a)

3+ B lines at 16cm MI=0.4	+	-
+	18 (35%)	1 (2%)
-	16 (31%)	17 (33%)

b)

3+ B lines at 16cm MI=1.3	+	-
+	9 (17%)	25 (48%)
-	3 (6%)	15 (29%)

Mortality 3mo

3+ B lines at 16cm MI=0.4	+	-
+	4 (8%)	15 (29%)
-	8 (15%)	25 (48%)

assessment of standard adherence by 4 readers on a 10 studies. Interrater reliability was assessed using a kappa statistic. **Results:** Echo lab reference standards were developed for grading aortic stenosis. Of the 20 studies retrospectively reviewed for AS grading, 70% agreed with the new AS standards. Fifteen percent reported a graded range of stenosis such as "moderate-to-severe." For the 10 studies read prospectively by 4 readers using the reference standards, 82.5% agreed with the reference standards and none reported a range of severity. Inter-rater reliability was moderate-to-strong (kappa statistic 0.61). **Conclusions:** Development of reference standards for grading aortic stenosis for an academic pediatric echo lab resulted in improved validity of AS grading relative to reference standards, and inter-rater reliability of AS grading using reference standards was substantial. Further work regarding the unique challenges of grading aortic stenosis in the pediatric population is warranted.

Aortic stenosis grading reference

	Mild	Moderate	Severe
Mean gradient	10-20 mmHg	20-40 mmHg	>40 mmHg
AoV area (unindexed) ($CSA_{AoV} \times VTI_{AoV} = CSA_{LVOT} \times VTI_{LVOT}$)	>1.5 cm^2	1-1.5 cm^2	<1 cm^2
AoV area (indexed to BSA) ($CSA_{AoV} \times VTI_{AoV} = CSA_{LVOT} \times VTI_{LVOT}$)	>0.85 cm^2/m^2	0.6-0.85 cm^2/m^2	<0.6 cm^2/m^2

P5-03

Effect of Organized 3D Echo Teaching Methods on "3D Beginner Level" Pediatric Sonographers- A Quality Improvement Project

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Background: Good quality 3D echo datasets produce ejection fractions (EF) that correlate well with axial imaging and are the basis for 3D presurgical assessment of congenital heart disease, yet it remains a novel modality in many labs. We sought to use QI methodology to train novice sonographers to produce excellent 3D volumes for EF and cropping. **Methods:** 15 sonographers underwent didactic teaching of 3D principles and instructional steps. 5 LV (Left Ventricular) and 5 RV (Right Ventricular) baseline 4 chamber full volume datasets were submitted and scored for window, gain, depth, lateral and elevation planes, stitch and TomTec EF analyzability (TomTec 4D LV analysis 3 and auto RV). Phase I PDSA cycle was then executed with 1:1 customized tutorial based on individual scores and areas of weakness. Surveys were conducted at baseline and post PDSA I. **Results:** All RV scores were lower than corresponding LV scores excluding depth (Table 1). Areas of difficulty were gain, elevation plane, avoidance of stitch and analyzability. 80% of sonographers felt more comfortable after 1:1 sessions than didactic sessions alone (Table 2). 100% preferred 1:1 over didactic group teaching. 90% now perform 3D full volumes at least weekly compared to 50% prior to baseline teaching and PDSA I. Image optimization and analysis were self-reported to be subjectively the most challenging. **Conclusions:** A combination of didactic lectures and 1:1 teaching can significantly improve sonographer comfort and use of 3D echo in day-to-day practice. Across the group, commonest challenges are gain, elevation, stitch and analyzability. RV acquisitions were also more challenging. Nearly all sonographers picked 1:1 sessions as their preferred method of training. Post PDSA I data collection is underway.

Table 1: Cumulative percentage scores of the group by scoring criteria.

	# Of data sets	Imaging Window	Gain	Depth	Lateral	Elevational	Stitch	Analyzability	Acquisition totals (excluding analyzability)
Right ventricle	72	75.00	49.73	86.67	81.00	33.33	43.73	31.20	61.6
Left Ventricle	74	90.67	57.00	86.67	97.33	69.33	51.67	75.00	71.4

Table 2: Survey results Pre and Post 1:1 sessions

	Post Group Didactic Lectures	Post 1:1 session
What is your current level of comfort with acquisition of 3D full volume datasets?	3/11 comfortable	4/11 comfortable
The recent 1:1 training has made me		8/11 more comfortable
How often do you perform a 3D full volume	5/11 > weekly	10/11 > weekly
In your opinion how important is it to obtain a 3D LV ejection fraction?	5/11 Important	6/11 Important
In your opinion, how easy it to obtain a 3D LV ejection fraction?	6/10 easy	7/10 Easy
What is the challenging part of obtaining a 3D LV ejection fraction	Offline analysis	Image optimization
What was your preferred modality of training on how to obtain full volume datasets?	1/11 (one person picked both didactic and 1:1session)	11/11 chose 1:1 session

P5-04

Real-Time Artificial Intelligence Based Guidance of Echocardiographic Imaging: Does Novice Profile Affect Image Quality and Suitability for Diagnostic Interpretation?

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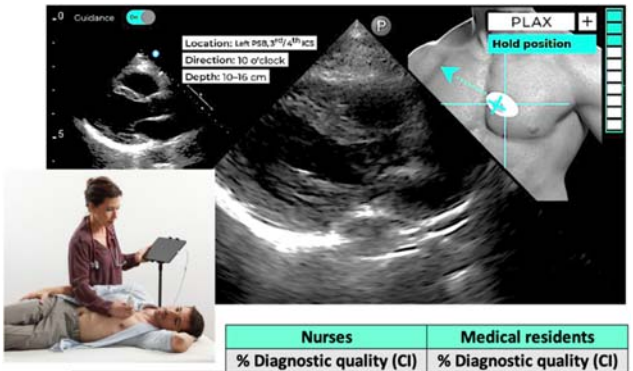
Background: An artificial intelligence (AI) algorithm to guide medical personnel with no imaging experience on how to acquire standard echocardiographic views was developed. The new software uses intuitive visual cues, and was recently tested in a prospective multicenter study that showed that after 12 hours of training, novice users are able to acquire images with diagnostic quality approaching that of expert sonographers. However, it is unclear whether the specific user profile influences the performance with the guidance software. We aimed to compare the quality of images acquired by nurses and medical residents, assuming that better background knowledge of cardiac anatomy might result in higher rates of diagnostic quality images the residents acquired. **Methods:** The AI software (UltraSight) was embedded into a handheld device (Philips Lumify). Nine novices (6 nurses and 3 medical residents), who underwent basic echocardiography training (8h of lectures, 8 practice exams), scanned 240 patients (61±16 yrs, BMI 27±5), including 10 standard views from 3 acoustic windows (parasternal, apical, subcostal). All studies were reviewed by 5 expert readers blinded to imagers' identities, and evaluated for sufficient quality to assess left and right ventricular (LV, RV) size and function, pericardial effusion, valve morphology (aortic (AV), mitral (MV), tricuspid (TV)), left atrial (LA) and inferior vena cava (IVC) sizes. Sufficient diagnostic quality was determined by consensus of the majority, namely ≥3/5, readers. Percentages of diagnostic quality images for each feature were compared between nurses and residents, using Chi-squared statistics. **Results:** Of the 240 exams, 165 were performed by nurses, and 75 by medical residents. While for the 10 most clinically relevant features of cardiac function, the proportions of images with sufficient quality were slightly higher for the nurses, none of the differences were statistically significant (Table). **Conclusion:** After minimal training with novel AI guidance software, nurses and medical resident were able to acquire echocardiographic images in 10 standard views with similar rates of diagnostic quality for features commonly evaluated by ultrasound imaging in situations where specialized echocardiography laboratory services are not available.



	Nurses	Medical residents
	% Diagnostic quality (CI)	% Diagnostic quality (CI)
LV size	100% (98-100)	97% (89-100)
LV function	100% (98-100)	99% (91-100)
RV size	95% (90-99)	99% (67-99)
Pericardial effusion	100% (98-100)	100% (95-100)
RV function	95% (90-99)	91% (74-99)
LA size	96% (91-98)	91% (82-96)
AV structure	89% (82-94)	89% (79-95)
MV structure	98% (95-100)	96% (88-99)
TV structure	77% (69-84)	68% (55-79)
IVC size	67% (55-77)	68% (57-78)

P5-05

Echocardiography Lab Workflow Expedites Pediatric Discharge-Dependent Echocardiograms

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Background: Clinical protocols can be impactful in improving systems of care, particularly when balancing competing demands of both detailed and efficient echo imaging to deliver appropriate care at the right time. Children with heart disease often require an echo to meet discharge criteria, and systems to identify and expedite completion of these studies may lead to earlier discharges and improved care. A discharge echo workflow system to identify these studies at the time of order placement, expedite their acquisition, and label them for prompt interpretation was developed and implemented at a high-volume pediatric hospital-based echo lab. The aim of this study was to evaluate the impact of this workflow on discharge-dependent echo result timeframes. **Methods:** After implementation of our discharge workflow system, discharge pending echoes were identified over a two-month period and compared with non-discharge, inpatient echoes from the same day. Time stamps of the first image recorded and interpretation signature were recorded, along with patient age, diagnosis, type of study (limited or complete), and sonographer experience level (junior or senior). Data were compared using mean +/-SD were for all continuous variables, along with 2-tailed students' t-test. **Results:** A total of 102 inpatient echoes, including 50 discharge pending and 52 inpatient echoes, were included in the study. Discharge-pending studies were performed earlier in the day (9:10 vs 11:10 am, $p < 0.05$) and finalized 2 hours earlier on average (11:05 vs 13:03, $p<0.05$) compared to non-discharge inpatient studies. There were no significant differences in time between first image and report generation, patient age, echo complexity, and sonographer experience level between the two groups. **Conclusions:** Implementation of a simple discharge echo workflow system was associated with earlier acquisition and interpretation of echoes in patients otherwise ready for discharge, which can lead to earlier hospital discharge and improved patient care.

P5-06

Clinical Echocardiogram Protocol Adherence Improvement Using Simple Survey Tool

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Background: Echocardiogram protocol adherence is a challenge for many large echo labs as traditional image review and quality assessment is difficult to achieve with limited time and resources. We tested the impact of a routine clinical implementation of a simple protocol adherence feedback tool. **Methods:** A survey was developed from the 56 image basic clinical echocardiogram protocol and consisted of a 'yes' or 'no' answer for each required image. Reviews were performed by Echocardiographer Advisors (EA), senior Level 3 sonographers at the time of survey. A random sample of complete echo studies for 48 sonographers from October 2020 - September 2022 were reviewed. Each required image was graded as 'yes' if the image was present, and 'no' if the image was not present with a target of ≥95% completeness. Staff received performance feedback during a 1:1 meeting with quality improvement team members. The survey was reimplemented for a six-month timeframe from September 2022 - February 2023. Echocardiogram protocol adherence was compared for pre and post feedback time points. Groups assessed were: All Staff, Cardiac Sonographer I (CSI), Cardiac Sonographer II (CSII), and Cardiac Sonographer III (CSIII). Categories assessed were: Percent of Total Protocol Adherence, ≥95% protocol adherence, and 100% protocol adherence. Welch's unequal variances t-test was performed to assess statistical significance. **Results:** Peer reviews were performed on 657 echocardiograms, with 297 reviews performed pre feedback and 360 post feedback. In total protocol adherence All Staff improved from 96.4% to 98.2% ($p=0.011$), CSI improved from 94.6 to 98.2% ($p=0.0002$), CSII improved from 92.9% to 98.2% ($p=0.034$), CSIII was unchanged at 98.2% to 98.2% ($p=0.417$). In studies with ≥95% protocol adherence All staff improved from 66.3 to 74.2% ($p<0.0001$), CSI improved from 65.9% to 76.5% ($p= 0.004$), CSII improved from 51.4% to 70.3% ($p<0.0001$), and CSIII decreased from 80.2% to 75.3% ($p=0.006$). In studies with 100% protocol adherence All staff improved from 11.8% to 34%, CSI improved from 11.9% to 32.7%, CSII improved from 6.9% to 38.1%, CSIII improved from 18.8% to 32.2%. **Conclusions:** Protocol adherence data can be performed in the course of clinical care using a simple survey created from the clinical echocardiogram protocol. Feedback provided to staff on overall trends of missing images in their echocardiogram studies based on a large sample size can drive improved protocol adherence. Future work will be directed towards refining and further automating the protocol adherence assessment survey.

P5-07

Echo Plus: A Quality Improvement Initiative to Reduce Sternal Wound Infections

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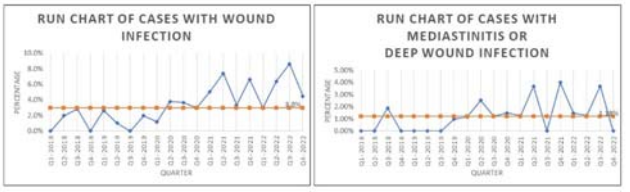
Background: Studies have shown a risk of microbial transmission during ultrasound procedures from both the probe and the conductive gel. Given this risk, the American Institute of Ultrasound in Medicine recommends the use of sterile single-use gel packets when infection is a concern or when near fresh surgical sites as well as using a single-use probe cover with non-intact skin. After surgical program changes and short-staffing due to the COVID-19 pandemic, we noticed an increase in our sternal wound infections. A quality improvement (QI) project was developed with the cardiac intensive care unit (CICU) to support a multi-pronged effort to reduce sternal wound infections in pediatric patients after cardiothoracic surgery. **Methods:** The new process developed during this QI project, Echo Plus, included thorough cleansing of the entire echocardiogram machine before and after studies, patient pre-study chest cleansing, and the use of sterile gloves and a single-use probe cover with sterile gel. Inclusion criteria were patients with an open chest, chest closure within 14 days, or chest tubes or pacing wires in place. The notation of "Echo Plus" was manually written by the ordering provider on the electronic medical record echo orders for patients meeting inclusion criteria. The Society of Thoracic Surgeon's definition for wound infection was used pre- and post-implementation of the protocol. **Results:** The first PDSA cycle was completed and encompassed the final quarter (Q4) of calendar year 2022, and 54 Echo Plus studies were completed in the CICU during that time. Wound infection data was divided into overall infections and deep wound infections. Data is graphed on run charts in the figure. Overall wound infection rate has begun to decrease but has not reached a significant change after the first PDSA cycle. The deep wound infection rate decreased significantly back to zero. **Conclusions:** The Echo Plus QI project has begun to show promise in reducing the burden of sternal wound infections in our patients after the first PDSA cycle. Additional PDSA cycles are planned to improve ease of ordering and documentation of these studies as well as to evaluate for continued improvement. We are hopeful this improvement project could provide a guide for post-operative imaging precautions for other centers.



P5-08

Tomographic Plane Visualization; a Tool to Enhance Echocardiographic Training

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Background: Acquisition of echocardiographic imaging involves many skills including understanding the physics of ultrasound, learning how to use an ultrasound machine, memorizing a protocol, and building a 3-D mental model of cardiac anatomy based on 2-D tomographic images. Visual learning is an important part of echocardiographic training. **Methods:** We describe a visual teaching tool, tomographic plane visualization (ToPlaV) as an adjunct to skills training in pediatric echocardiography image acquisition. This is a linear laser with the line of sight applied to a heart model which can be used to simultaneously "scan" a heart model (figure 1a) while watching a video of an echocardiogram of a scan of a similar tomographic plane (figure 1b). Thus, the learner can learn to correlate anatomy with spatial orientation. This tool incorporates learning theory; applying psychomotor skills that closely emulate the skills used in echocardiography. Trainees were sent an anonymous survey asking if the linear laser and heart model, individually and as a unit, were useful for their training in echocardiography. **Results:** 4 categorical pediatric cardiology 1st year fellows and a cardiac critical care fellow were enrolled in the echocardiographic bootcamp, used ToPlaV and all completed the survey, and there was universal agreement amongst fellow trainees that this is a useful training tool. **Conclusion:** ToPlaV is a small, but important component of the entire strategy in learning echocardiography (figure 2). It serves to develop hand-eye coordination, spatial orientation and motor skills. It is suggested that this be incorporated into early training in echocardiography skills in pediatric cardiology fellowship.