Use of the Ambulatory Electronic Health Record (Allscripts® AEHR) to Mine Quality Metrics: A Pilot Study in an Ambulatory Pediatric Cardiac Practice for Evaluation of Chest Pain in Children 5-18 years of Age

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CERTIFICATE OF APPROVAL

This is to certify that the Master's Capstone Project of

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Has been approved

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Abstract

Background: Chest pain is a common presenting complaint for evaluation of a child (<18 years of age) in a pediatric cardiology clinic. Despite the large number of patients evaluated for this complaint, a cardiac cause is rarely found. The American College of Cardiology sponsored an Expert Panel to develop and publish Quality Metrics for evaluation of children 5-18 years of age for providers to use in order to deliver quality care to these patients. Using a Modified Delphi Process to reach consensus, they found that only 3 of 10 candidate quality metrics would be useful.

Purpose: The purpose of this study was a "proof of concept". Frustration with the use of the Allscripts Electronic Health Record (AEHR) is a common complaint amongst our providers with the belief that it is only used to improve billing and allow for better readability as compared to the written record. Demonstrating that mining data from the AEHR used at Northwell Health System allows for secondary uses for the providers, in terms of improving quality and value as well as helping with clinical research endeavors, might improve acceptance of this process.

Study Design: Retrospective data were mined from the AEHR of patients between five and eighteen years of age presenting for "chest pain". Patients with any known or likely co-morbidity that could present with chest pain due to that condition were excluded. The remainder were analyzed with respect to performance of 15-lead surface electrocardiogram and the use of transthoracic cardiac ultrasound in the absence of exertional chest pain.

Results: 958 patients out of an initial screening of 2270 patients (42%) met criteria for the study. Of that group of 958 patients, 479 (50%) of them received an electrocardiogram (ECG) at the visit for chest pain and the rest had a copy of a recent electrocardiogram brought or sent to the appointment resulting in 100% of patients receiving appropriate care on that metric.. Of the 958 patients in the study cohort, 335 patients (35%) had a transthoracic echocardiogram performed at our institution, exceeding the target of 15-20%.

Conclusions: Despite published criteria for use of cardiac testing for children with a presenting complaint of chest pain without co-morbid conditions (congenital heart disease, recent chest trauma, rheumatologic diseases, etc;) and without exertional chest pain, over one third of patients still underwent transthoracic echocardiograms. This result is significantly higher than published studies using consensus algorithm-based recommendations.

Background

Electronic Health Records (EHRs) are omnipresent throughout the health care environment in the United States in both small medical offices as well as in the large academically affiliated hospitals. The initial effort was to install these systems to enhance billing and other operational functions of medical practice. The clerical burden of gathering and entering the data in these records falls mostly on nurses and physicians. Medical records now include clinical data elements, other than mostly administrative data, that can be used to better understand potential causes and progression of diseases. The amount of time now spent by providers entering patient data is a major cause of provider dissatisfaction and is partly responsible for provider "burnout". A recent study by Shanafelt et al. (1) surveyed a national sample of private practice as well as academically affiliated physicians from a wide variety of primary care as well as sub-specialty practitioners. Physician satisfaction of those using EHRs was generally described as "low". These "clerical" tasks then result in burnout. What is not clear however is whether this clerical burden would not be as dissatisfying if the EHR data can be used in a secondary use to improve the quality of and affect the outcomes of the patients.

In 2017, the American College of Cardiology Adult Congenital and Pediatric Cardiology Section (ACPC) sought to develop Quality Metrics (QM) for ambulatory congenital heart practice using available evidence based medicine (EBM) (2). They used a 2-step process utilizing an expert panel and rated each QM for feasibility and validity. The process included using a modified RAND-UCLA methodology. They chose 5 separate areas to explore. These were: chest pain, infective endocarditis prevention, Kawasaki's

disease, Tetralogy of Fallot and Transposition of the Great arteries after arterial switch operation.

The purpose of this pilot study was to demonstrate that we could mine data to calculate pediatric cardiovascular quality measures from our current EHR system (Allscripts® AEHR, Chicago, Illinois, USA) using the current ambulatory template. For this demonstration/pilot study, we chose to look at the type of clinical testing methods used for patients 18 years of age or younger with a presenting symptom of chest pain. By demonstrating that discrete data entry into the EHR can be mined and that the individual providers as well as the group could compare our practice to that of the published QMs from the ACPC, I could demonstrate that secondary use, i.e. for clinical research or as a Quality Metric, was feasible.

Ultimately, I hoped to improve the enthusiasm of the providers in actively engaging in the development of specific templates to use in the ambulatory environment in the future. Secondarily, I hoped that, going forward, such efforts would improve physician satisfaction and lessen future burnout. Support for this use has developed over time as presented in a White Paper from Safran et al (3). The authors noted that the initial use over “several decades” was to collect administrative, claims and prescription data. Their goal was to establish a “framework for secondary use of health data with a robust infrastructure of policies, standards and best practices”. As experience began to demonstrate, this goal was more likely to be reached using “structured data’ in the electronic medical record. The summary of the findings in a systematic review of the secondary use of this data included the following statement: “Structured documentation can produce more complete and reliable patient records,

better fulfilling the requirements of data quality for secondary use purposes" (4).

Methods

This study was submitted as a Quality Improvement (QI) project. Northwell Health requires any QI project that includes PHI be submitted to the System Investigational Review Board (IRB) for review. Thus, this study received an Expedited Review as a QI project and was approved as such by the IRB. The letter approving the study, attached to the study description and protocol was sent to the OHSU IRB for review and was determined to be a QI project as well. These letters were then forwarded to Northwell Health Information Services for their records.

Allscripts® AEHR is an open source platform and is one of the largest EHRs utilized in U.S. healthcare. Approved personnel in the Northwell Health System can perform data mining from Allscripts® AEHR. The actual process requires approval from Information Services and uses a software product, Centricity™, a General Electric Financial Services product that interacts directly with the EHR. Requests go through a centralized committee that inspects who is asking for the data, the purpose of the inquiry and the responsible party supervising the person requesting the data. This process usually takes several weeks with the committee asking for further information. Once approval was granted, I communicated with an analyst assigned to this project about what information I required.

I requested that all patients seen in our cardiology practice who were between five and eighteen years of age over a thirteen month period (10/1/2017-10/31/2018) with a diagnosis that included "chest pain" be queried from the database.

The query returns a so-called “flat file” which is in table format with one record per line. This table is a “csv” file can be exported to a program, in this case to Microsoft® Excel, for further processing or analysis.

Many patients with a diagnosis of chest pain also have concurrent diagnoses of post-operative congenital heart disease, juvenile rheumatoid arthritis, varied chest wall deformities or spinal abnormalities such as scoliosis. Filtering of these diagnoses was then possible using the tool included in the Excel spreadsheet that included all listed diagnoses in addition to chest pain. Thus, I was able to exclude patients with other diagnoses coincident with chest pain that might be result in that complaint. The purpose of excluding patients with known reasons for chest pain, such as those with previous midline sternotomies is due to the occurrence of broken sternal wires, displacement of the sternum in the postoperative state, site infection from a previous chest wall incision, all of which may be a cause for cause chest pain. Thus, their primary complaint was not “chest pain”, per se, but chest pain due to a known cause. In those cases, it is entirely possible an echocardiogram was indicated. The list of exclusions is found in **Table 1**.

The specific indicators to be included in this study were the proportion of patients with a primary complaint of chest pain who had electrocardiograms (ECGs) and the transthoracic echocardiograms performed. The goal of this analysis was to evaluate whether our current practice appropriately utilized, over-utilized or under-utilized these tests on this cohort as compared to published recommendations by the American College of Cardiology.

The target for the ECGs was 100% and the goal for echocardiograms was between 15-20%. ECGs are an appropriate first-line test for all children with a complaint of chest pain as it may indicate a primary cause, such as inflammation of the pericardium (the lining surrounding the heart itself), presence of a cardiomyopathy, an abnormality of electrical conduction or other known causes of chest pain. The test can be performed in 5 minutes and does not required a skilled technician (as opposed to an echocardiogram) to perform. Moreover, the cost is nominal, usually in the range of $25 to $50 as opposed to hundreds of dollars for an echocardiogram. Family history was not included as an indicator and is discussed in the Limitations section at the end of the manuscript.

For electrocardiograms, the numerator was the number of patients who had an ECG at or within one month of the evaluation in our clinic for chest pain. The denominator was patients 5-18 years of age seen in the ambulatory pediatric cardiology clinic with a chief complaint of chest pain. For echocardiograms, the numerator was the number of patients that had an echocardiogram performed or ordered the day of the ambulatory visit. The denominator was the number of patients 5-18 years of age seen in the pediatric cardiology clinic with clinical evidence of musculoskeletal chest wall pain reproducible over the costochondral junctions, chest wall or under the costal margins. Excluded were patients with exertional chest pain, a family history of sudden cardiac death or cardiomyopathy or abnormal findings on their ECGs.

Results

The initial query included all patients over the aforementioned thirteen month period presenting with chest pain as a primary or secondary diagnosis. Serial filtering (**Figure 2**) excluded diagnoses listed in **Table 1.** This resulted in a cohort of 958 patients out of an initial screening of 2270 patients (42%). Of that group of 958, 479 (50%) had an ECG at the time of their cardiology clinic visit and the remaining half were performed beforehand and either brought or sent to us for review. Thus, 100% of the patients had an ECG. Of the 958 in the study cohort, 335 (35%) had an echocardiogram ordered and performed at our institution.

Discussion

This study demonstrated that data mining from the AEHR using the current ambulatory template could be successfully accomplished and return results demonstrating the utilization of cardiac related testing for children presenting with chest pain. The finding of over-utilization of echocardiograms in this population can be socialized amongst the group for further discussion of how we can more closely follow published guidelines for appropriate use. The impact of this result can be viewed from the perspective of a "double-edged sword". Less testing means less revenue but appropriate use criteria establishes best practices based on evidence-based medicine. This is an issue beyond the scope of this manuscript but is one that plagues the entire industry and requires further discussion in another venue.

Chest pain is one of the most common diagnoses referred to pediatric cardiologists in the United States (5). Due to the wide variability in clinical decision making for this problem and only scarce evidence-based guidelines, the use of our electronic medical records to demonstrate the ability to understand how we manage this problem was ideal. In this case I used the ACPC Quality Metrics to compare how my group practices as compared to the panel recommendations (2). As noted in this reference, positive findings are rare for this complaint and "improved quality care and cost effectiveness may be reflected in the absence, rather than in the performance of further testing".

To be sure, the issue of chest pain evaluation in children has been the focus of several important studies published prior to this recent paper. Harahsheh et al. (6) published a study from a consortium of eleven hospitals in the New England Congenital Cardiac Association and the Children's National Health System in Washington, D.C. using a specific quality improvement tool called SCAMPs®. This unique instrument was developed and implemented at Boston Children's Hospital when introduced in 2010 by Rathod et al. (7) who describe the methodology in detail. SCAMPs stands for "Standardized Clinical Assessment and Management Plans and differs from a Clinical Practice Guideline (CPG) in that it is an iterative process of incorporating new knowledge gained by clinical experience in evaluating variance and the outcomes of the variance as an ongoing enterprise. Unlike the CPGs which are developed by expert opinion and published data, the SCAMPS use a Bayesian approach to educate clinicians about prior beliefs that may be "flawed based on real data from their own patients" (8).

The Harasheh et al.(6) study looked at two groups of patients presenting with chest pain. In their Group 1 cohort, they included only patients that had a so-called "red flag" that indicated a "concerning clinical element" that, to many clinicians, might indicate a high risk for finding a cardiac cause for chest pain. The Group 2 patients were those without any "red flags". All patients in both groups had electrocardiograms. However, only 23.4% of Group 2 patients, as compared to 77.5% of Group 1 patients had echocardiograms performed. A cardiac cause for chest pain was found in 8/1656 (0.48%, 95% CI=0.21% to 0.95%) in those Group 2 while 0/1511 patients from Group 2 (95% CI =n 0% to 0.32%) was found in Group 1. A cost analysis of the the results demonstrates a nearly five million dollar savings nationally each year if the low probability (no "red flag") group did not receive an echocardiogram. This is in contradistinction to the 35% of patients from this pilot study. Here, we specifically looked at a filtered group of children with the equivalent no “red flag” status and saw that we performed echocardiograms on 35% of our patients.

How do I explain the difference from the above study from what I found in this pilot study (23.4% in their study versus 35% in "no red flag" patients receiving an echocardiogram in my study)? In a 2012 study of cardiologists practicing in the "source hospital" for SCAMPs, Boston Children's Hospital, Varghese et al.(9) compared how their physicians practiced historically as compared to the SCAMPs data presented above. Prior to implementing the SCAMPs algorithm, 28% of the "no red flag" patients underwent echocardiographic testing as compared to only 15% in the SCAMPS cohort in the later era. While the Boston group historically ordered echocardiogram testing less than the current Northwell group, there is no doubt that the SCAMPS algorithm proved successful in reducing the number of unnecessary studies.

A final note on SCAMPs is worthy of mention here. The question of physician acceptance of any type of “guideline” whether a published CPG or the use of a process such as SCAMPs is problematic. Physician autonomy results in a perception of rigidity that might be inherent to these recommendations and remains a barrier that must be considered. Farias et al.(10) anonymously surveyed sixty-nine providers who had been educated to the background and use of SCAMPs. With a response rate over 73%, just over 90% of respondents had "complete trust" in the validity of the evidence supporting the the algorithm and three quarters felt the use of the tool would improve the care of their patients. However, as encouraged by the developer of SCAMPs, 66% felt comfortable deviating from the algorithm when they personally felt it was justified and 23% felt "erosion" of their autonomy.

With all of the data demonstrating that an echocardiogram is rarely justified in a no “red flag” patient, why are they still done”? In the case of chest pain in children, both children and their parents become anxious and conflate chest pain in adults, indicating possible cardiac issues, with that of causes for chest pain in children. Not infrequently, a parent will “demand” that further testing, other than an electrocardiogram be done. In addition, a primary care provider (PCP) will send a patient for a cardiology consultation and tell the parent that the cardiologist is going to do an echocardiogram “just to be sure”. It is exceptionally rare for a patient to have to pay “out of pocket” for an expensive test such as an ultrasound study and thus moral hazard plays a role in pursuing this course. Specialists are also dependent on PCPs to send patients for evaluation. If a parent is unhappy with the level of care and believe it was insufficient, the PCP may be disinclined to continue to send patients to that specialist.

Summary

In summary, I have demonstrated that the Allscripts® AEHR used at Northwell Health can be queried and return valuable information that can be used to give feedback to the providers such that they can evaluate whether recently published report (14) can be used to understand the process of the ACPC group and how the final recommendations were advised.

Limitations

The currentelectronic record we use at Northwell is used mostly for capturing administrative data for use in financial and operational decision making making in the hospital. Physician satisfaction with the system is low and there is little or no feedback from the use of Allscripts®AEHR. Developing templates for ambulatory use is encouraged but in the current environment, very few providers are willing to spend the time doing this, as they have not been educated about the potential secondary usesof thedata. In this study, a family history was performed 100% of the time but I did not review every chart to see if it was performed correctly as this data was not discrete in natureand, atthis time, could not be mined from the medical record. It is possible that some of the echocardiograms were performed appropriately if there was a history of sudden cardiac death or inherited cardiomyopathy. However, the incidence of sudden cardiac death due to heritable causes is rare. Wong et al. (15) described evidence for comprehensive cardiology evaluation in first-degree relatives with a positive family history of sudden cardiac death (SCD).

A cultural barrier that currently exists will need attention if we hope to develop a process to understand our practice with the goal of improving patient care. Much of the data is currently in free text format, despite the ability to develop a template with discrete data that is more easily accessible. There are no current plans to use natural language processing (NLP) in the near future to mine data form the electronic record, as the cost in this system of 22 hospitals plus a growing number of community-based practices is prohibitive. Most of these patients died of an arrhythmic death. A total of 112 child relatives from 61 families with one adult with cardiomyopathy were tested and a probable diagnosis was made in 18 of those families giving a yield of 29.5%. The other major cause of SCD in children are patients with a cardiomyopathy. Pahl et al. (16) reported on 1803 patients who were enrolled in a large Cardiomyopathy Registry between 1990-2009. The incidence of SCD was 3% and echocardiographic findings were a major evaluative tool to establish a risk profile in these patients.

Conclusion

In conclusion, I have demonstrated that the electronic medical record currently in use at Northwell is capable of being mined for data that can be used to assess quality measures for cardiovascular disease in children. Future efforts to develop templates in both the ambulatory and inpatient record that focuses on inputting discrete data, rather than free text, will facilitate it's use beyond capturing administrative data.

Bibliography

1. Shanafelt TD, Hasan O, Dyrbye LN, et al. Changes in Burnout and Satisfaction With Work-Life Balance in Physicians and General US Working Population Between 2011-2014. Mayo Clin Proc. 2015;90:1600-1613.
2. Chowdry D, Gurvitz M, Marelli A, et al. Development of Quality Metrics in Ambulatory Pediatric Cardiology. J Am Coll Cardiol 2017;69:541-55.
3. Safran C, Bloomrosen M, Hammond WE, et al. Toward a national Framework for the Secondary use of Health Data: An American Medical Informatics Association White paper. J Am Med Inform Assoc 2007;14:1-9.
4. Vuokko R, Makela-Bengs P, Hypponen H, et al. Impacts of structuring the electronic health record: Results of a systematic literature review from the perspective of secondary use of patient data. International Journal of Medical Informatics 2017;293-303.
5. Forrest CB, Glade GB, Baker AE, et al. The Pediatric Primary-Specialty Care Interface: How Pediatricians Refer Children and Adolescents to Specialty Care. Arch Pediatr Adolesc Med. 1999;153:705-714.
6. Harahsheh AS, O'Byrne ML, Pastor B, et al. Pediatric Chest Pain-Low-Probability Referral: A Multi-Institutional Analysis From Standardized Clinical Assessment and Management Plans (SCAMPs®), the Pediatric Health Information Systems Database, and the National Ambulatory Medical Care Survey. Clinical Pediatrics 2017;.56:1201-1208.
7. Rathod RH, Farias M, Friedman KG, et al. A Novel Approach to Gathering and Acting on Relevant Clinical Information: SCAMPs. Congenit Heart Dis 2010;5:343-353
8. Farias, M, Friedman KG, Lock JE, et al. Differentiating Standardized Clinical Assessment and Management Plans From Clinical Practice Guidelines. Acad Med 2015;9☹1002).
9. Verghese GR, Friedman KG, Rathod RH, et al. Resource Utilization Reduction for Evaluation of Chest Pain in Pediatrics Using a Novel Standardized Clinical Assessment and management Plan (SCAMP). J Am Heart Assoc 2012;1:jah3-e000349 doi : 10.1161/JAHA.111.000349. pp 1-7.
10. Farias M, Friedman KG, Lock JE, et al. Gathering and Learning from Relevant Clinical Data: A New Framework. Acad Med 2015;90:143-148.
11. Porter JB, Rosenthal EL, Winget M, et al. Improving Care with a Portfolio of Physician-Led Cancer Quality Measures at an Academic Medical Center. Journal of Oncology Practice 2017;13:e673-682.
12. Broberg C, Sklenar J, Burchill L, et al. Feasability of Using Electronic medical Record Data for Tracking Quality Indicators in Adults with Congenital Heart Disease. Congenit Heart Dis 2015; 10:e268-e277.
13. Stephen Tsaur, Lacey Gleason, Yuli Kim. Quality Indicator Completion Rates for Adults with Tetralogy of Fallot. .Pediatric Cardiology 2018;39:1700-1706.
14. Lu JC, Bansal M, Behera SK, et al. Development of Quality metrics for Ambulatory Pediatric Cardiology: Chest Pain. Congenit Heart Dis 2017;12:751-755.
15. Wong LCH, Roses-Noguer F, Till JA et al. Cardiac evaluation of Pediatric Relatives in Sudden Arrhythmic Death Syndrome. A 2-Center Experience. Circ Arrhythm Electrophysiol. 2014;7:800-806
16. Phal E, Sleeper LA, Canter CE, et al. Incidence and Risk Factors for Sudden Cardiac Death in Children with Dilated Cardiomyopathy. J Am Coll Cardiol. 2012;59:607-615.

Tables, Figures and Appendices

Table 1.

Conditions Associated with Exclusion from Final Patient Cohort

1. Any significant*** congenital heart defect previously requiring open thoracotomy or median sternotomy.
2. Any congenital heart disease that might be reasonably associated with chest pain including history of aortic valve stenosis, coarctation of the aorta, aortic valve insufficiency, anomalous origin of a coronary artery.
3. Any bone structure abnormality potentially affecting chest wall symmetry including scoliosis, pectus deformities, and previous fracture of any bony structure of the chest or recent chest trauma.
4. Any congenital musculoskeletal condition i.e. muscular dystrophies
5. Any diagnosis, either clinical or confirmed by standard surface ECG that might reasonably be expected to include an echocardiogram as part of the evaluation i.e. myocarditis, ventricular hypertrophy, myocardial dysfunction including history of myocarditis, pericarditis or pericardial effusion.
6. Abnormal findings on ECG.
7. A family history of sudden cardiac death or other heritable cardiomyopathy.
8. Duplicate entries of patients.

*** Ventricular septal defect, atrial septal defect utilizing open technique, tetralogy of Fallot, atrio-ventricular septal defect of any kind, transposition of the great arteries, any lesion requiring a systemic-pulmonary shunt, pulmonary artery banding technique.

Table 2.

Approved Measures*

Chest pain *

Chest pain: family history

ECG for chest pain

Echocardiogram for exertional chest pain+

*Modified from: Devyani Chowdhury, MD, Michelle Gurvitz, MD, MS, Ariane Marelli, MD, MPH, Jeffrey Anderson, MD, MBA, Carissa Baker-Smith, MD, MPH, et al. Development of Quality Metrics in Ambulatory Pediatric Cardiology. JACC 2017; 39:541-555.

+ Exertional Chest pain was part of exclusion criteria for this study and not used in the analysis. It is included here for reporting the use of cardiac ultrasound for this excluded diagnosis. The reason for exclusion is that, rarely, it may be associated with certain congenitally acquired coronary arterial anomalies.

Table 3.

Results

	Numerator/Denominator	% Performed	Ideal Goal (%)	Goal Met.
ECG	958/958	100	100	YES
Echo	335/958	35	15-20	NO

The number of ECGs that should have been performed was successful at 100% while the goal of no more than 15-20% of patients receiving echocardiograms was not.

Appendix 1 Source Material from the American College of Cardiology for Chest Pain

Metric #: 007 Effective: 6.12.2016

ACC/AHA Guidelines
A Scientific Statement From the American Heart Association Expert Panel on Population and Prevention Science; the Councils on Cardiovascular Disease in the Young, Epidemiology and Prevention, Nutrition, Physical Activity and Metabolism, High Blood Pressure Research, Cardiovascular Nursing, and the Kidney in Heart Disease; and the Interdisciplinary Working Group on Quality of Care and Outcomes Research. Circulation. 2006; 114:2710- 2738

Chest Pain – Documentation of Family History	
Measure Description: Proportion of patients, 5-18 years old, with a chief complaint of chest pain who have documentation of a family history of early coronary artery disease, cardiomyopathy and sudden cardiac or unexplained death.	
Numerator	Number of patients with documentation of family history[1] of early coronary artery disease[2] (in a first and/or second degree relative[3]), cardiomyopathy, and sudden cardiac or unexplained death during the measurement period or in the past 12 months from the clinic visit[4].
Denominator	Number of patients, ages 5-18 years old, seen for initial consultation in an ambulatory pediatric cardiology clinic visit[1] with a chief complaint of chest pain during the measurement period.
Denominator Exclusions	• Patients who were adopted and have unknown family history
Denominator Exceptions	None
Definitions/Notes	1. **Documentation of family history**: includes documentation of the presence or absence of cardiomyopathy, early coronary artery disease, and sudden cardiac or unexplained death 2. **Early coronary artery disease (CAD)**: includes those with CAD before the age of 55 years for males and before the age of 65 years in females. 3. **First and/or second-degree relative**: a patient's first-degree relative is a parent, sibling, or child. A second-degree relative is an uncle, aunt, nephew, niece, grandparent, grandchild, or half-sibling.

	4. **Clinic Visit:** If the patient has had multiple visits during the measurement period, use the most recent visit (i.e. last visit in the measurement period).
Measurement Period	Quarterly
Sources of Data	Retrospective medical record review, electronic medical record
Attribution	This measure should be reported by pediatric cardiologists and practitioners evaluating children in the outpatient setting.
Care Setting	Outpatient
Rationale	
Family history should document the presence or absence of cardiomyopathy, early coronary artery disease in a first-degree relative, and sudden cardiac or unexplained death. Several retrospective studies have shown chest pain can be the presenting symptom in HCM[1-5]. The AHA recommendations for screening child athletes recommends obtaining a family history to include HCM, DCM, SCD<50[6]. Our expert panel supports this recommendation in children presenting with chest pain. Class IIa recommendation	

- Overwhelmingly consistent evidence from observational studies strongly supports inclusion of a positive family history of early coronary heart disease in identifying children at risk for accelerated atherosclerosis and for the presence of an abnormal risk profile. (Grade B)
- For adults, a positive family history is defined as a parent and/or sibling with a history of treated angina, myocardial infarction, percutaneous coronary catheter interventional procedure, coronary artery bypass grafting, stroke or sudden cardiac death before age 55 years in men or age 65 years in women. Because the parents and siblings of children and adolescents are usually young themselves, it was the Expert Panel's consensus that when evaluating family history in a child, history should also be ascertained for the occurrence of CVD in grandparents, aunts, and uncles, although the evidence supporting this is insufficient to date. (Grade D)
- Overwhelmingly consistent evidence from observational studies shows that identification of a positive family history for CVD and/or CV risk factors should lead to evaluation of all family members, especially parents, for CV risk factors. (Grade B)
- Family history evolves as a child matures, so regular updates are necessary as part of routine pediatric care. (Grade D)
- Education about the importance of accurate and complete family health information should be part of routine care for children and adolescents. As genetic sophistication increases, linking family history to specific genetic abnormalities will provide important new knowledge about the atherosclerotic process.(Grade D).
- References:

1. Kane DA, Fulton DR, Saleeb S, Zhou J, Lock JE, Geggel RL. Needles in hay: chest pain as the presenting symptom in children with serious underlying cardiac pathology. Congenit Heart Dis 2010;5:366-73.
2. Yetman AT, McCrindle BW, MacDonald C, Freedom RM, Gow R. Myocardial bridging in children with hypertrophic cardiomyopathy--a risk factor for sudden death. N Engl J Med 1998;339:1201-9.
3. Azzano O, Bozio A, Sassolas F, et al. [Natural history of hypertrophic obstructive cardiomyopathy in young patients: apropos of 40 cases]. Archives des maladies du coeur et des vaisseaux 1995;88:667-72.
4. Hickey EJ, McCrindle BW, Larsen SH, et al. Hypertrophic cardiomyopathy in childhood: disease natural history, impact of obstruction, and its influence on survival. Ann Thorac Surg 2012;93:840-8.
5. Sharma J, Hellenbrand W, Kleinman C, Mosca R. Symptomatic myocardial bridges in children: a case report with review of literature. Cardiol Young 2011;21:490-4.

Electrocardiogram for chest pain	
Measure Description: Proportion of patients, 5-18 years old, with a chief complaint of chest pain who completed an electrocardiogram (ECG).	
Numerator	Number of patients who had an ECG performed within 30 days (before or after) their initial consultation for chest pain.
Denominator	Number of patients, age 5-18 years old, seen for an initial consultation in an ambulatory pediatric cardiology clinic with a chief complaint of chest pain during the measurement period.
Denominator Exclusions	Patient refusal
Denominator Exceptions	None
Definitions/Notes	None
Measurement Period	Quarterly
Sources of Data	Retrospective medical record review, electronic medical record, ECG storage systems
Attribution	This measure should be reported by physicians or physician extenders
Care Setting	Outpatient
Rationale	
Cardiac etiology for chest pain is rare in children[1-11]. Of 3700 patients presenting with chest pain to outpatient cardiology clinic with an ECG, there were no cardiac deaths at median 4.4 year follow up[1]. Multiple retrospective studies show small number of abnormal ECGs in patients presenting with chest pain with the following diagnoses: pericarditis, myocarditis, arrhythmias, and cardiomyopathy[2-7]. Meta-analysis of asymptomatic children who underwent ECG screening demonstrated high negative predictive value for hypertrophic cardiomyopathy, long QT syndrome, and Wolff-Parkinson-White syndrome[9].	

Class I Recommendation Level of evidence: C

References

1. Saleeb SF, Li WY, Warren SZ, Lock JE. Effectiveness of screening for life-threatening chest pain in children. Pediatrics 2011;128:e1062-8.
2. Sert A, Aypar E, Odabas D, Gokcen C. Clinical characteristics and causes of chest pain in 380 children referred to a paediatric cardiology unit. Cardiol Young 2012:1-7.
3. Massin MM, Bourguignont A, Coremans C, Comte L, Lepage P, Gerard P. Chest pain in pediatric patients presenting to an emergency department or to a cardiac clinic. Clinical pediatrics 2004;43:231-8.
4. Cohn HE, Arnold LW. Chest pain in young patients in an office setting: cardiac diagnoses, outcomes, and test burden. Clinical pediatrics 2012;51:877-83.
5. Kane DA, Fulton DR, Saleeb S, Zhou J, Lock JE, Geggel RL. Needles in hay: chest pain as the presenting symptom in children with serious underlying cardiac pathology. Congenit Heart Dis 2010;5:366-73.
6. Ratnapalan S, Brown K, Benson L. Children presenting with acute pericarditis to the emergency department. Pediatric emergency care 2011;27:581-5.
7. Drossner DM, Hirsh DA, Sturm JJ, et al. Cardiac disease in pediatric patients presenting to a pediatric ED with chest pain. The American journal of emergency medicine 2011;29:632-8.
8. Friedman KG, Kane DA, Rathod RH, et al. Management of pediatric chest pain using a standardized assessment and management plan. Pediatrics 2011;128:239-45.
9. Rodday AM, Triedman JK, Alexander ME, et al. Electrocardiogram screening for disorders that cause sudden cardiac death in asymptomatic children: a meta-analysis. Pediatrics 2012;129:e999-1010.
10. Hanson CL, Hokanson JS. Etiology of chest pain in children and adolescents referred to cardiology clinic. WMJ 2011;110:58-62.
11. Evangelista JA, Parsons M, Renneburg AK. Chest pain in children: diagnosis through history and physical examination. Journal of pediatric health care : official publication of National Association of Pediatric Nurse Associates & Practitioners 2000;1.
12. Saleeb SF, Li WY, Warren SZ, Lock JE. Effectiveness of screening for life-threatening chest pain in children. Pediatrics 2011;128:e1062-8

Challenges to Implementation
ECG may not be well documented in patient chart. Chest pain may not be listed as the chief complaint but may be an associated symptom. Noncompliance with getting the ECG done.

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Schema of Project Design in Developing Local Quality Metric for Evaluation of Chest Pain

Figure 1. *Modified from*: Porter JB et al. Journal of Oncology Practice 2017;13:e773-682

The top tier involves collection of all published materials with respect to Quality Metrics in Pediatric Cardiology in the English language only. Once that data is collected, the next step is to include the "local" health system Quality Metrics and adapt them to the ambulatory pediatric cardiology environment. Finally, the cardiology group meets and discusses the literature gathered and decides upon an acceptable set of metrics they wish to use to analyze both individually and as a group.

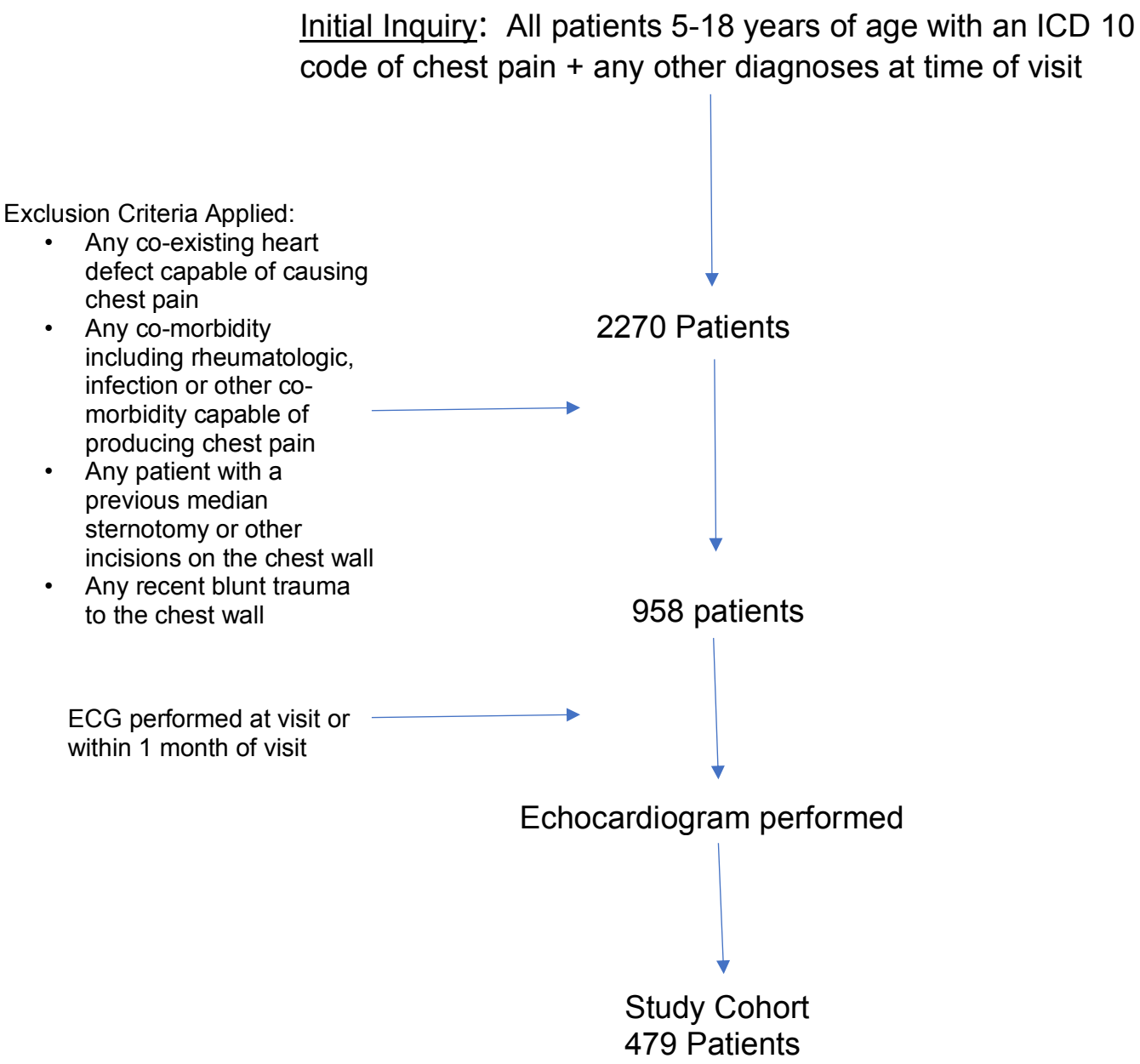

Figure 2. Flow Diagram form the initial query of patients who had, as one of their diagnoses, “Chest Pain” and formation of the ultimate study cohort