nutrition in the first 7 days post-operatively does providing supplemental PN vs no supplemental PN impact clinical outcomes?		
Outcomes		**Importance**	
ICU & Hospital Length of Stay		Critical	
Time on Mechanical Ventilation		Critical	
Infection Rate		Critical	
Mortality (ICU, Hospital, 30/60/90 Day/12 months)		Critical	
Frailty (6-minute walk test, Frailty Index, grip strength)		Critical	
Acute Kidney Injury		Critical	
Hospital/ICU Readmission Rates		Critical	
Time on inotropic/vasopressor support		Critical	
Time on mechanical circulatory system support		Critical	
Time to discharge alive		Important but not critical	
% of nutrition needs met		Important but not critical	
Calorie and protein delivery		Important but not critical	
Malnutrition rates		Important but not critical	
Inflammation (CRP, IL-6)		Important but not critical	
Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, NTproBNP)		Important but not critical	
GI adverse events (bowel ischemia, emesis, ileus, nausea, GI Complications)		Important but not critical	
Cointerventions	**None**	**RCT's Ethical?**	Yes
PICOT 22	In adult postoperative cardiac surgery patients, does performing a swallow evaluation immediately post-extubation vs waiting ≥ 24 hrs improve PO intake and impact adverse events?		
Outcomes		**Importance**	
ICU & Hospital Length of Stay		Critical	
Time on Mechanical Ventilation		Critical	
Infection Rate		Critical	
Mortality (ICU, Hospital, 30/60/90 Day/12 months)		Critical	
Frailty (6-minute walk test, Frailty Index, grip strength)		Critical	
Acute Kidney Injury		Critical	
Hospital/ICU Readmission Rates		Critical	
Time on inotropic/vasopressor support		Critical	
Time on mechanical circulatory system support		Critical	
Time to discharge alive		Important but not critical	
% of nutrition needs met		Important but not critical	
Calorie and protein delivery		Important but not critical	
Malnutrition rates		Important but not critical	
Inflammation (CRP, IL-6)		Important but not critical	
Cardiac markers (high-sensitivity troponin, plasma-free hemoglobin, NTproBNP)		Important but not critical	
GI adverse events (bowel ischemia, emesis, ileus, nausea, GI Complications)		Important but not critical	
Cointerventions	**None**	**RCT's Ethical?**	Yes

Methods:

The Search Strategy

PubMED/MEDLINE, EMBASE, Cochrane Central, and CINAHL Databases will be searched from 2001 to present (shortly before journal submission).

Search Strategy:

1. **Cardiac Surgical Terms:**
    - **MeSH Terms**: Thoracic Surgery, Cardiac Surgical Procedures, Cardiopulmonary Bypass, Heart Diseases/surgery, Hemodynamics, Cardiovascular Agents, Cardiovascular Diseases/surgery, Perioperative Care (in conjunction with Heart Diseases), Heart-Assist Devices, Shock, Cardiogenic/surgery.
    - Keywords: Thoracic Surgery, Thoracic Surgical Procedures, Chest Surgery, Cardiac Surgical Procedures, Heart Surgery, Cardiac Operations, Cardiac Surgery, Cardiopulmonary Bypass, Heart-Lung Bypass, Heart-Assist Devices, Cardiac Support Devices, Heart Support Devices, Hemodynamics, Blood Flow Dynamics, Cardiovascular Agents, Cardiac Medications, Cardiovascular Drugs, Cardiovascular Diseases, Heart Disease, Heart Disorders, Cardiac Disorders, Heart Diseases, cardiac shock, cardiogenic shock, and related surgical terms.
2. **Nutritional Aspects:**
    - MeSH Terms: Nutrition Assessment, Body Composition, Nutrition Therapy, Nutritional Physiological Phenomena.
    - Keywords: nutrition risk, nutrition screening, nutrition assessment, nutritional screening, nutritional assessment, nutrition support, enteral nutrition, tube feed, tube feeding, tube feeds, nasogastric, PEG, gastrointestinal complications, Percutaneous Endoscopic Gastrostomy, RIG, Radiologically Inserted Gastrostomy, parenteral nutrition, IV Feeding, intravenously fed, nutrition supplementation, Oral Nutrition Supplement, ONS, supplemental PN, PN, Oral Feeding, oral nutrition, nutrition therapy, medical nutrition therapy, nutritionist, nutrition support team, immunonutrition, immune-modulating nutrition, omega-3, glutamine, arginine, dietary counseling, malnutrition, nutrition status, nutritional status, nutrition indices, nutritional indices, nutrition index, nutritional index, Body Composition, lean mass, fat-free mass, myosteatosis, sarcopenia, muscle mass, muscle strength, Body Mass Index, BMI, dysphagia, nutritional intake, nutrition team , weight, muscle wasting, nil per os, NPO, carbohydrates, carbohydrate loading, clear liquids, glycemic control, lipids, fat, fatty acids, lipid emulsions, SMOF, soy, soya, MOLE, SOLE, fish oil, SO-ILE, antioxidant, inflammatory markers, IL-6, CRP, PCT, micronutrients, iron, selenium, vitamin D, gastric residuals, protein, amino acids, protein needs, protein requirements, protein intake, amino acid intake, calories, calorie needs, calorie requirements, caloric needs, caloric requirements, energy, energy requirements, energy needs, energy intake, kcal, kcal/kg, exercise, MNT, nutrition, energy target, swallow evaluation, PO intake, oral nutrition.
3. **Inclusion/Exclusion Criteria:**
    - MeSH Terms: Adult, Humans.
    - Filter: Randomized controlled trial.
    - Filter: For Studies where RCT's are not ethical, the following filter will be used to capture quasi-experimental studies.

("Quasi-Experimental Study" [Title/Abstract] OR "Quasi-Experimental Studies" [Title/Abstract] OR "Quasi-Experimental Design" [Title/Abstract] OR "Quasi-Experimental Designs" [Title/Abstract] OR "Nonrandomized Controlled Trials as Topic"[MeSH Terms] OR "Non-Randomized Controlled Trials" [Title/Abstract] OR "Nonrandomized Controlled Trials" [Title/Abstract] OR "Controlled Before-After Studies" [Title/Abstract] OR "Interrupted Time Series Analysis" [Title/Abstract] OR "Non-Randomized" [Title/Abstract] OR "Nonrandomized" [Title/Abstract] OR "Pretest-Posttest Design" [Title/Abstract] OR "Pre-Post Study" [Title/Abstract] OR "Pre-Post Studies" [Title/Abstract])

Data Acquisition

Training: Twenty-five citations will be uploaded into Rayyan for the team calibration test. Using their PICOT questions and inclusion criteria, the team will individually screen the 25 studies and determine if they meet inclusion criteria. If the team achieves less than 75% overall percent agreement, the discrepancies will be discussed, 25 new citations will be uploaded, and the group will try again. This will continue until they achieve ≥ 75 overall percent agreement, at which time, they will be permitted to move onto to official citation screening in Covidence.

Screening: All citations will be uploaded into Covidence for screening. For any given article, all steps below will be performed in duplicate (by two reviewers) and discrepancies will be adjudicated by a third reviewer. First, citation titles and abstracts will be screened for relevance to our PICOT questions. Then, a full text review will be performed for any citations that were deemed relevant in the previous phase of review. Articles that meet our inclusion criteria will be moved forward to the final phase of data extraction.

Inclusion/Exclusion Criteria/Study Design Selection

Studies (or study subgroups) considered for inclusion will be restricted to patients 16 years or older, capable of receiving nutrition support, who were scheduled to undergo elective or urgent cardiac surgery at a cardiac surgery center. Elective/urgent cardiac surgery is defined as a non-emergent cardiac surgery followed by immediate organ support (ventilation, inotropic/vasopressors/mechanical circulatory systems) requiring an ICU stay.

Studies will be excluded if they are restricted to the following: emergent surgeries or patients not receiving nutrition support.

For each question, we will restrict the study design most able to answer that specific question. The decision will be made as follows (Figure 2). If randomized control trials (RCT) are available, we will restrict to RCT's. If RCT's are not available, but are ethically feasible, we will call for RCT's and include high quality quasi-experimental designs, defined as those designs that have a true control group and demonstrable baseline similarity between groups. If RCT's are not ethically feasible, we will ask ourselves if there are known confounders in the exposure/outcome relationship that cannot be completely managed through adjustment. If the answer is no, then we will restrict to prospective cohort studies that adjust for the known confounder and high quality quasi-experimental designs. If the answer is yes, we will restrict to

only include high-quality quasi-experimental designs. To be considered a high-quality quasi-experimental design, the study must have a true control group and demonstrate similarity between the two groups compared. Co-interventions will be permitted only if they can be reasonably assumed to be similar between groups.

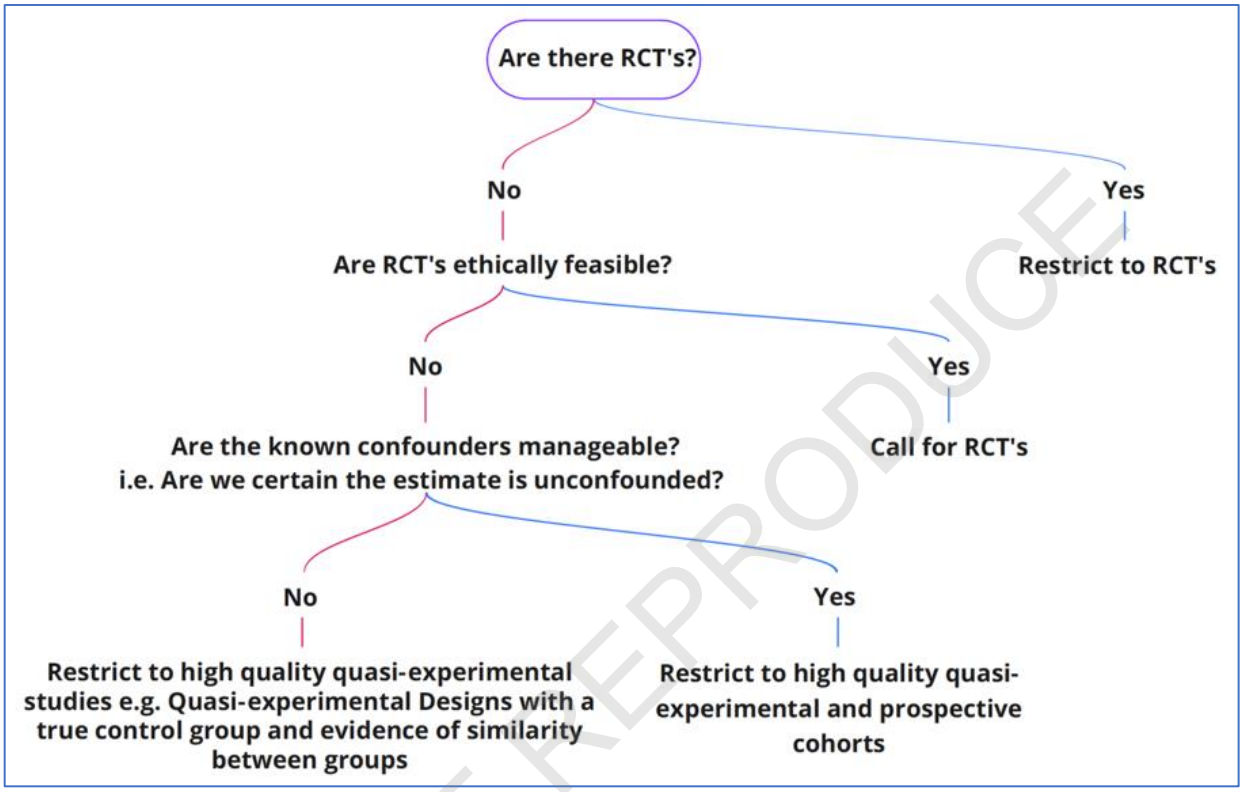

Figure 1: Decision Tree for Study Design Inclusion

Bias Analysis

Study quality will be assessed according to its methodologic vulnerability to bias using different tools for different study types. For RCT's, the Risk of Bias 2 (ROB2) [20] tool will be used. For quasi-experimental studies, the Risk of Bias in Non-randomized Study Interventions (ROBINS-I) [21] tool will be used. For prospective cohort studies, the Newcastle-Ottawa scale [22] will be used. For RCT's the Clinical Experts Panel will create a list of potential co-interventions to be considered in the bias assessment. For prospective cohorts, they will determine a list of confounders that require adequate adjustment. These lists will be handed to the Bias Panel who will perform the official bias analysis. All bias analyses will be performed in duplicate. The results of all bias analyses will be published as part of the supplement for this guideline and discussed as strengths and limitations in the body of the guideline.

Quality of Evidence

The Grading of Recommendations Assessment, Development and Evaluation (GRADE) system will be used to assess the quality of our evidence in regard to its ability to answer our PICOT questions. This will be used to rate the quality of evidence for each outcome across all

studies. The Clinical Experts Panel will then determine which outcomes are most critical and this will be used to inform the overall quality of the evidence for each PICOT question. All data will be tabulated and presented in the supplement as a Summary of Findings Table.

Statistical Analysis

Wherever three or more studies exist with interventions, comparators, outcomes, and populations similar enough to justify conflation, Forest Plots will be created with summary statistics using a random effects model to account for the minor population differences between hospitals. Heterogeneity will be assessed using the I^2 statistic. If the I^2 is greater than 0.5, we will perform sub-analyses as an attempt to explain the heterogeneity. Publication bias will be assessed through funnel plots and Egger tests wherever >=10 studies are available for conflation into a forest plot.

Formulation of Recommendations

Recommendations will be formulated using the GRADE Criteria. The GRADE process separates the body of evidence quality rating from the strength of the recommendation permitting a benefits and harms analysis. Evidence quality will be listed underneath each recommendation. Recommendations will be labeled as strong or weak based upon the balance of potential benefit and harm. Where the recommendation is strong, we will use the term "recommend" regarding our guideline recommendation. Where the recommendation strength is weak, we will use the term "suggest".

Wherever possible, these recommendations will be based upon the data analyzed. Where inadequate data is present to guide a recommendation, the clinical panel will formulate a consensus of expert opinions using a modified Delphi technique. Briefly, the Clinical Experts panel will meet to discuss the various potential benefits and harms of the intervention in question. Based on this conversation, the chair will formulate recommendations for each PICOT question. This will be sent out to the Clinical Experts panel, who will either agree with the wording of the recommendation or return it with comments. These responses will be de-identified and returned to the chair. If each expert opinion recommendation has <70% agreement, the chair will alter the questions to be more agreeable to the panel and send them out again. This process will repeat until ≥70% agreement is achieved. The process will then start over with an external panel of at least 8 outside experts who will receive the current state of the recommendations from the chair and send back de-identified responses. When the external panel has ≥70% agreement on each expert opinion recommendation, the recommendation will be considered as final. The external panel will have at least 1 patient representative to ensure input from this often-neglected stakeholder.

Review

Upon completion, a draft of the guideline will be sent to both the ASPEN Clinical Practice Committee and the ASPEN Pediatric Section for review. It will also be sent to external reviewers through the Journal of Parenteral and Enteral Nutrition for Review.

Updates

This guideline will be updated every 5 years.

Conclusion

Involvement of all key stakeholders is crucial to the success and generalizability of any guideline. We need their expertise to help make this guideline the best it can be. All stakeholders are warmly welcomed to send comments and concerns, which will be considered carefully in the next iteration of this protocol.

References

1. Drover JW, Cahill NE, Kutsogiannis J, Pagliarello G, Wischmeyer P, Wang M, et al. Nutrition therapy for the critically ill surgical patient: we need to do better! Journal of Parenteral and Enteral Nutrition. 2010;34:644–52. doi:10.1177/0148607110372391.
2. Stoppe C, Goetzenich A, Whitman G, Ohkuma R, Brown T, Hatzakorzian R, et al. Role of nutrition support in adult cardiac surgery: a consensus statement from an International Multidisciplinary Expert Group on Nutrition in Cardiac Surgery. Crit Care. 2017;21:131. doi:10.1186/s13054-017-1690-5.
3. Xiao S-C, Zhu S-H, Xia Z-F, Lu W, Wang G-Q, Ben D-F, et al. Prevention and treatment of gastrointestinal dysfunction following severe burns: a summary of recent 30-year clinical experience. WJG. 2008;14:3231–5. doi:10.3748/wjg.14.3231.
4. Gottschlich MM, Jenkins ME, Mayes T, Khoury J, Kagan RJ, Warden GD. THE 2002 CLINICAL RESEARCH AWARD. Journal of Burn Care & Rehabilitation. 2002;23:401–15. doi:10.1097/00004630-200211000-00006.
5. Rodriguez NA, Jeschke MG, Williams FN, Kamolz L-P, Herndon DN. Nutrition in burns: Galveston contributions. JPEN J Parenter Enteral Nutr. 2011;35:704–14. doi:10.1177/0148607111417446.
6. Porter C, Tompkins RG, Finnerty CC, Sidossis LS, Suman OE, Herndon DN. The metabolic stress response to burn trauma: current understanding and therapies. The Lancet. 2016;388:1417–26. doi:10.1016/S0140-6736(16)31469-6.
7. Dickerson RN, Gervasio JM, Riley ML, Murrell JE, Hickerson WL, Kudsk KA, Brown RO. Accuracy of predictive methods to estimate resting energy expenditure of thermally-injured patients. JPEN J Parenter Enteral Nutr. 2002;26:17–29. doi:10.1177/014860710202600117.
8. Williams FN, Jeschke MG, Chinkes DL, Suman OE, Branski LK, Herndon DN. Modulation of the hypermetabolic response to trauma: temperature, nutrition, and drugs. Journal of the American College of Surgeons. 2009;208:489–502. doi:10.1016/j.jamcollsurg.2009.01.022.
9. Wolf SE, Rose JK, Desai MH, Mileski JP, Barrow RE, Herndon DN. Mortality determinants in massive pediatric burns. An analysis of 103 children with or = 80% TBSA burns (or = 70% full-thickness). Annals of Surgery. 1997;225:554-65; discussion 565-9. doi:10.1097/00000658-199705000-00012.
10. Sudenis T, Hall K, Cartotto R. Enteral nutrition: what the dietitian prescribes is not what the burn patient gets! J Burn Care Res. 2015;36:297–305. doi:10.1097/BCR.0000000000000069.
11. Hill A, Heyland DK, Elke G, Schaller SJ, Stocker R, Haberthür C, et al. Meeting nutritional targets of critically ill patients by combined enteral and parenteral nutrition: review and

rationale for the EFFORTcombo trial. Nutr Res Rev. 2020;33:312–20. doi:10.1017/S0954422420000165.
12. Wei X, Day AG, Ouellette-Kuntz H, Heyland DK. The Association Between Nutritional Adequacy and Long-Term Outcomes in Critically Ill Patients Requiring Prolonged Mechanical Ventilation: A Multicenter Cohort Study. Critical Care Medicine. 2015;43:1569–79. doi:10.1097/CCM.0000000000001000.
13. Rubinson L, Diette GB, Song X, Brower RG, Krishnan JA. Low caloric intake is associated with nosocomial bloodstream infections in patients in the medical intensive care unit. Critical Care Medicine. 2004;32:350–7. doi:10.1097/01.CCM.0000089641.06306.68.
14. Pingleton SK. Nutrition in Chronic Critical Illness. Clinics in Chest Medicine. 2001;22:149–63. doi:10.1016/S0272-5231(05)70031-9.
15. McClave SA, Lowen CC, Kleber MJ, Nicholson JF, Jimmerson SC, McConnell JW, Jung LY. Are patients fed appropriately according to their caloric requirements? JPEN J Parenter Enteral Nutr. 1998;22:375–81. doi:10.1177/0148607198022006375.
16. Huang YC, Yen CE, Cheng CH, Jih KS, Kan MN. Nutritional status of mechanically ventilated critically ill patients: comparison of different types of nutritional support. Clinical Nutrition. 2000;19:101–7. doi:10.1054/clnu.1999.0077.
17. Galbán C, Montejo JC, Mesejo A, Marco P, Celaya S, Sánchez-Segura JM, et al. An immune-enhancing enteral diet reduces mortality rate and episodes of bacteremia in septic intensive care unit patients. Critical Care Medicine. 2000;28:643–8. doi:10.1097/00003246-200003000-00007.
18. Hill A, Nesterova E, Lomivorotov V, Efremov S, Goetzenich A, Benstoem C, et al. Current Evidence about Nutrition Support in Cardiac Surgery Patients-What Do We Know? Nutrients 2018. doi:10.3390/nu10050597.
19. Stoppe C, Whitlock R, Arora RC, Heyland DK. Nutrition support in cardiac surgery patients: Be calm and feed on! The Journal of Thoracic and Cardiovascular Surgery. 2019;158:1103–8. doi:10.1016/j.jtcvs.2019.02.132.
20. Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. BMJ. 2019;366:l4898. doi:10.1136/bmj.l4898.
21. Hinneburg I. Nichtrandomisierte Studien bewerten ROBINS-I-Checkliste für die Überprüfung des Verzerrungspotenzials. [ROBINS-1: A tool for asssessing risk of bias in non-randomised studies of interventions]. Med Monatsschr Pharm. 2017;40:175–7.
22. Wells G, Shea, B, O'Connell, D, Peterson, J, Welch, V, Losos,M, Tugwell, P. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses.