American Heart Association.

Evolution of the American College of Cardiology and American Heart Association Cardiology Clinical Practice Guidelines: A 10-Year Assessment

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***Background*—**The American College of Cardiology and American Heart Association periodically revise clinical practice guidelines. We evaluated changes in the evidence underlying guidelines published over a 10-year period.

***Methods and Results*—**Thirty-five American College of Cardiology/American Heart Association guidelines were divided into 2 time periods: 2008 to 2012 and 2013 to 2017. Guidelines were categorized into the following topic areas: arrhythmias, prevention, acute and stable ischemia, heart failure, valvular heart disease, and vascular medicine. Changes in recommendations were assessed for each topic area. American College of Cardiology/American Heart Association designated class of recommendation as level I, II, or III (I represented "strongly recommended") and levels of evidence (LOE) as A, C, or C (A represented "highest quality"). The median number of recommendations per each topic area was 281 (198–536, interquartile range) in 2008 to 2012 versus 247 (190–451.3, interquartile range) in 2013 to 2017. The median proportion of class of recommendation I was 49.3% and 44.4% in the 2 time periods, 38.0% and 44.5% for class of recommendation II, and 12.5% and 11.2% for class of recommendation III. Median proportions for LOE A were 15.7% and 14.1%, 41.0% and 52.8% for LOE B, and 46.9% and 32.5% for LOE C. The decrease in the proportion of LOE C was highest in heart failure (24.8%), valvular heart disease (22.3%), and arrhythmia (19.2%). An increase in the proportion of LOE B was observed for these same areas: 31.8%, 23.8%, and 19.2%, respectively.

***Conclusions*—**There has been a decrease in American College of Cardiology/American Heart Association guidelines recommendations, driven by removal of recommendations based on lower quality of evidence, although there was no corresponding increase in the highest quality of evidence. **(*J Am Heart Assoc*. 2019;8:e012065. DOI: 10.1161/JAHA.119.012065.)**

Key Words: cardiovascular recommendations • class of recommendation • clinical practice guidelines • evidence-based medicine • level of evidence

Clinical practice guidelines provide a vetted framework for high-quality, up-to-date standards of care to guide clinicians in important management decisions. National professional organizations make these recommendations through committee consensus after systematic review of scientific evidence,[1] while using caution to minimize conflict of interest and ensure that the guidelines are relevant to clinical practice.[2] To keep pace with evolving practice standards and evidence, new guidelines are created while older guidelines are periodically revised.

Since 1984, the American College of Cardiology (ACC) and American Heart Association (AHA) have concurrently produced recommendations for clinicians who care for patients with, or who are at risk for, cardiovascular disease.[3] The strength and relative benefit-to-risk ratio of each recommendation is expressed as the class of recommendation (COR), while the quality of the underlying evidence is expressed by the level of evidence (LOE) designation (Table 1).[4–6] Full-guideline revisions occur approximately every 4 or more years, but individual recommendations may be reviewed annually.[7] Individual recommendation revisions are termed "focused updates," as they represent the most current

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Clinical Perspective

What Is New?

- Over the past decade, there has been a decrease in the total number of recommendations in the American College of Cardiology/American Heart Association guidelines, driven by removal of recommendations based on lower quality of evidence (Level C evidence), although there has not been a corresponding increase in the highest quality of evidence (Level A evidence).
- Over the past 10 years, American College of Cardiology/American Heart Association clinical practice guidelines have been significantly streamlined and increasingly emphasize high-quality evidence and de-emphasize expert opinion and other lower levels of evidence.

What Are the Clinical Implications?

- This focus on condensing recommendations has the potential to increase the clinical utility of guidelines for practicing clinicians.

amendments, deletions, or additions to guidelines based on significant new research.

It is important to understand how the guidelines evolve in order to keep pace with advances in clinical practice. An important, previous study demonstrated that only a median of 11% of ACC/AHA recommendations before 2009 were based on LOE A and nearly half relied on LOE C.[5] Additionally, this same article determined that only 19% of recommendations were of class I with LOE A. However, little is known about how the guidelines have evolved over the past decade. There was only 1 study looking at the change in guidelines over the past decade, but this previous study only focused on atrial fibrillation.[8]

Our study examined all cardiology topic areas of ACC/AHA clinical practice guidelines published in the past decade, stratified by 6 topic areas ([1] arrhythmias; [2] prevention; [3] acute and stable ischemia; [4] heart failure; [5] valvular heart disease; and [6] vascular medicine) to assess changes in the number of recommendations as well as the distribution of recommendations across LOE and COR over time (Table 2).[9–51]

Methods

Data Source and Sample

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ACC/AHA clinical practice guidelines and focused updates published between 2008 and 2017 were separated into 2 time periods, 2008 to 2012 and 2013 to 2017, as the last comprehensive analysis of ACC/AHA recommendations was accomplished in 2008.[5] Guidelines during these 2 periods were determined by those listed on the ACC "guideline and clinical documents" webpage (http://www.acc.org/guidelines) and PubMed MEDLINE database search terms of "ACC/AHA guideline" or "ACCF/AHA."[52] Guidelines were categorized into the following cardiology topic areas: (1) arrhythmias, (2) prevention, (3) acute and stable ischemia, (4) heart failure, (5) valvular heart disease, and (6) vascular medicine to loosely represent cardiology subspecialties. Focused updates were included, as they represent the most current amendments, deletions, or additions to guidelines based on significant research or clinical findings, similarly to a recent study.[8] If a focused update was included with an earlier full guideline in that time period, the full guideline recommendation associated with that focused update was revised accordingly and not counted twice. "Extracranial Carotid and Vertebral Artery Disease"[53] and "Thoracic Artery Disease"[54] were excluded because they have not been updated since their 2011 and 2010 versions, respectively, and thus would not have a counterpart for comparison.

Main Outcome Measures

The total number of recommendations, designated COR, and LOE for each individual recommendation, were abstracted.[13–55] Definitions of each COR and LOE class can be found in Figure 1. Class IIa and IIb were categorized into Class II for our evaluation. It should be noted that IIa recommendations are considered "reasonable" in terms of expected benefit versus risk for a patient (Table 1). In comparison, COR IIb recommendations are considered "may/might be reasonable."[1,5,6] Next, each combined COR-LOE class (ie, I-A, I-B, etc) was collected per recommendation for each time period (2008–2012, 2013–2017) to compare which specific recommendation class occurred most frequently, and if changes over time existed. All data were collected via 1 abstracter during a consecutive 2-month period and stored into Microsoft Excel work pages.

Statistical Analysis

In each cardiology topic area, the proportion of recommendations in each COR category and each LOE category was calculated. Percentage differences in the number of recommendations, COR, and LOE across the 2 study periods (2008–2012, 2013–2017) for each topic area were determined. Correlation coefficients were determined between class of recommendation and level of evidence via Microsoft Excel for the 2 time periods.

Table 1. Cardiology Clinical Practice Guideline Level of Evidence and Class of Recommendations Definitions

Level (quality) of evidence	
Level A	• High-quality evidence; from more than 1 RCT; meta-analyses of high-quality RCTs; 1 or more RTCs corroborated by high-quality registry studies
Level B	• Moderate-quality evidence; from 1 or more RCTs; meta-analyses of moderate-quality RCTs
Level C	• Randomized or nonrandomized observational or registry studies with limitations of design or execution; meta-analyses of such studies; physiological or mechanistic studies in human subjects; expert opinion based on clinical experience
Class (strength, relative benefit to risk) of recommendation	
Class I (strong)	• Is recommended; is indicated/useful, effective, beneficial; should be performed/administered
Class IIa (moderate)	• Is reasonable; can be useful/effective/beneficial
Class IIb (weak)	• May/might be reasonable; may/might be considered; usefulness/effectiveness is unknown/unclear/uncertain or not well established
Class III no benefit/harm (strong)	• Is not recommended; is not indicated/useful/effective/beneficial; potentially harmful; causes harm; associated with excess morbidity/mortality; should not be performed/administered

Level of evidence (LOE) indicates the quantity and type of scientific evidence supporting a recommendation. The scientific evidence can consist of randomized controlled trials (RCT), meta-analyses, observational studies, etc. Definitions, as stated by American College of Cardiology/American Heart Association, are above.[1,4–6] As stated by the 2015 American College of Cardiology/American Heart Association recommendations, levels B and C have been separated into B-R (randomized), B-NR (nonrandomized), C-LD (limited data), and C-EO (expert opinion). However, to stay consistent with past data, recommendations that fell into these categories were defined as levels B and C in this study.[7] Class of recommendation (COR) suggests the strength of a recommendation and thereby indicates the expected benefit vs risk for a patient. There are 2 determinant factors in designating a COR score. The first is a judgment based on strengths and weaknesses of scientific evidence on the matter. The second determinant is a judgment by a panel of experts in cardiology on the general agreement regarding efficacy and usefulness for patients. Definitions, as stated by American College of Cardiology/American Heart Association, are above.[1,4–6] As stated by the 2015 American College of Cardiology/American Heart Association recommendations, class III is separated into "no benefit" and "harm"; however, to stay consistent with past data, class III was defined as 1 category in this study.

Results

Overall, 35 guidelines were included in this study; 16 were published from 2008 to 2012 and 19 were published from 2013 to 2017. The guidelines comprised 4711 total recommendations, including 2713 from 2008 to 2012 and 1998 from 2013 to 2017 (Table 3). The median number of recommendations per each of the 6 topic areas was 281 (interquartile range 198–536) in 2008–2012 versus 247 (interquartile range 190–451) in 2013–2017. The greatest proportional decrease in the number of recommendations was in the acute and stable ischemia, arrhythmia, and valvular heart disease topic areas, with a reduction of 44% (decrease of 535), 15% (decrease of 91), and 25% (decrease in 80) recommendations, respectively. There were roughly the same number of full guidelines in almost every topic area when comparing the 2008 to 2012 group to the 2013 to 2017 group (Table 2). The only topic area to incur an increase in number of full guidelines was "prevention," with an increase of 39% (increase of 71 recommendations). This topic area also had an increase in number of guidelines from 4 full guidelines in the 2008 to 2012 group to 6 full guidelines in the 2013 to 2017 group.

Class of Recommendation

When assessing COR, guidelines available from 2008 to 2012 included 48.5% (1316) COR I, 39.1% (1061) COR II, and 12.4% (336) COR III recommendations (Figure 1). By comparison, guidelines published from 2013 to 2017 contained 44.3% (886 compared with 2008–2012) COR I, 44.4% (888) COR II, and 11.2% (224) COR III recommendations.

Of the 6 topic areas, the median proportion for COR I from 2008 to 2012 recommendations was 49.3%, while for 2013 to 2017 the median proportion was 44.4% (Figure 2). COR II demonstrated median proportions of 38.0% and 44.5% for the time periods 2008 to 2012 and 2013 to 2017, respectively. Lastly, the median proportion for COR III from 2008 to 2012 recommendations was 12.5%, and the median proportion for 2013 to 2017 was 11.2%.

Level of Evidence

Guidelines published from 2008 to 2012 comprised 12.6% (343) LOE A recommendations, 42.4% (1151) LOE B recommendations, and 44.9% (1219) LOE C recommendations (Figure 3). Comparatively, guidelines from 2013 to 2017 consisted of 11.2% (223 compared with 2008–2012) LOE A, 53.1% (1060) LOE B recommendations, and 35.8% (715) LOE C recommendations. The overall reduction in the number of recommendations was mainly driven by the reduction in proportion of LOE C recommendations.

Of the 6 topic areas, the median proportion of LOE A recommendations was 15.7% and 14.1% in the 2 time periods, 41.0% and 52.8% for LOE B recommendations, and 46.9% and 32.5% for LOE C recommendations. The decrease in the proportion of LOE C recommendations was highest in heart failure (24.8%), valvular heart disease (22.3%), and arrhythmia (19.2%) guidelines (Figure 4). An increase in the proportion of LOE B recommendations was observed for these same areas: 31.8%, 19.2%, and 23.8% for heart failure, valvular heart disease, and arrhythmias, respectively.

Table 2. Cardiology Topic Areas

Arrhythmias	Arrhythmias
Atrial fibrillation (2006 and 2011 focused update)	Atrial fibrillation (2014)
Ventricular and prevention of sudden cardiac death (2006)	Ventricular and prevention of sudden cardiac death (2017)
Supraventricular tachycardia (2003)	Supraventricular tachycardia (2015)
Device-based therapy of cardiac rhythm (2008 and 2012 focused update)	Syncope (2017)
Prevention	Prevention
Secondary prevention (2011)	High blood pressure (2017)
Cardiovascular prevention in women (2011)	Perioperative cardiovascular evaluation (2014)
Perioperative evaluation (2007)	Cardiovascular risk (2013)
Cardiovascular risk for asymptomatic patients (2010)	Blood cholesterol (2013)
	Overweight/obese (2013)
	Lifestyle management (2013)
Acute and stable ischemia	Acute and stable ischemic
ST-segment–elevation myocardial infarction I (2004, 2007 and 2009 focused update)	ST-segment–elevation myocardial infarction (2013)
Non-ST elevation (2007)	Non-ST elevation acute coronary syndrome (2014)
Stable ischemic heart disease (2012)	Stable ischemic heart disease (2014)
Coronary artery bypass surgery (2011)	Dual antiplatelet therapy (2016 focused update)
Percutaneous coronary intervention (2011)	Percutaneous coronary intervention (2015 Focused Update)
Heart failure	Heart failure
Heart failure (2005 and 2009 focused update)	Heart failure (2013 and 2017 focused update)
Valvular heart disease	Valvular HD
Valvular heart disease (2008 focused update)	Valvular heart disease (2014 and 2017 focused update)
Vascular medicine	Vascular medicine
Peripheral artery disease (2005 and 2011 focused update)	Peripheral artery disease (2013)
	Lower extremity peripheral artery disease (2016)

Each topic area consists of various American College of Cardiology/American Heart Association Cardiology Guidelines.[9–51] Atrial fibrillation (2006 and 2011 focused update), ventricular and prevention of sudden cardiac death (2006), supraventricular tachycardia (2003), and device-based therapy of cardiac rhythm (2008 and 2012 focused update) are categorized into "arrhythmias." Secondary prevention (2011), cardiovascular prevention in women (2011), perioperative evaluation (2007), and cardiovascular risk for asymptomatic patients (2010) are categorized into "prevention." ST-segment–elevation myocardial infarction (2004, 2007, and 2009 focused update), non-ST elevation (2007), stable ischemic heart disease (2012), coronary artery bypass surgery (2011), and percutaneous coronary intervention (2011) are categorized into "acute and stable ischemia." Heart failure (2005 and 2009 focused update) is categorized into "heart failure." Valvular heart disease (2008 focused update) is categorized into valvular heart disease. Peripheral artery disease (2005 and 2011 focused update) is categorized into "vascular medicine." Atrial fibrillation (2014), ventricular and prevention of sudden cardiac death (2017), supraventricular tachycardia (2015), and syncope (2017) are categorized into "arrhythmias." High blood pressure (2017), perioperative cardiovascular evaluation (2014), cardiovascular risk (2013), blood cholesterol (2013), overweight/obese (2013), and lifestyle management (2013) are categorized into "prevention." ST-segment–elevation myocardial infarction (2013), non-ST acute coronary syndrome (2014), stable ischemic heart disease (2014), dual antiplatelet therapy (2016 focused update), and percutaneous coronary intervention (2015 update) are categorized into "acute and stable ischemia." Heart failure (2013 and 2017 focused update) is categorized into "heart failure." Valvular heart disease (2014 and 2017 focused update) is categorized into "valvular heart disease." Peripheral artery disease (2013) and lower extremity peripheral artery disease (2016) are categorized into "vascular medicine."

Distribution of Recommendations by Level of Evidence and Class of Recommendation

In guidelines published between 2008 and 2012, the greatest proportion of recommendations were COR I-LOE B (20.9% [568 recommendations]) and COR II-LOE C (19.8% [537 recommendations]). The smallest proportion of recommendations were COR III-LOE A (1.29% [35 recommendations) and COR II-LOE A (1.81% [49 recommendations]). Findings were overall similar in guidelines published from 2013 to 2017, though the largest proportion of recommendations was COR II-LOE B (24.2%, Figure 5), representing a shift towards recommendations of moderate-quality evidence and moderate strength of benefit or risk for patients. The largest reduction in proportion of recommendations over time occurred in COR I-LOE C (40.8% [200 fewer recommendations in 2013–2017]), COR II-LOE C (32.6% [175 fewer recommendations]), and COR III-LOE C (66.2% [129 fewer recommendations]).

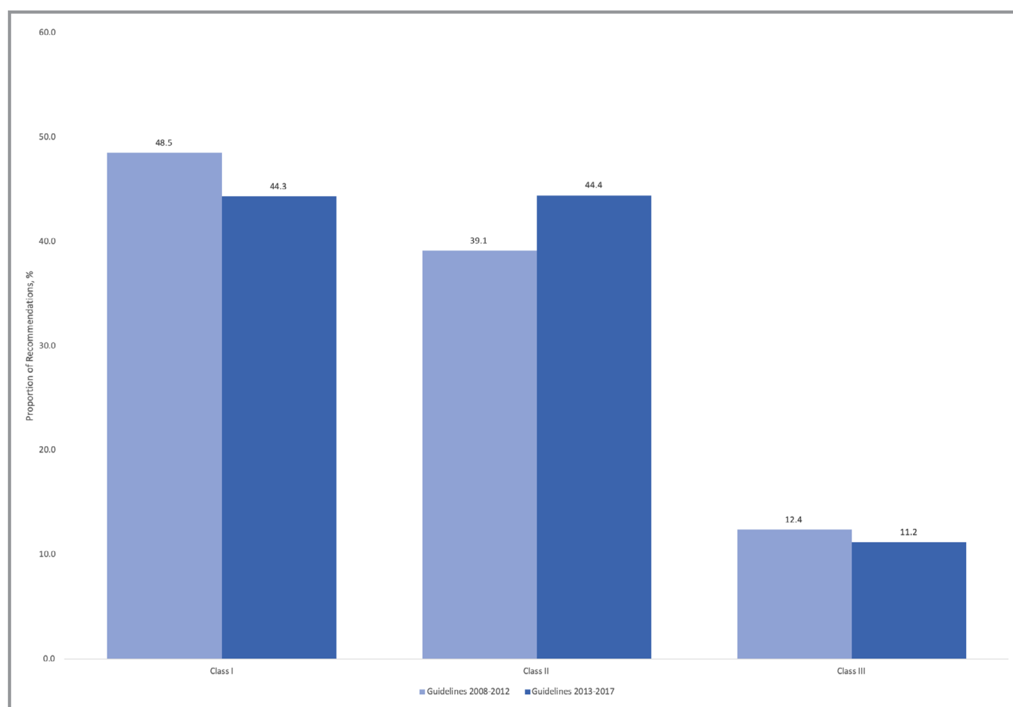

Figure 1. The proportion of total recommendations in each time period according to class of recommendation. Each topic area consists of various ACC/AHA Cardiology Guidelines.[9–51] Atrial fibrillation (2006 and 2011 focused update), ventricular and prevention of sudden cardiac death (2006), supraventricular tachycardia (2003), and device-based therapy of cardiac rhythm (2008 and 2012 focused update) are categorized into "arrhythmias." Secondary prevention (2011), cardiovascular prevention in women (2011), perioperative evaluation (2007), and cardiovascular risk for asymptomatic patients (2010) are categorized into "prevention." ST-elevation myocardial infarction (2004, 2007 and 2009 focused update), non-ST elevation (2007), stable ischemic heart disease (2012), coronary artery bypass surgery (2011), and percutaneous coronary intervention (2011) are categorized into "acute and stable ischemia." Heart failure (2005 and 2009 focused update) is categorized into "heart failure." Valvular heart disease (2008 focused update) is categorized into valvular heart disease. Peripheral artery disease (2005 and 2011 focused update) is categorized into "vascular medicine." Atrial fibrillation (2014), ventricular and prevention of sudden cardiac death (2017), supraventricular tachycardia (2015), and syncope (2017) are categorized into "arrhythmias." High blood pressure (2017), perioperative cardiovascular evaluation (2014), cardiovascular risk (2013), blood cholesterol (2013), overweight/obese (2013), and lifestyle management (2013) are categorized into "prevention." ST-elevation myocardial infarction (2013), non-ST acute coronary syndrome (2014), stable ischemic heart disease (2014), dual antiplatelet therapy (2016 focused update), and percutaneous coronary intervention (2015 update) are categorized into "acute and stable ischemia." Heart failure (2013 and 2017 focused update) is categorized into heart failure. Valvular heart disease (2014 and 2017 focused update) is categorized into "valvular heart disease." Peripheral artery disease (2013) and lower extremity peripheral artery disease (2016) are categorized into "vascular medicine." ACC/AHA indicates American College of Cardiology/American Heart Association.

Specific Guideline Changes

Of guidelines published from 2008 to 2012, the topic area "acute and stable ischemia" consisted of the largest proportion of recommendations (44.4% [n=1205]), the greatest number of which came from the "ST-Elevation Myocardial Infarction" clinical practice guideline (428 recommendations). While "acute and stable ischemia" still had the leading proportion of recommendations from 2013 to 2017 (33.5% [n=670]), this represented a 10.9% proportional reduction over time, largely driven by a 69.2% reduction in the number of recommendations in the ST-Elevation Myocardial Infarction clinical practice guideline (from 428 to 132 recommendations).

Secondary Analysis

A secondary analysis was conducted to analyze the results in terms of guidelines that were published during both periods

Table 3. Cardiology Topic Area Class of Recommendation and Level of Evidence

Cardiology Topic Area	Class of Recommendation, No. (%)				Level of Evidence No. (%)		
	Total	Class I	Class II	Class III	A	B	C
Arrhythmias (2008–2012)[5–10]	608	244 (40)	288 (47)	76 (13)	54 (9.0)	209 (34)	345 (57)
Arrhythmias (2013–2017)[27–30]	517	209 (40)	260 (50)	48 (10)	22 (4.0)	301 (58)	194 (38)
Prevention (2008–2012)[11–14]	183	80 (44)	80 (44)	23 (12)	34 (19)	103 (56)	46 (25)
Prevention (2013–2017)[31–36]	254	109 (43)	113 (44)	32 (13)	51 (20)	121 (48)	82 (32)
Acute and stable ischemia (2008–2012)[15–21]	1205	601 (50)	450 (37)	154 (13)	177 (15)	573 (47)	455 (38)
Acute and stable ischemia (2013–2017)[37–41]	670	307 (46)	272 (40)	91 (14)	90 (13)	347 (52)	233 (35)
Heart failure (2008–2012)[22,23]	155	84 (54)	50 (32)	21 (14)	36 (23)	32 (21)	87 (56)
Heart failure (2013–2017)[42,43]	144	58 (41)	64 (44)	22 (15)	27 (19)	76 (53)	41 (28)
Valvular heart disease (2008–2012)[24]	320	156 (49)	124 (39)	40 (12)	1 (0.0)	93 (29)	226 (71)
Valvular heart disease (2013–2017)[44,45]	240	110 (46)	116 (48)	14 (6.0)	8 (3.0)	116 (48)	116 (48)
Vascular medicine (2008–2012)[25,26]	242	151 (62)	69 (29)	22 (9.0)	41 (17)	141 (58)	60 (25)
Vascular medicine (2013–2017)[46,47]	173	93 (54)	63 (36)	17 (10)	25 (14)	99 (57)	49 (28)
Total recommendations							
Time period 2008–2012	2713	1316 (49)	1061 (39)	336 (12)	343 (13)	1151 (42)	1219 (45)
Time period 2013–2017	1998	886 (44)	888 (44)	224 (11)	223 (11)	1060 (53)	715 (36)

Each topic area consists of various American College of Cardiology/American Heart Association Cardiology Guidelines.[9–51] Atrial fibrillation (2006 and 2011 focused update), ventricular and prevention of sudden cardiac death (2006), supraventricular tachycardia (2003), and device-based therapy of cardiac rhythm (2008 and 2012 focused update) are categorized into "arrhythmias." Secondary prevention (2011), cardiovascular prevention in women (2011), perioperative evaluation (2007), and cardiovascular risk for asymptomatic patients (2010) are categorized into "prevention." ST-segment–elevation myocardial infarction (2004, 2007, and 2009 focused update), non-ST elevation (2007), stable ischemic heart disease (2012), coronary artery bypass surgery (2011), and percutaneous coronary intervention (2011) are categorized into "acute and stable ischemia." Heart failure (2005 and 2009 focused update) is categorized into "heart failure." Valvular heart disease (2008 focused update) is categorized into "valvular heart disease." Peripheral artery disease (2005 and 2011 focused update) is categorized into "vascular medicine." Atrial fibrillation (2014), ventricular and prevention of sudden cardiac death (2017), supraventricular tachycardia (2015), and syncope (2017) are categorized into "arrhythmias." High blood pressure (2017), perioperative cardiovascular evaluation (2014), cardiovascular risk (2013), blood cholesterol (2013), overweight/obese (2013), and lifestyle management (2013) are categorized into "prevention." ST-segment–elevation myocardial infarction (2013), non-ST acute coronary syndrome (2014), stable ischemic heart disease (2014), dual antiplatelet therapy (2016 focused update), and percutaneous coronary intervention (2015 update) are categorized into "acute and stable ischemia." Heart failure (2013 and 2017 focused update) is categorized into "heart failure." Valvular heart disease (2014 and 2017 focused update) is categorized into "valvular heart disease." Peripheral artery disease (2013) and lower extremity peripheral artery disease (2016) are categorized into "vascular medicine." Level A: high-quality evidence; from more than 1 RCT; meta-analyses of high-quality RCTs; 1 or more RTCs corroborated by high-quality registry studies. Level B: moderate-quality evidence; from 1 or more RCTs; meta-analyses of moderate-quality RCTs. Level C: randomized or nonrandomized observational or registry studies with limitations of design or execution; meta-analyses of such studies; physiological or mechanistic studies in human subjects; expert opinion based on clinical experience.[1,4–6] Class I: Strongly recommended; is indicated/useful, effective, beneficial; should be performed/administered/other. Class II: Moderately recommended; is reasonable; can be useful/effective/beneficial or usefulness/effectiveness is unknown/unclear/uncertain or not well established. Class III: Strongly not recommended; no benefit or can cause harm, is not indicated/useful/effective/beneficial; should not be performed/administered/other; potentially harmful; associated with excess morbidity/mortality.[1,4–6]

(Tables 4 and 5). There was a decrease in total recommendations across all topic areas. The largest decrease in total recommendations was found in "acute and stable ischemia" (decrease of 422 recommendations) as similar to when all guidelines were included in the analysis. Guidelines CABG 2011 and DAPT 2016 were not included in this analysis as compared with when all guidelines were included. Trends continued to be similar as to when all guidelines were included (Table 5).

Discussion

There has been a reduction in the number of recommendations in the ACC/AHA clinical practice guidelines published in 2013 to 2017 when compared with those published in 2008 to 2012. This reduction was most notable in the acute and stable ischemia, arrhythmia, and valvular heart disease topic areas, which was driven by the reduction in proportion of recommendations based on the lowest quality of evidence, LOE C. Although the current guidelines have fewer recommendations, these recommendations are proportionally based on higher-quality evidence (LOE B increase from 42.4% to 53.1%). However, the proportion of the highest level of evidence (LOE A) remains low and still accounts for only about 15% of the total recommendations.

The current study offers an update to the pivotal article by Tricoci et al which, in contrast, demonstrated a nearly 50% increase in number of recommendations between 1984 and 2008.[5] Since this study, there appears to have been a shift

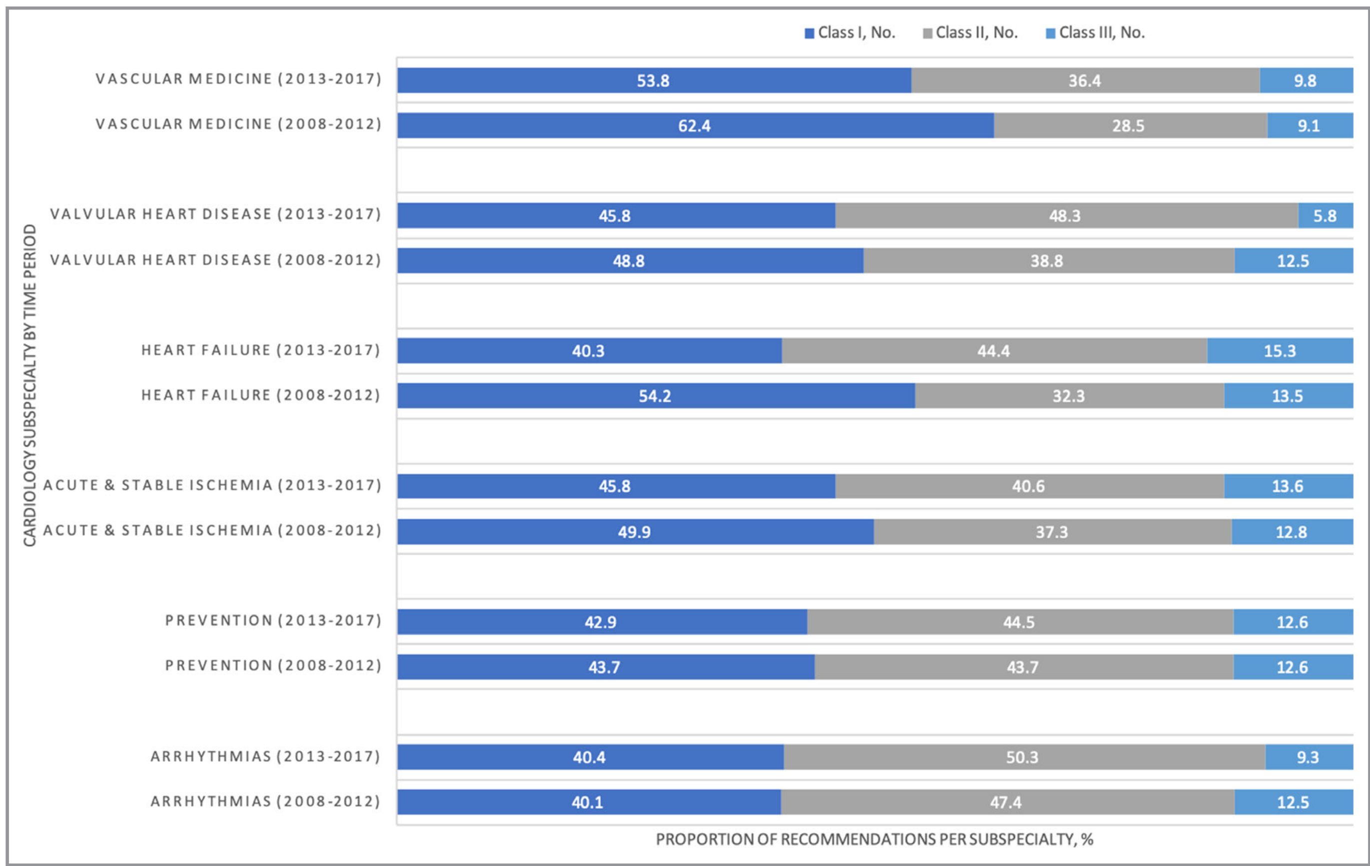

Figure 2. The proportion of total recommendations for each cardiology topic area and time period according to class of recommendation. Each topic area consists of various ACC/AHA Cardiology Guidelines.[9–51] Atrial fibrillation (2006 and 2011 focused update), ventricular and prevention of sudden cardiac death (2006), supraventricular tachycardia (2003), and device-based therapy for cardiac rhythm (2008 and 2012 focused update) are categorized into “arrhythmias.” Secondary prevention (2011), cardiovascular prevention in women (2011), perioperative evaluation (2007), and cardiovascular risk for asymptomatic patients (2010) are categorized into “prevention.” ST-segment–elevation myocardial infarction (2004, 2007, and 2009 focused update), non-ST-segment–elevation (2007), stable ischemic heart disease (2012), coronary artery bypass surgery (2011), and percutaneous coronary intervention (2011) are categorized into “acute and stable ischemia.” Heart failure (2005 and 2009 focused update) is categorized into “heart failure.” Valvular heart disease (2008 focused update) is categorized into valvular heart disease. Peripheral artery disease (2005 and 2011 focused update) is categorized into “vascular medicine.” Atrial fibrillation (2014), ventricular and prevention of sudden cardiac death (2017), supraventricular tachycardia (2015), and syncope (2017) are categorized into “arrhythmias.” High blood pressure (2017), perioperative cardiovascular evaluation (2014), cardiovascular risk (2013), blood cholesterol (2013), overweight/obese (2013), and lifestyle management (2013) are categorized into “prevention.” ST-segment–elevation myocardial infarction (2013), non-ST acute coronary syndrome (2014), stable ischemic heart disease (2014), dual antiplatelet therapy (2016 focused update), and percutaneous coronary intervention (2015 update) are categorized into “acute and stable ischemia.” Heart failure (2013 and 2017 focused update) is categorized into heart failure. Valvular heart disease (2014 and 2017 focused update) is categorized into “valvular heart disease.” Peripheral artery disease (2013) and lower extremity peripheral artery disease (2016) are categorized into “vascular medicine.” ACC/AHA indicates American College of Cardiology/American Heart Association.

over the past decade towards condensed recommendations underpinned by a higher-quality LOE. Our findings are also consistent with a 2017 analysis on changes in quality of evidence from 2001 to 2014 for Atrial Fibrillation ACC/AHA/Heart Rhythm Society guidelines.[8] Although this previous study only investigated 1 cardiology topic, analogous outcomes were determined: (1) a decrease in the LOE C recommendations, (2) an increase in LOE B recommendations; and (3) a low and unchanged proportion of LOE A recommendations.

Many useful and beneficial cardiology clinical practice guidelines exist, but with growing knowledge and research, constantly adding new recommendations to the already existing list could make it difficult for care providers to utilize all of the recommendations.[1] Thus, efforts to streamline recommendations could be very beneficial for clinicians. The largest reduction in number of recommendations occurred in the ST-Segment–Elevation Myocardial Infarction guideline (a reduction of more than two thirds). Overall, the topics covered

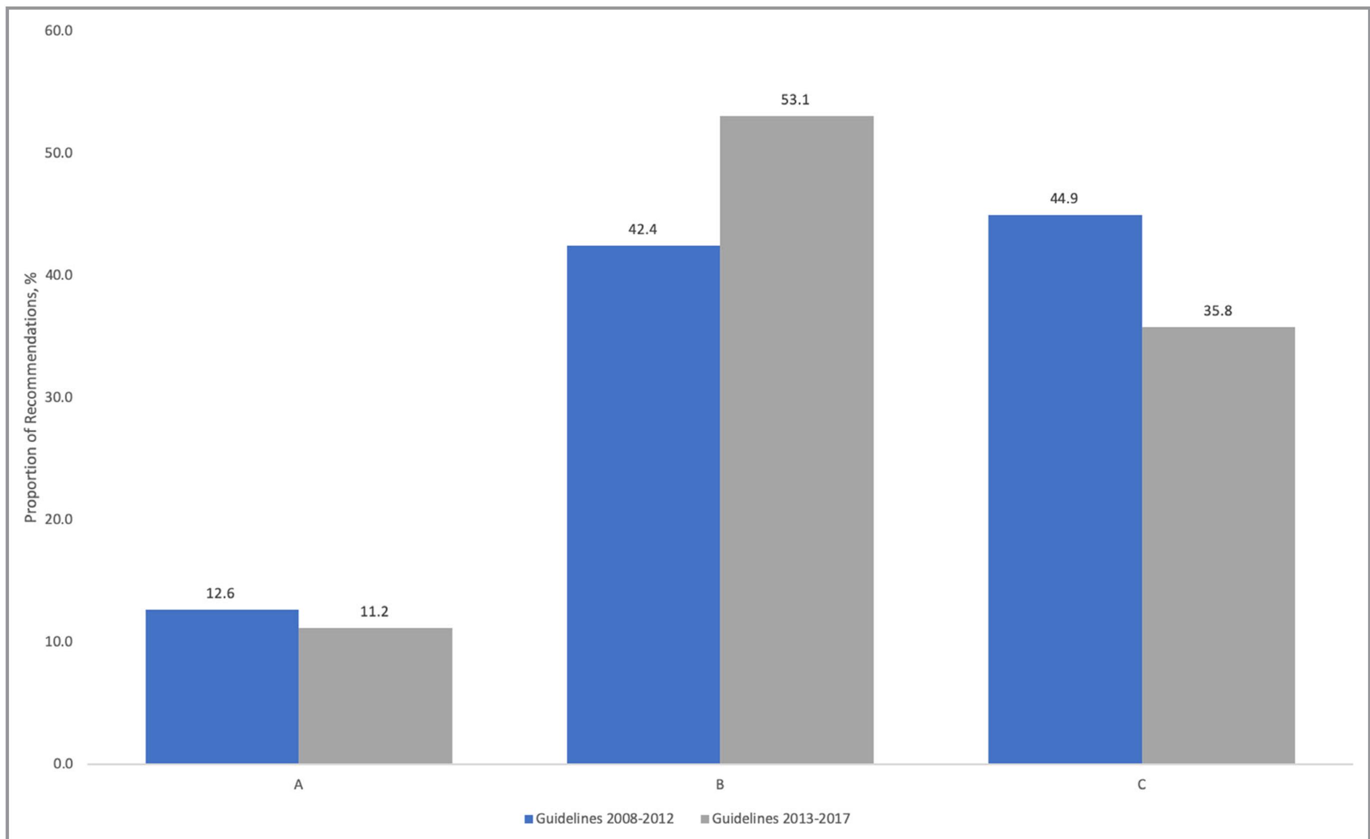

Figure 3. The proportion of total recommendations in each time period according to level of evidence. Each topic area consists of various ACC/AHA Cardiology Guidelines.[9–51] Atrial fibrillation (2006 and 2011 focused update), ventricular and prevention of sudden cardiac death (2006), supraventricular tachycardia (2003), and device-based therapy of cardiac rhythm (2008 and 2012 focused update) are categorized into "arrhythmias." Secondary prevention (2011), cardiovascular prevention in women (2011), perioperative evaluation (2007), and cardiovascular risk for asymptomatic patients (2010) are categorized into "prevention." ST-segment–elevation myocardial infarction (2004, 2007, and 2009 focused update), non-ST-elevation (2007), stable ischemic heart disease (2012), coronary artery bypass surgery (2011), and percutaneous coronary intervention (2011) are categorized into "acute and stable ischemia." Heart failure (2005 and 2009 focused update) is categorized into "heart failure." Valvular heart disease (2008 focused update) is categorized into valvular heart disease. Peripheral artery disease (2005 and 2011 focused update) is categorized into "vascular medicine." Atrial fibrillation (2014), ventricular and prevention of sudden cardiac death (2017), supraventricular tachycardia (2015), and syncope (2017) are categorized into "arrhythmias." High blood pressure (2017), perioperative cardiovascular evaluation (2014), cardiovascular risk (2013), blood cholesterol (2013), overweight/obese (2013), and lifestyle management (2013) are categorized into "prevention." ST-segment–elevation myocardial infarction (2013), non-ST acute coronary syndrome (2014), stable ischemic heart disease (2014), dual antiplatelet therapy (2016 focused update), and percutaneous coronary intervention (2015 update) are categorized into "acute and stable ischemia." Heart failure (2013 and 2017 focused update) is categorized into "heart failure." Valvular heart disease (2014 and 2017 focused update) is categorized into "valvular heart disease." Peripheral artery disease (2013) and lower extremity peripheral artery disease (2016) are categorized into "vascular medicine." ACC/AHA indicates American College of Cardiology/American Heart Association.

in the updated guideline are very similar to those found in the initial guideline. However, there is a reduction in the number of recommendations listed in the updated version, suggesting that multiple recommendations were condensed into more parsimonious recommendations. The most recent guideline also acknowledged an "attempt to provide a more focused tool for practioners,[55]" indicating their expressed goal to condense information for ease of use.

Recommendations based on the weakest evidence were disproportionally removed. This was most apparent in the "heart failure," "acute and stable ischemia," and "valvular heart disease" guidelines, which each had an ≈50% reduction in LOE C recommendations. Condensing extensive documents to include a greater proportion of stronger recommendation underpinned by higher-quality evidence focuses the messages to practicing clinicians. However, LOE A recommendations remain fairly uncommon. This is likely because, although more randomized controlled trials have been published, these trials may not have the necessary size or rigor to produce increased LOE A recommendations.

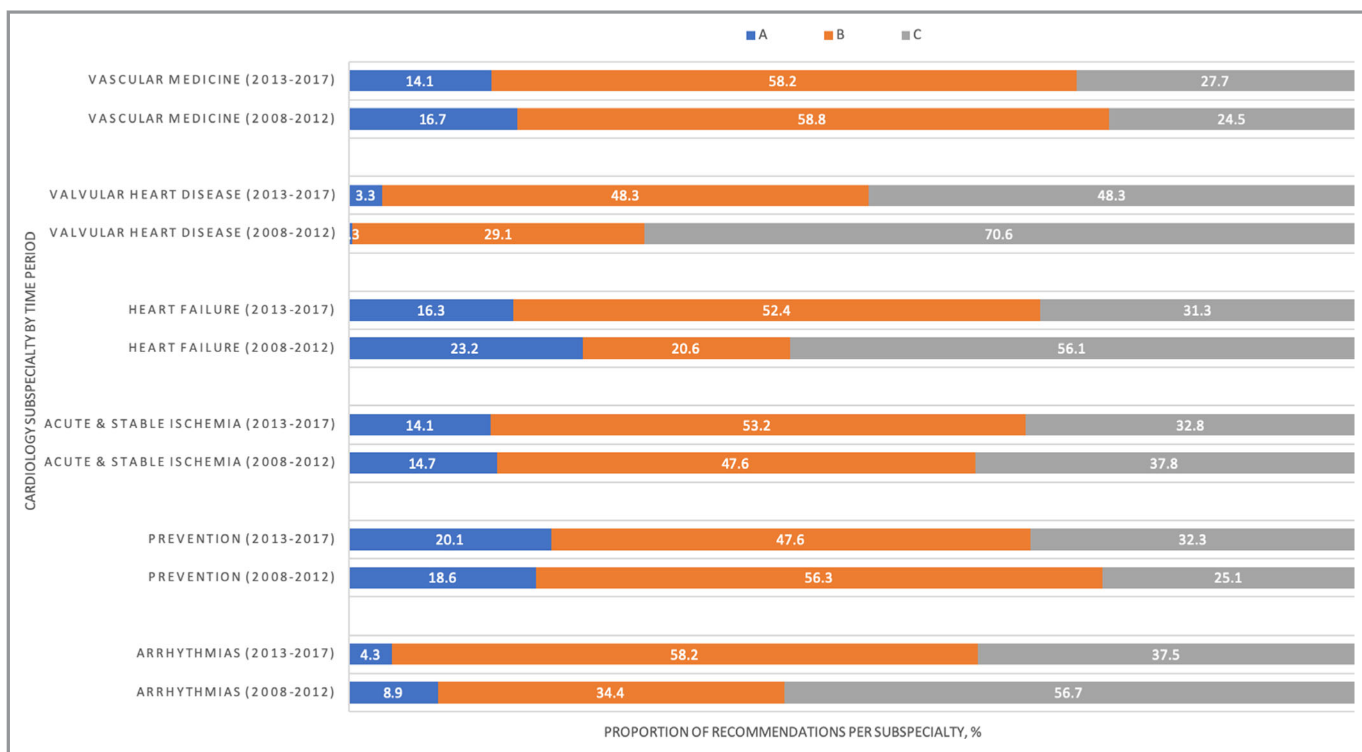

Figure 4. The proportion of total recommendations for each cardiology topic area and time period according to level of evidence. Each topic area consists of various ACC/AHA Cardiology Guidelines.[9–51] Atrial fibrillation (2006 and 2011 focused update), ventricular and prevention of sudden cardiac death (2006), supraventricular tachycardia (2003), and device-based therapy of cardiac rhythm (2008 and 2012 focused update) are categorized into "arrhythmias." Secondary prevention (2011), cardiovascular prevention in women (2011), perioperative evaluation (2007), and cardiovascular risk for asymptomatic patients (2010) are categorized into "prevention." ST-segment–elevation myocardial infarction (2004, 2007, and 2009 focused update), non-ST elevation (2007), stable ischemic heart disease (2012), coronary artery bypass surgery (2011), and percutaneous coronary intervention (2011) are categorized into "acute and stable ischemia." Heart failure (2005 and 2009 focused update) is categorized into "heart failure." Valvular heart disease (2008 focused update) is categorized into valvular heart disease. Peripheral artery disease (2005 and 2011 focused update) is categorized into "vascular medicine." Atrial fibrillation (2014), ventricular and prevention of sudden cardiac death (2017), supraventricular tachycardia (2015), and syncope (2017) are categorized into "arrhythmias." High blood pressure (2017), perioperative cardiovascular evaluation (2014), cardiovascular risk (2013), blood cholesterol (2013), overweight/obese (2013), and lifestyle management (2013) are categorized into "prevention." ST-segment–elevation myocardial infarction (2013), non-ST acute coronary syndrome (2014), stable ischemic heart disease (2014), dual antiplatelet therapy (2016 focused update), and percutaneous coronary intervention (2015 update) are categorized into "acute and stable ischemia." Heart failure (2013 and 2017 focused update) is categorized into "heart failure." Valvular heart disease (2014 and 2017 focused update) is categorized into "valvular heart disease." Peripheral artery disease (2013) and lower extremity peripheral artery disease (2016) are categorized into "vascular medicine." ACC/AHA indicates American College of Cardiology/ American Heart Association.

It is possible that some LOE C recommendations were upgraded to LOE B as more published data become available over time. However, it is also possible that certain eliminated recommendations were relocated to ACC/AHA Expert Consensus Documents, also referred to as Expert Consensus Decision Pathways or AHA Scientific Statements. These documents provide guidance on making clinical decisions, especially on topics that have limited data or are new and thus research has not been completed on the topic.[2] Use of expert consensus documents and/or decision pathways may be more appropriate for topics where expert opinion is important but high-quality evidence is not yet available. Thus, if the committee felt that a recommendation did not consist of high-quality evidence, the recommendation may have been removed from a guideline and placed in an Expert Consensus Document to still allow communication of accepted best practices to the cardiology community.

There was a decrease in proportion of COR I and COR III recommendations and an increase in proportion of COR II recommendations over time. Since these classifications are determined by a panel of experts based on benefit-to-risk ratio, if not enough data are available to determine if a recommendation is fully beneficial or not beneficial, a recommendation is designated as COR II (may or may not be beneficial).[7] We speculate that the increase in COR II

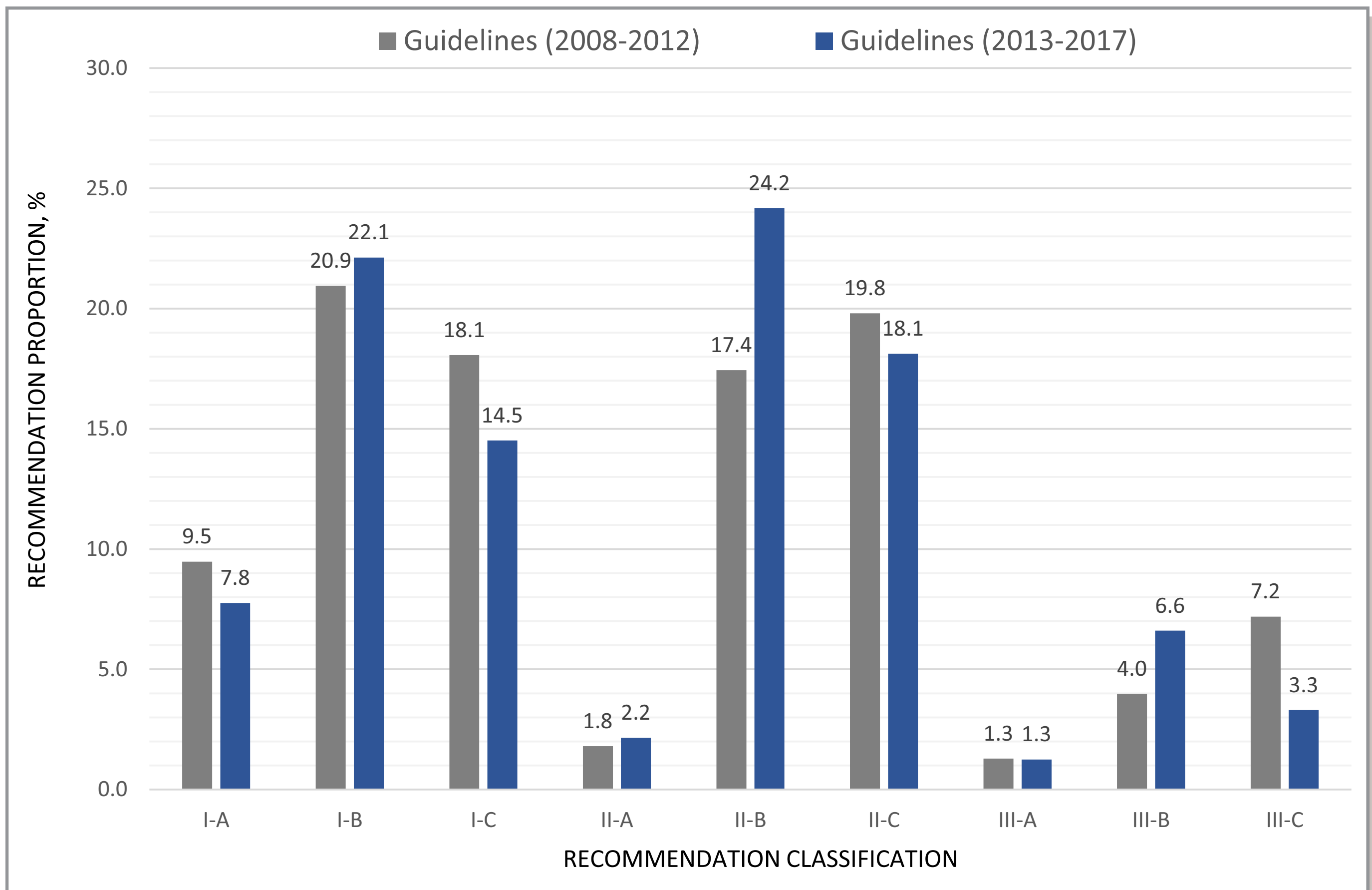

Figure 5. The proportion of total recommendations for each time period according to class of recommendation and level of evidence. Each topic area consists of various ACC/AHA Cardiology Guidelines.[9–51] Atrial fibrillation (2006 and 2011 focused update), ventricular and prevention of sudden cardiac death (2006), supraventricular tachycardia (2003), and device-based therapy of cardiac rhythm (2008 and 2012 focused update) are categorized into "arrhythmias." Secondary prevention (2011), cardiovascular prevention in women (2011), perioperative evaluation (2007), and cardiovascular risk for asymptomatic patients (2010) are categorized into "prevention." ST-segment–elevation myocardial infarction (2004, 2007 and 2009 focused update), non-ST-elevation (2007), stable ischemic heart disease (2012), coronary artery bypass surgery (2011), and percutaneous coronary intervention (2011) are categorized into "acute and stable ischemia." Heart failure (2005 and 2009 focused update) is categorized into "heart failure." Valvular heart disease (2008 focused update) is categorized into "valvular heart disease." Peripheral artery disease (2005 and 2011 focused update) is categorized into "vascular medicine." Atrial fibrillation (2014), ventricular and prevention of sudden cardiac death (2017), supraventricular tachycardia (2015), and syncope (2017) are categorized into "arrhythmias." High blood pressure (2017), perioperative cardiovascular evaluation (2014), cardiovascular risk (2013), blood cholesterol (2013), overweight/obese (2013), and lifestyle management (2013) are categorized into "prevention." ST-segment–elevation myocardial infarction (2013), non-ST acute coronary syndrome (2014), stable ischemic heart disease (2014), dual antiplatelet therapy (2016 focused update), and percutaneous coronary intervention (2015 update) are categorized into "acute and stable ischemia." Heart failure (2013 and 2017 focused update) is categorized into "heart failure." Valvular heart disease (2014 and 2017 focused update) is categorized into "valvular heart disease." Peripheral artery disease (2013) and lower extremity peripheral artery disease (2016) are categorized into "vascular medicine." ACC/AHA indicates American College of Cardiology/American Heart Association.

recommendations over time indicates maintenance of a rigorous consensus process by the panel of experts to classify each recommendation in the context of an increasingly complex and, at times, conflicting body of literature.

We note that a limitation of the current study is that, while we examined the total number of recommendations by LOE and COR, we did not map individual recommendations over time to assess how each might have been combined, eliminated, or changed over the study period. Additionally, some guidelines differed between the 2 time periods, which limits our ability to make direct comparisons between the 2 time periods.

Conclusion

Over the past 10 years, ACC/AHA clinical practice guidelines have been significantly streamlined and increasingly

Table 4. Guidelines Published in Both Time Periods

Guidelines (2008–2012)	Guidelines (2013–2018)
Arrhythmias	Arrhythmias
Atrial fibrillation (2006 and 2011 update)	Atrial fibrillation (2014)
Ventricular and SCD (2006)	Ventricular and prevention SCD (2017)
Supraventricular (2003)	Supraventricular tachycardia (2015)
Prevention	Prevention
Perioperative evaluation (2007)	Perioperative cardio evaluation (2014)
Cardiovascular risk (2010)	Cardiovascular risk (2013)
Acute and stable ischemic	Acute and stable ischemic
ST-elevation myocardial infarction (2004, 2007 and 2009 Update)	ST-elevation myocardial infarction (2013)
Non-ST elevation (2007)	Non-ST elevation acute coronary (2014)
Stable IHD (2012)	Stable IHD (2014)
PCI (2011)	PCI (2015 update)
Heart failure	Heart failure
Heart failure (2005 and 2009 update)	Heart failure (2013 and 2017 update)
Valvular HD	Valvular HD
Valvular heart disease (2008)	Valvular heart disease (2014 and 2017 update)
Vascular medicine	Vascular medicine
PAD (2005 and 2011 update)	PAD (2013)

Each topic area consists of various American College of Cardiology/American Heart Association Cardiology Guidelines.[9–51] Atrial fibrillation (2006 and 2011 focused update), ventricular and prevention of sudden cardiac death (2006), supraventricular tachycardia (2003), and device-based therapy of cardiac rhythm (2008 and 2012 focused update) are categorized into "arrhythmias." Secondary prevention (2011), cardiovascular prevention in women (2011), perioperative evaluation (2007), and cardiovascular risk for asymptomatic patients (2010) are categorized into "prevention." ST-segment–elevation myocardial infarction (2004, 2007, and 2009 focused update), non-ST elevation (2007), stable ischemic heart disease (2012), coronary artery bypass surgery (2011), and percutaneous coronary intervention (2011) are categorized into "acute and stable ischemia." Heart failure (2005 and 2009 focused update) is categorized into "heart failure." Valvular heart disease (2008 focused update) is categorized into "valvular heart disease." Peripheral artery disease (2005 and 2011 focused update) is categorized into "vascular medicine." Atrial fibrillation (2014), ventricular and prevention of sudden cardiac death (2017), supraventricular tachycardia (2015), and syncope (2017) are categorized into "arrhythmias." High blood pressure (2017), perioperative cardiovascular evaluation (2014), cardiovascular risk (2013), blood cholesterol (2013), overweight/obese (2013), and lifestyle management (2013) are categorized into "prevention." ST-segment–elevation myocardial infarction (2013), non-ST acute coronary syndrome (2014), stable ischemic heart disease (2014), dual antiplatelet therapy (2016 focused update), and percutaneous coronary intervention (2015 update) are categorized into "acute and stable ischemia." Heart failure (2013 and 2017 focused update) is categorized into "heart failure." Valvular heart disease (2014 and 2017 focused update) is categorized into "valvular heart disease." Peripheral artery disease (2013) and lower extremity peripheral artery disease (2016) are categorized into "vascular medicine." HD indicates heart disease; IHD, ischemic heart disease; PAD, peripheral artery disease; PCI, percutaneous coronary intervention; SCD, sudden cardiac death.

emphasize high-quality evidence and de-emphasize expert opinion and other lower levels of evidence. This focus on condensing recommendations has the potential to increase the clinical utility of guidelines for practicing clinicians.

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Table 5. Class of Recommendation and Level of Evidence for Guidelines Published in Both Time Periods

Guidelines	Guidelines (2008–2012)							Guidelines (2013–2018)						
	Class of Recommendation			Level of Evidence			Total	Class of Recommendation			Level of Evidence			Total
	Class I	Class II	Class III	A	B	C		Class I	Class II	Class III	A	B	C	
Arrhythmias														
Atrial fibrillation	43	57	17	17	37	63	117	50	48	15	10	45	58	113
Ventricular and SCD	103	100	14	21	69	127	217	83	75	18	11	130	35	176
Supraventricular tachycardia	61	77	9	9	55	83	147	49	69	3	1	70	50	121
	207	234	40	47	161	273	481	182	192	36	22	245	143	410
Prevention														
Perioperative evaluation	13	27	10	6	28	16	50	15	38	16	3	39	27	69
Cardiovascular risk	4	18	13	0	24	11	35	1	4	1	0	4	2	6
	17	45	23	6	52	27	85	16	42	17	3	43	29	75
Acute and stable ischemic														
ST-segment–elevation myocardial infarction	250	126	52	58	173	197	428	79	44	9	16	80	36	132
Non-ST elevation	187	82	29	70	139	89	298	98	52	16	29	77	60	166
Stable IHD	51	72	28	14	77	60	151	53	72	31	14	81	61	156
PCI	56	81	30	20	87	60	167	56	82	30	21	81	66	168
	544	361	139	162	476	406	1044	286	250	86	80	319	223	622
Heart failure														
Heart failure	84	50	21	36	32	87	155	58	64	22	27	76	41	144
Valvular heart disease														
Valvular heart disease	156	124	40	1	93	226	320	110	116	14	8	116	116	240
Vascular medicine														
PAD	151	69	22	41	141	60	242	51	26	7	9	58	17	84

Each topic area consists of various American College of Cardiology/American Heart Association Cardiology Guidelines.[9–51] Atrial fibrillation (2006 and 2011 focused update), ventricular and prevention of sudden cardiac death (2006), supraventricular tachycardia (2003), and device-based therapy of cardiac rhythm (2008 and 2012 focused update) are categorized into "arrhythmias." Secondary prevention (2011), cardiovascular prevention in women (2011), perioperative evaluation (2007), and cardiovascular risk for asymptomatic patients (2010) are categorized into "prevention." ST-segment–elevation myocardial infarction (2004, 2007, and 2009 focused update), non-ST elevation (2007), stable ischemic heart disease (2012), coronary artery bypass surgery (2011), and percutaneous coronary intervention (2011) are categorized into "acute and stable ischemia." Heart failure (2005 and 2009 focused update) is categorized into "heart failure." Valvular heart disease (2008 focused update) is categorized into "valvular heart disease." Peripheral artery disease (2005 and 2011 focused update) is categorized into "vascular medicine." Atrial fibrillation (2014), ventricular and prevention of sudden cardiac death (2017), supraventricular tachycardia (2015), and syncope (2017) are categorized into "arrhythmias." High blood pressure (2017), perioperative cardiovascular evaluation (2014), cardiovascular risk (2013), blood cholesterol (2013), overweight/obese (2013), and lifestyle management (2013) are categorized into "prevention." ST-segment–elevation myocardial infarction (2013), non-ST acute coronary syndrome (2014), stable ischemic heart disease (2014), dual antiplatelet therapy (2016 focused update), and percutaneous coronary intervention (2015 update) are categorized into "acute and stable ischemia." Heart failure (2013 and 2017 focused update) is categorized into "heart failure." Valvular heart disease (2014 and 2017 focused update) is categorized into "valvular heart disease." Peripheral artery disease (2013) and lower extremity peripheral artery disease (2016) are categorized into "vascular medicine." IHD indicates ischemic heart disease; PAD, peripheral artery disease; PCI, percutaneous coronary intervention; SCD, sudden cardiac death.

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