Title:	Trends in intraoperative transfusion thresholds and association with post-operative outcomes: A Report From the Multicenter Perioperative Outcomes Group (MPOG)
Principal Investigator:	Douglas Colquhoun MB ChB, MSc, MPH
Co-Investigators:	Fiona Linton MB BCh, FRCA Jonathan Linton BM BS, FRCA Amy Shanks PhD Aleda Thomson MS Leif Saager MD, MMM Sachin K. Kheterpal MD, MBA Milo C. Engoren MD Paul Picton MB ChB, MRCP, FRCA And other interested MPOG investigators
Type of Study:	Retrospective observational – descriptive study
IRB Number / Status:	University of Michigan: HUM00052066 / Accepted
Aims:	1) To investigate the trend in measured hemoglobin/hematocrit and subsequent transfusion in a US academic general surgery population 2) To investigate factors associated with transfusion (particularly institution, temporal trend, surgery type and presence of cardiac disease) 3) To investigate the relationship between transfusion and post-operative mortality, AKI or myocardial injury.
Patients/Participants:	Inclusion: 18yrs or older. Undergoing orthopedic, general, vascular, gynecologic, urologic, ENT or thoracic surgery. Inpatient stay. At participating MPOG institution. Exclusion: Transfusion >3u PRBCs during a single case, Outpatient Surgery, Cardiac Surgery or ASA 5 or 6 Classification.

Proposed statistical test/analysis:	For our primary and second outcomes, the trend of median pre-transfusion hemoglobin by quarter will be assessed for any change over time by testing whether the slope is significantly different from 0 using a bivariate linear regression model with the dependent variable of median pre-transfusion hemoglobin. If the slope is different than 0, then a Joinpoint analysis will be conducted to determine if there are any inflection points in the trend and reported accordingly. ANOVA will be used to determine if the proportion of cases receiving PRBC significantly changes through the study period. In addition mixed-effects logistic regression models will be developed to determine independent predictors of secondary outcomes 4 and 5 as outlines in the study protocol.
Resources:	Perioperative records query from MPOG-participating institutions, performed with support of MPOG Coordinating center.

Introduction

Packed red blood cell transfusion can be lifesaving in the treatment of bleeding and in the US alone, 13.6 million units of blood are collected each year.[1] However transfusion is associated with major morbidity and mortality,[2-6] therefore, it is critical to identify those for whom this therapy will provide the most benefit.

Older, observational data from patient populations who refuse transfusions of red blood cells demonstrates increasing morbidity and mortality as hemoglobin concentrations fall below 7.1-8 g/dL, with significant mortality accrued below 5 g/dL.[7,8] A succession of large, prospective randomized controlled trials have subsequently been performed to compare restrictive transfusion (with varying hemoglobin thresholds between 7-8 g/dL) with liberal transfusion (using thresholds of 9-10 g/dL) practice. Meta-analyses of these studies have not shown differences in mortality between groups in orthopedic trauma[9], cardiovascular surgery[10], or unselected hospitalized populations;[11-13] recommendations regarding the utilization of restrictive transfusion practice have subsequently been incorporated into professional society guidelines worlwide.[14,15] Some controversy remains in patients with ischemic cardiac disease.[13,16]

Surveys of blood banks reveal that transfusions of packed red blood cells have declined overall.[1] From Europe, a large prospective observational trial revealed pre-transfusion hemoglobin of 8.1 g/dL prior to intraoperative transfusion, however noted that in 41% of cases providers gave more than 1 unit of packed red blood cells irrespective of the starting hemoglobin.[17] This study did not examine patients in whom transfusion was not performed and were unable to comment on patient outcomes.

It is not yet clear how the results of this increasing body of work favoring restrictive transfusion practice has translated into intraoperative clinical practice within the United States. Therefore, we seek to perform a retrospective observational study to evaluate trends in transfusion practices and to assess changes in outcome in patients undergoing major surgery within centers in the United States.

We hypothesized that: 1) We would observe a reduction in pre-transfusion intraoperative hemoglobin, as a proxy for transfusion trigger, and reduction in nadir hemoglobin in cases where intraoperative transfusion was not performed. 2) A diminishing number of intraoperative transfusions would be observed, overall and at each hemoglobin value. 3) There would be a reduction in the nadir postoperative hemoglobin. 4) That any observed trends would be modulated by year, surgery type, institution and the presence of coronary artery disease. 5) That in the presence of a change in transfusion practice, we would not observe a change in mortality, post-operative myocardial injury or acute kidney injury.

Methods:

The MPOG Consortium assembles a database of perioperative information of patients undergoing anesthetic care at institutions across the US and the Netherlands. Data is assembled from electronic health record systems (including anesthesia specific systems), administrative, laboratory and outcome data sources. Full details of the functioning of the MPOG Consortium are described elsewhere.[18] IRB approval for this study is provided by University of Michigan Institutional Review Board (HUM00052066). Sites participating in the MPOG collaborative obtain local IRB approval to assemble, organize and transmit this dataset. In keeping with the normal operating procedure of the MPOG collaborative the study protocol was presented to and approved by the MPOG Perioperative Clinical Research Committee (PCRC) on October 9th 2017. It was finalized on Feb 2nd 2018, prior to data extraction or analysis. A completed STROBE checklist for this study is attached to this manuscript (Appendix 1).

Sites will be included if they participated in the MPOG collaborative and data, including perioperative labs, and hospital and professional billing data were consistently available for the period between January 1, 2012 and July 1, 2017. We anticipate including data from 8 participating US sites: Cleveland Clinic, University of Colorado, University of Michigan, University of Oklahoma, University of Tennessee, University of Vermont, University of Virginia and Vanderbilt University.

Subjects will be included in the study if they were 18 years or older at time of surgery, underwent an orthopedic, general, transplant, vascular, gynecologic, urologic, neurosurgery, plastic, ENT or thoracic procedure with an associated inpatient stay. Subjects will be excluded if they underwent transfusion of greater than 3 units of packed red blood cells during the intraoperative period, underwent outpatient surgery, cardiac surgery, obstetric surgery, any procedure involving CPB or were assessed as having an ASA physical status classification of 5 or 6. Case groupings will be performed based on Anesthesia CPT Codes (see Appendix 2).

The primary outcomes of this study are: the change in the pre-transfusion hemoglobin (ie transfusion threshold) and the nadir hemoglobin not-followed with an intraoperative transfusion over the course of the study period. The secondary outcomes of this study are: proportions of cases receiving a packed red blood cell transfusion throughout the study period (including stratification by prior laboratory measurements); the number of units of packed red blood cells transfused during the intraoperative period; the nadir postoperative hemoglobin (lowest value measured 0 – 72 hrs after the completion of intraoperative anesthesia care), the relationship between patient, surgical and institutional factors and the occurrence of transfusion and determination of the subsequent impact of any transfusion trends on blood product utilization; the relationship between in hospital mortality, post-operative myocardial injury, acute kidney injury and the pre-transfusion hemoglobin (for transfused cases – definition below) and lowest (for non-transfused cases) intraoperative hemoglobin.

In this study, we define coronary artery disease based on the present of a discharge ICD9/10 as listed in Appendix 3. Determination of AKI was based on the KIDIGO laboratory based definition AKI (Cr rise of 0.3 mg/dL rise within 48hrs of anesthesia end time or rise by more than 50% in 7 days).[19] We will use intraoperative hemoglobin values documented, regardless of method of measurement. We preferentially use hemoglobin measures over hematocrit if these are documented simultaneously. If only a hematocrit is present at the time of lab measurement, we will perform an estimated conversion to hemoglobin, by dividing by 3. For blood transfusions documented exclusively in volume based units, we will convert this to units by assuming that any blood volume transfused greater than or equal to 250ml and less than or equal to 450 ml in one charting increment corresponds to one unit of blood.

For those transfused, the hemoglobin analyzed will be the value immediately prior to the transfusion of the case. In the cases with multiple transfusions, it will be the highest of the identified pre-transfusion hemoglobin measures across each of the transfusions. We will define immediately prior to transfusion as the lab value drawn closest to transfusion within a 30-minute pre-transfusion window. If this proves too restrictive and more than 30% of pre-transfusion lab values will be excluded, the window will be liberalized to 45 minutes. The hemoglobin measurement identified is referred to as the "pre-transfusion hemoglobin" throughout this document. For those who were not transfused, the nadir hemoglobin will be the lowest value of the case.

The covariates to be included in all models (discussed below) are surgical specialty (defined based on anesthesia CPT Code assigned to the case), age, BMI, sex, presence of coronary artery disease (defined by ICD 9/10 codes), Elixhauser comorbidities, quarter of the study period, and nadir hemoglobin. The unit of measure for time used in trend analysis will be by quarter. The use of autologous blood will not be considered in this analysis. Patients who receive exclusively cell saver blood (and no PRBCs) will be considered not to be transfused for the purposes of the analysis.

We will describe the proportion of cases with a non-red blood cell blood product administered and the frequency of use of measures of coagulation (PT/INR, PTT, PLTs etc) as documented in the anesthesia record and the use of "cell saver" blood. Additionally, we will perform a survey of participating institutions to determine if formal blood transfusion protocols or blood transfusion management efforts, pre-operative preparation strategies were routinely used and which point of care coagulation tests were in place at the time the studied cases occurred.

Statistical Analysis:

Summary statistics will be presented as means and standard deviations or medians with interquartile ranges for continuous variables, as appropriate, and frequencies with percentages for categorical variables. All continuous variables will be assessed for normality using the Kolmogorov-Smirnov test. Univariate demographic and covariate comparisons between those who did and did not receive a transfusion will be analyzed using Student's t-tests or Mann-

Whitney U tests for continuous variables, and Chi-squared or Fisher's Exact tests for categorical variables, as appropriate.

Mixed-effects multivariable linear or logistic regression models will be constructed as necessary. Prior to model entry, all covariates selected for model inclusion will be checked for collinearity using a Pearson correlation matrix. Variable pairs with a correlation > 0.70 will be considered collinear and either combined into one variable, or one of the covariates will be excluded from the model. All variable pairs with a correlation <= 0.70 will be deemed fit for model entry. Model effect size will be presented as adjusted odds ratios with 95% confidence intervals, or beta coefficients with standard error, as appropriate. The covariates to be included in all models (discussed below) are surgical specialty, age, BMI, sex, presence of coronary artery disease, Elixhauser comorbidities, quarter of the study period, and hemoglobin. Time will be included in all models as a fixed effect by quarter, half-year, or year based on available sample size. The first quarter, half-year, or year will serve as the reference group. The random effects of institution and attending, where appropriate, will be presented as intraclass correlation coefficients and median odds ratios with 95% confidence intervals. Measures of effect size will be reported as adjusted odds ratios for logistic regression and beta coefficients for linear regression, and will be presented with 95% confidence intervals. For logistic regression models, model predictive capability will be presented as the area under the receiver operating curve (ROC) c-statistic. For linear regression, the extent to which the model explains the variability of the data will be presented as R^2 values. Covariates with a statistically significant adjusted odds ratio or beta coefficient (as appropriate) will be considered independent predictors of the outcome.

Primary Outcome 1: The change in documented hemoglobin prior to an intraoperative transfusion.

The hemoglobin of interest for this outcome is the pre-transfusion hemoglobin. See additional definitions above. Additionally, for this primary outcome we will perform a sensitivity analysis, following the same statistical methodology, to compare the effect of including only the first transfusion of the case in those cases with multiple transfusion with our definition.

First, the trend of median pre-transfusion hemoglobin measurement by quarter will be assessed for any change over time by testing whether the slope is significantly different from 0 using a bivariate linear regression model with the dependent variable of median pre-transfusion hemoglobin measurement. If the slope is not significantly different from 0, then the analyses for this aim will conclude. Otherwise, a Joinpoint analysis will be conducted to determine if there are any inflection points in the trend. If no inflection points are found and the slope is negative and significantly different from 0, then Hypothesis 1 will be assumed true. If the Joinpoint analysis finds one or more inflection points in the data, then a Student's t test or Mann-Whitney U test will be used to compare the values between consecutive quarters to analyze the significance of the change. A similar analysis will be conducted at the institution level.

Primary Outcome 2: The change in documented nadir hemoglobin not followed with an intraoperative transfusion.

The hemoglobin of interest for this outcome is the lowest documented intraoperative hemoglobin for the case, for those who did not receive an intraoperative transfusion.

The analysis for this outcome will be conducted identical to that for Primary Outcome 1.

Secondary Outcome 1: Proportion of cases receiving a packed red blood cell transfusion throughout the study period.

An analysis similar to that for Primary Outcome 1 will be used to determine if there was a difference in trend over time for the proportion of cases receiving a pRBC transfusion. A similar analysis will be conducted at the institution level.

The proportion of people transfused at each hemoglobin threshold level (<6, 6-7, 7-8, 8-9, 9-10, >10) will be compared between 2012 and 2016 to determine if a change in practice occurred using a Chi-square or Fisher's Exact test, as appropriate.

Secondary Outcome 2: The number of units of packed red blood cells transfused during the intraoperative period.

The number of units of pRBC transfused during the intraoperative period will be analyzed similar to Primary Outcome 1.

To determine independent predictors of the number of units of pRBC transfused during a case, two mixed effects linear regression models will be constructed with the independent covariates listed in the methods and the dependent variable of number of units of packed red blood cells transfused. The first model will contain the mixed effect of institution, and the second model will contain the hierarchical mixed effects of primary attending nested within institution.

Secondary Outcome 3: The nadir postoperative hemoglobin (lowest value measured 0 – 72 hrs after the completion of intraoperative anesthesia care)

The lowest postop hemoglobin will be examined for a trend over time for all cases using a Joinpoint analysis as for previous outcomes. The lowest postop hemoglobin will be compared at each time point between those with and without an intraoperative transfusion using a Student's t test or Mann-Whitney U test, as appropriate.

Secondary Outcome 4: The relationship between patient, surgical and institutional factors and the occurrence of transfusion and determination of the subsequent impact of any transfusion trends on blood product utilization.

Two mixed-effects logistic regression models will be used to determine if surgery type, year, and cardiac disease are independent predictors of intraoperative transfusion. The outcome of intraoperative transfusion will be defined as any PRBC use between Anesthesia Start and

Anesthesia End. The first model will contain the mixed effect of institution, and the second model will contain the hierarchical mixed effects of primary attending nested within institution. Independent variables to be included in the model are: Age, Sex, Elixhauser co-morbidities (as numeric and also CAD y/n, heart failure y/n, cancer y/n), WHO BMI classifications, ASA Status, Pre-op Hb, lowest Intra-op Hb for cases without intraop transfusion or the pre-transfusion hemoglobin, Pre-op Plts (abnormal y/n), Pre-op Creatinine (abnormal y/n), Abnormal coags (y/n – PT, PTT or INR), Surgical Specialty, EBL, Cell saver (Scavenged) blood use (y/n), Emergent Surgery, Use of anti-fibronlytics (Aminocaproic Acid, Tranexamic Acid, Aprotinin) – y/n, and surgical Case Duration.

To determine if transfusion practice changed over time, a multivariable linear regression model will be constructed as above, with the outcome of intraoperative hemoglobin (lowest throughout the case for those who were not transfused and prior to transfusion as defined above for those who received an intraop transfusion). The covariate of intraoperative transfusion y/n will be added to the list specified above. Model-based least square means with standard error will be reported and compared between those who were transfused and those who were not with a Student's t test. These means are the adjusted marginal mean of the outcome for the population, which we will consider a proxy for transfusion threshold. A one-way t-test will be used to test if the model-based mean hemoglobin for those who were transfused changed over time.

An observed vs. expected analysis will be conducted for the occurrence of transfusion, comparing practice patterns between the first and last time periods (quarters/half-years/years as appropriate) using a Chi-squared or Fisher's Exact test.

Secondary Outcome 5: The relationship between in hospital mortality, post-operative myocardial injury, acute kidney injury and intraoperative hemoglobin concentration (with and without transfusion).

Due to the small sample size expected for in-hospital mortality and post-operative myocardial infarction, the outcome for this analysis will be a composite variable of post-operative morbidity and mortality. Multiple mixed-effects logistic regression models will be used to determine if perioperative hemoglobin is an independent predictor of post-operative morbidity and mortality in ranges which are typically considered consistent with restrictive transfusion. In one model the lowest intraoperative hemoglobin will be considered as a continuous variable, for modelling outcome, in another, we will compare lowest intraoperative hemoglobin ranges of <6 g/dL, 6-7 g/dL, 7-8 g/dL, 8-9 g/dL, 9-10 g/dL, > 10 g/dL. Due to sample size constraints, we may have to redefine these boundaries. We will further analyze this to include the mixed effect of institution, and the second model will contain the hierarchical mixed effects of primary attending nested within institution. All models will include transfusion as a binary variable.

Sample Size:

Based on a rough approximation of the inclusion criteria using DataDirect, we found around 113,000 cases with intraoperative Hemoglobin/Hematocrit values, which should provide sufficient power for all planned analyses.

References:

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7. Viele MK, Weiskopf RB. What can we learn about the need for transfusion from patients who refuse blood? The experience with Jehovah's Witnesses. *Transfusion.* 1994;34(5):396-401.
8. Carson JL, Noveck H, Berlin JA, Gould SA. Mortality and morbidity in patients with very low postoperative Hb levels who decline blood transfusion. *Transfusion.* 2002;42(7):812-818.
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Society of Anesthesiologists Task Force on Perioperative Blood Management*. *Anesthesiology.* 2015;122(2):241-275.
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17. Meier J, Filipescu D, Kozek-Langenecker S, et al. Intraoperative transfusion practices in Europe. *Br J Anaesth.* 2016;116(2):255-261.
18. Kheterpal S. Clinical research using an information system: the multicenter perioperative outcomes group. *Anesthesiol Clin.* 2011;29(3):377-388.
19. Kellum JA, Lameire N, Group KAGW. Diagnosis, evaluation, and management of acute kidney injury: a KDIGO summary (Part 1). *Crit Care.* 2013;17(1):204.

Appendix 1 – Completed STROBE Statement

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Result
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Y
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	N/A
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Y
Objectives	3	State specific objectives, including any prespecified hypotheses	Y
Methods			
Study design	4	Present key elements of study design early in the paper	Y
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Y
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	Y
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Y
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe	Y

		comparability of assessment methods if there is more than one group	
Bias	9	Describe any efforts to address potential sources of bias	N/A
Study size	10	Explain how the study size was arrived at	Y
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Y
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Y
		(*b*) Describe any methods used to examine subgroups and interactions	Y
		(*c*) Explain how missing data were addressed	N/A
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	Y
		(*e*) Describe any sensitivity analyses	N/A

Results

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	N/A
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	N/A
		(b) Indicate number of participants with missing data for each variable of interest	N/A
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	N/A
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A

		Cross-sectional study—Report numbers of outcome events or summary measures	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	N/A
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	N/A
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	N/A
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	N/A
Generalisability	21	Discuss the generalisability (external validity) of the study results	N/A
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Y

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Appendix 2: Case Groupings by CPT Code

CPT Codes Specifically Included (based on 2014 CPT Codes):

Case Category	CPT Codes
Orthopedic	00450, 00452, 00454, 00640, 00600, 00604, 00620, 00622, 00625, 00626, 00630, 00632, 00634, 00635, 00670, 01112, 01130, 01160, 01180, 01190, 01120, 01140, 01150, 01170, 01173, 01200, 01220, 01340, 01380, 01390, 01420, 01462, 01490, 01202, 01210, 01212, 01214, 01215, 01230, 01232, 01234, 01250, 01320, 01360, 01382, 01392, 01400, 01402, 01404, 01464, 01470, 01472, 01474, 01480, 01482, 01484, 01486, 01620, 01680, 01682, 01730, 01820, 01860, 01610, 01622, 01630, 01634, 01636, 01638, 01710, 01712, 01714, 01716, 01732, 01740, 01742, 01744, 01756, 01758, 01760, 01810, 01829, 01830, 01832, 01650, 01652, 01654, 01656, 01670, 01770, 01772, 01780, 01782, 01840, 01842, 01844, 01850, 01852
General	00400, 00410, 00404, 00406, 00700, 00702, 00730, 00740, 00750, 00752, 00754, 00756, 00790, 00792, 00794, 00797, 00800, 00820, 00810, 00830, 00832, 00840, 00844, 00848, 00866, 00902, 00904
Transplant	00796, 00868
Vascular	00350, 00352, 00770, 00880, 00882, 01260, 01270, 01272, 01274, 01430, 01432, 01440, 01442, 01444, 01500, 01502, 01520, 01522
Gynecologic	00842, 00948, 00950, 00952, 00846, 00851, 00942, 00944, 00906, 00940
Urologic	00862, 00864, 00870, 00872, 00873, 00865, 00908, 00910, 00912, 00914, 00916, 00918, 00860, 00921, 00922, 00924, 00926, 00928, 00930, 00932, 00934, 00936, 00938, 00920
Neurosurgery	00210, 00211, 00212, 00214, 00215, 00216, 00218, 00220, 00222
Plastic	00102, 00402, 00802
ENT	00160, 00162, 00164, 00100, 00170, 00172, 00174, 00176, 00120, 00124, 00126, 00190, 00192, 00300, 00320, 00322, 00326
Thoracic	00470, 00472, 00474, 00500, 00520, 00522, 00524, 00528, 00529, 00539, 00540, 00541, 00546, 00548, 00542

CPT Codes Specifically Excluded (based on 2014 CPT Codes):

Case Category	CPT Codes
Cardiac	00550, 00560, 00561, 00562, 00563, 00567, 00580
Obstetric Surgery	01958, 01960, 01961, 01968, 01967, 01962, 01963, 01969, 01964, 01965, 01966

Appendix 3: ICD 9 or 10 codes used for the determination of Coronary Artery Disease

ICD-9-CM: 410.00, 410.01, 410.02, 410.10, 410.11,410.12, 410.20, 410.21, 410.22, 410.30, 410.31, 410.32, 410.40, 410.41, 410.42, 410.50,410.51, 410.52, 410.60, 410.61, 410.62, 410.70, 410.71, 410.72, 410.80, 410.81, 410.82,410.90, 410.91, 410.92, 411.0, 411.1, 411.81, 411.89, 412, 413.0, 413.1, 413.9, 414.00, 414.01, 414.02, 414.03, 414.04, 414.05, 414.06, 414.07, 414.2, 414.3, 414.4, 414.8, 414.9, V45.81, V45.82

ICD-10-CM: I20.0, I20.1, I20.8, I20.9, I21.01, I21.02, I21.09, I21.11, I21.19, I21.21, I21.29, I21.3, I21.4, I22.0, I22.1, I22.2, I22.8, I22.9, I24.0, I24.1, I24.8, I24.9, I25.10, I25.110, I25.111, I25.118, I25.119, I25.2, I25.5, I25.6. I25.700, I25.701, I25.708, I25.709, I25.710, I25.711, I25.718, I25.719, I25.720, I25.721, I25.728, I25.729, I25.730, I25.731, I25.738, I25.739, I25.750, I25.751, I25.758, I25.759, I25.760, I25.761, I25.768, I25.769, I25.790, I25.791, I25.798, I25.799, I25.810, I25.811, I25.812, I25.82, I25.83, I25.84, I25.89, I25.9, Z95.1, Z95.5, Z98.61