IntelliSpace Portal - cardiovascular portfolio and competition
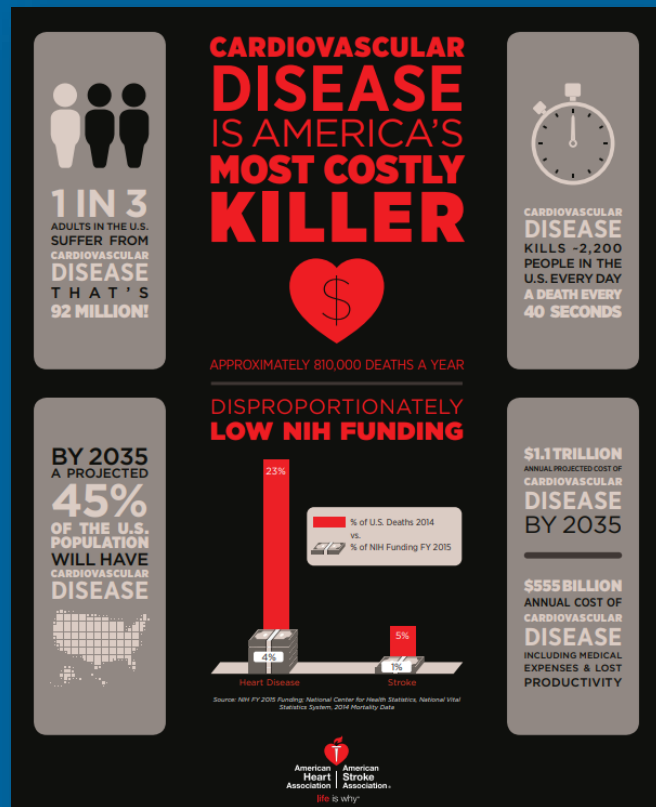
Lior Wolloch
22 October 2019

Global Burden of Cardiovascular Diseases (CVD)

- CVD is the leading global cause of death, accounting for >17.3 million deaths per year in 2013, this number is expected to grow to >23.6 million by 2030.
- Deaths attributable to ischemic HD increased by an estimated 41.7% from 1990 to 2013.
- In 2013, CVD deaths represented 31% of all global deaths.
- 80% of CVD deaths take place in low- and middle-income countries and occur almost equally in men and women.
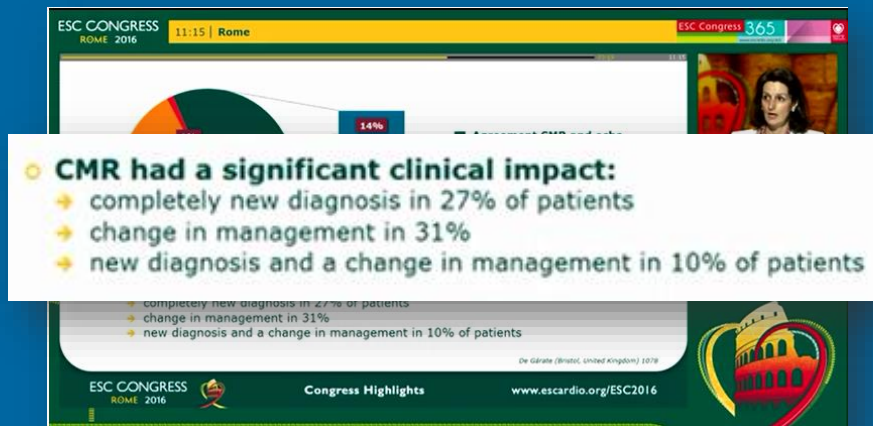
Cost

- In 2010, the estimated global cost of CVD was $863 billion, and it is estimated to rise to $1044 billion by 2030.
- In the US
  - ➤ The estimated direct and indirect cost of CVD for 2011 to 2012 is $316.6 billion
  - ➤ By 2030, (2012$) total direct medical costs of CVD are projected to increase to ≈$918 billion

PHILIPS

CARDIOVASCULAR DISEASE IS AMERICA'S MOST COSTLY KILLER

1 IN 3 ADULTS IN THE U.S. SUFFER FROM CARDIOVASCULAR DISEASE THAT'S 92 MILLION!

CARDIOVASCULAR DISEASE KILLS ~2,200 PEOPLE IN THE U.S. EVERY DAY A DEATH EVERY 40 SECONDS

APPROXIMATELY 810,000 DEATHS A YEAR

DISPROPORTIONATELY LOW NIH FUNDING

BY 2035 A PROJECTED 45% OF THE U.S. POPULATION WILL HAVE CARDIOVASCULAR DISEASE

23%

% of U.S. Deaths 2014 vs. % of NIH Funding FY 2015

4% Heart Disease   5% 1% Stroke

Source: NIH FY 2015 Funding; National Center for Health Statistics, National Vital Statistics System, 2014 Mortality Data

$1.1 TRILLION ANNUAL PROJECTED COST OF CARDIOVASCULAR DISEASE BY 2035

$555 BILLION ANNUAL COST OF CARDIOVASCULAR DISEASE INCLUDING MEDICAL EXPENSES & LOST PRODUCTIVITY

American Heart Association | American Stroke Association. life is why™

Why AV in Cardiology?

- Cardiologists are imaging orientated by nature (Echo, Angio)

- Increase adoption and usage of advanced imaging in cardiology

- AV is mandatory (no alternative for interpretation on PACS / C-PACS): 1/3 of ISP portfolio which accounts to ~40% of revenues

ESC CONGRESS ROME 2016   11:15 | Rome   ESC Congress 365

CMR had a significant clinical impact:
- completely new diagnosis in 27% of patients
- change in management in 31%
- new diagnosis and a change in management in 10% of patients

ESC CONGRESS ROME 2016   Congress Highlights   www.escardio.org/ESC2016

ISP Cardiovascular applications: OIT & utilization

PHILIPS

OIT 2014-Jun 2019

#	App_Name	Sum of Option_Qty	Sum of Adj OIT
1	MM AVA	1728	12,930,046 €
2	CT CCA	1831	12,503,984 €
3	CT Brain Perfusion	1481	8,847,204 €
4	CT AVA Stenosis (AVA)	1006	8,252,090 €
5	CT LNA	1289	7,248,748 €
6	MR Cardiac (MRC)	1063	7,210,294 €
7	MM Tumor Tracking	641	6,762,300 €
8	CT Virtual Colonoscopy	1197	6,354,718 €
9	Zero Click Performance	1692	5,907,092 €
10	MR T1 Perfusion	1783	5,883,498 €
11	MR Neuro Perfusion	1761	5,743,026 €
12	Reporting	2717	5,599,531 €
13	MRC Temp. Enhancement	937	4,687,474 €
14	MR Diffusion	1770	4,623,183 €
15	MR Qflow	1078	4,476,485 €
32	TAVI Planning	201	2,244,917 €

ISP apps utilization, 783 systems, 6 months

#	LaunchedAppP	count
1	AVA	77516
2	Quick Review	77434
3	Cardiac CT Viewer	46778
4	Cardiac MR Viewer	40041
5	Cardiac MR Analysis	39567
6	Comp. Cardiac (CCA)	26284
7	AutoQuant	25162
8	Lung Nodule Assessment	23014
9	HeartBeat-CS	19513
10	AutoSPECT Pro	17050
11	NM Whole Body	14568
12	MR T1Perfusion	12794
13	Spectral CT Viewer	10605
14	MR Neuro Perfusion	8952
15	Brain Perfusion	8011

Cardiovascular continuum of care supported in ISP

PHILIPS

	Screening	Diagnosis				Treatment Planning & Follow-up	
General		CT Cardiac Viewer	MR Cardiac Viewer			CT Cardiac Viewer / 3D Modeling	MR Cardiac Viewer
Coronary Artery Disease	CT Calcium Scoring*	CT Comprehensive Cardiac Analysis / NM Cedars-Sinai Cardiac Suite	CT-MI Fusion / NM Corridor4DM	CT Myocardial Defect Assessment / NM Emory Cardiac Toolbox	CT Cardiac Plaque Assessment		
Structural Heart Disease		MR Cardiac Whole heart				CT TAVI Planning / MR Cardiac Whole heart	CT EP Planning
Cardiomyo-pathies & Heart Failure		MR Functional Analysis	MR Cardiac Temporal Enhancement	MR Spatial Enhancement	MR Cardiac Quantitative Mapping		
Vascular Disease	US Q-App Intima Media Thickness*	MM Advanced Vessel Analysis (AVA) / US Q-App Vascular Plaque Quantification	CT Spectral Advanced Vessel Analysis / US Q-App Intima Media Thickness	CT Pulmonary Artery Analysis (PAA) / US Q-App MicroVascular Imaging	MR QFlow	CT AVA Stent Planning	

IntelliSpace Portal can be integrated with IntelliSpace PACS, IntelliSpace Cardiovascular, and communicate with the Philips Allura & Azurion interventional systems

*Screening must be performed within the established inclusion criteria of programs/protocols that have been approved and published by either a governmental body or professional medical society. Please refer to clinical literature.

Target group of users / customers for cardiovascular AV

Familiarity with AV solution

Core

Imaging Cardiologist

Radiologists

Extended

Interv. Card.

Car. Sur / Vas. Sur

Need for AV solution
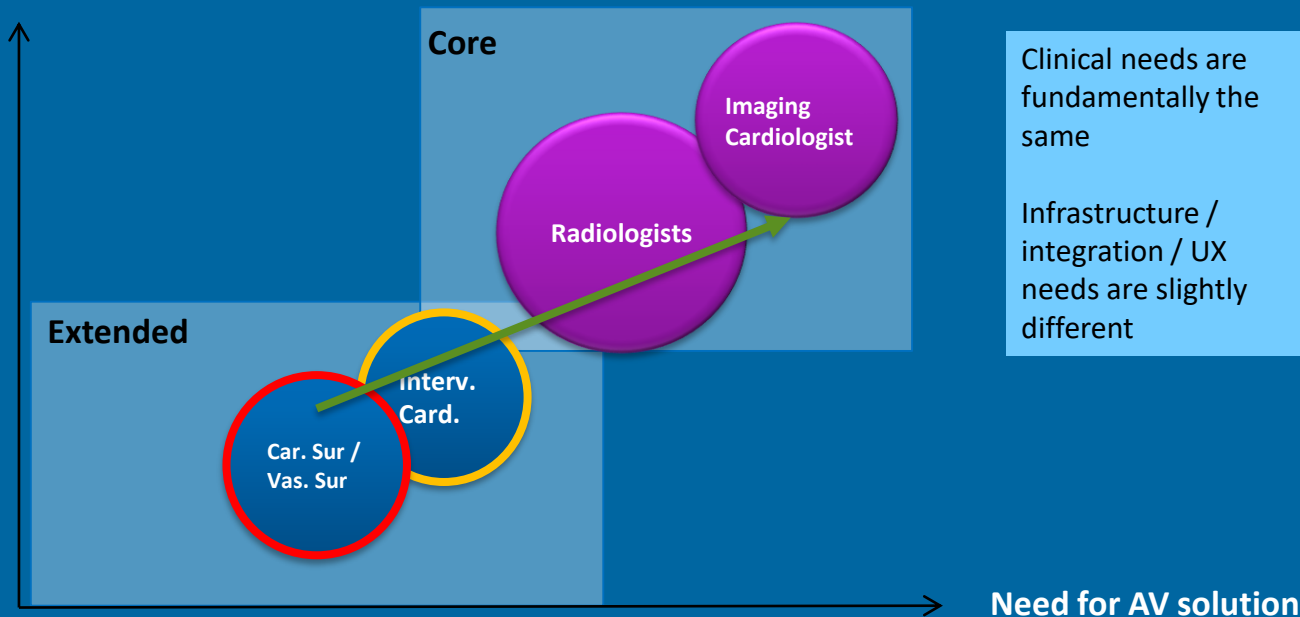
Clinical needs are fundamentally the same

Infrastructure / integration / UX needs are slightly different

Interv. Card. = Interventional cardiologists
Car. Sur = Cardiac surgeons
Vas. Sur = Vascular surgeons

*Estimation based

Overall AV competitive landscape

Big Irons
Established medical imaging vendors

PHILIPS

SIEMENS Healthineers

GE Healthcare

Canon

PACS vendors

Carestream

SECTRA

McKESSON

Big Tech. vendors

Google

Tencent 腾讯

Microsoft

AliHealth 阿里健康

IBM Watson

ICAP
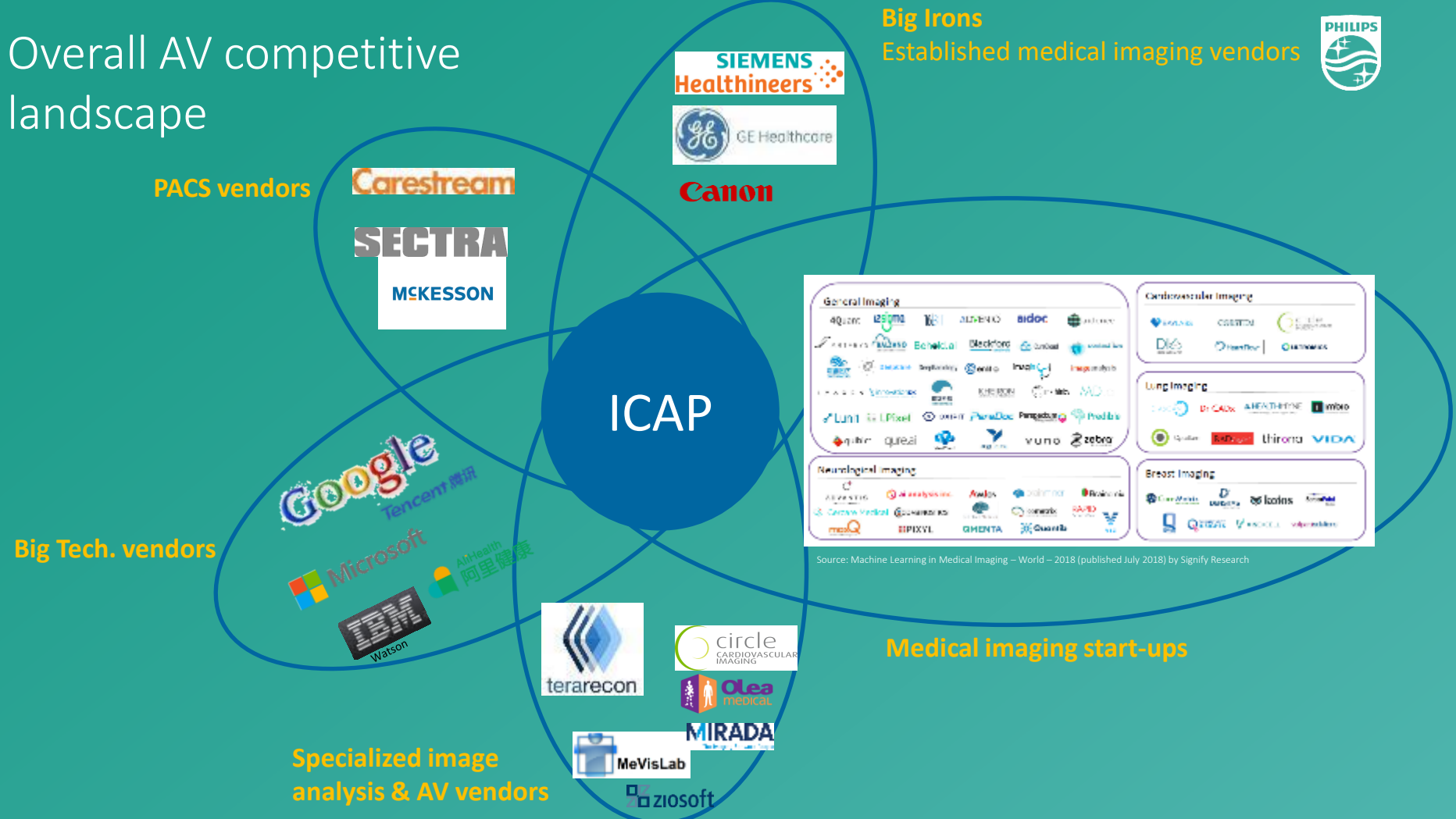
General Imaging

Cardiovascular Imaging

Lung Imaging

Neurological Imaging

Breast Imaging

Source: Machine Learning in Medical Imaging – World – 2018 (published July 2018) by Signify Research

Medical imaging start-ups

Specialized image analysis & AV vendors

terarecon

circle CARDIOVASCULAR IMAGING

OLea MEDICAL

MIRADA

MeVisLab

ziosoft

Cardiovascular competitive landscapes and key trends

- Core capabilities (Vascular, Coronaries) are offered by all main vendors
- More collaborations with 'niche' players for specialized capabilities (MR Cardiac)
- Overall ISP has one of the most comprehensive cardiovascular portfolios

Established medical imaging vendors

Specialized image analysis & AV vendors

| Vascular (AVA) | Coronary Artery Disease (CCA) | MR Cardiac | Structural Heart Disease (TAVI) |

FFR-CT services

Multimodality Advanced Vessels Analysis (AVA)

- Key driving engines: Prevalence and burden of vascular diseases is increasing worldwide.
  Advanced imaging (CT & MR) plays a significant role in the diagnosis, procedure planning (increase number of minimal invasive procedures), and follow up for the different types of vascular diseases.

- IntelliSpace Portal's MM-AVA offers automatic and semi-automatic robust capabilities for visualization and quantification of both CT and MR vascular scans, within one application, all in a streamline workflow.

- Competition: GE, TeraRecon, Vital, 3mensio, Siemens

- Currently ISP's AVA is perceived as a medium-level solution, mainly due to its lack of interactive editing and segmentation tools, performance, and old-style UI (all planned to be addressed in ISPv12)

Procedure number (T)EVAR (2010–2015–CAGR 10.7%)*

Europe I France, Germany, Italy, UK
Europe II Benelux, Nordic, Spain, Switzerland
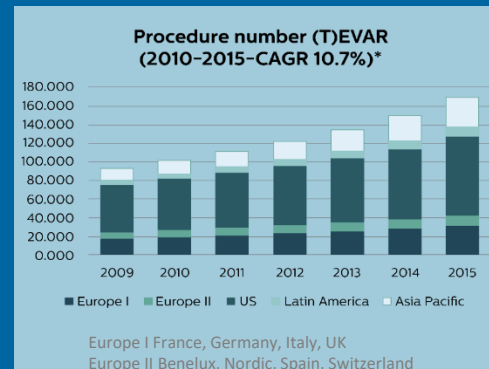
AVA – features level comparison

PHILIPS

GE Autobone & VesselIQ Xpress / MR VesselIQ Xpress

- Separate CT / MR applications (no multi modality)
- Zero-click bone segmentation and tracking
- Auto Aorta fully automates aorta and illiac tracking (no auto for Head & Neck)
- Quantification of different pathologies
- Stent deployment planning
- Multiple-study comparison mode for follow-ups
- Well appreciated 1 or 2 clicks (Quick AVA) 'Vessel Growth' capability

https://www.gehealthcare.com/en/products/advanced-visualization/all-applications/autobone-vesseliq-xpress
https://www.gehealthcare.com/products/advanced-visualization/all-applications/mr-vesseliq-xpress

Siemens syngo.CT Vascular Analysis & & syngo.MR Vascular Analysis

- Separate CT / MR applications (no multi modality)
- Auto Bone removal and vessel centerline extraction
- Different reformation options: CPR, sMPR, cross sectional
- Good preprocessing mechanism for bone removal and centerline extraction
- MR specific vessel segmentation algorithm
- Seamless integration of Dual Energy data
- **Overall, perception of non user-friendly UI, cumbersome editing**

https://www.healthcare.siemens.com/computed-tomography/options-upgrades/clinical-applications/syngo-ct-vascular-analysis/features
https://www.siemens-healthineers.com/magnetic-resonance-imaging/options-and-upgrades/clinical-applications/syngo-mr-vascular-analysis

Vitrea Vessel Probe and Endovascular Stent Planning
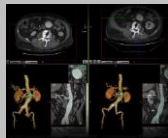
- Use Digital Subtraction (requires 2 scans – w/wo contrast)
- Auto segmentation of the aorta with centerline and contour editing tools
- Different vessels measurements for both CT and MR
- Well appreciated single click vessel segmentation and extraction
- No outer vessel wall segmentation and measurements
- Modern UI
- **Perceived as a strong solution**

http://www.vitalimages.com/enterprise-imaging-solution/cardiovascular-imaging-videos/
http://www.vitalimages.com/product-information/vessel-probe/

TeraRecon Interventional Radiology & CT Head and Neck Packages
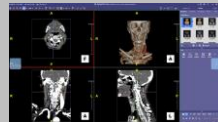
- Vessel stenosis calculations, aneurysm evaluation, and planning capabilities
- Different reformation options: CPR, sMPR, MAR
- Endo flythrough
- User definable stent planning template
- Users-tailored workflows
- **Considered as a very strong solution, but mostly for interactive** (less for full automation)

https://www.terarecon.com/advanced-visualization/interventional-radiology-package?hsCtaTracking=978bab93-2883-4950-9092-dfcb33c3afb2%7C914ae8ab-fe62-417a-9b78-d5247ca1e6a5
https://www.terarecon.com/advanced-visualization/ct-head-neck?hsCtaTracking=72b2e02f-4f08-4833-b862-342ce0f5fdc1%7C7f2e48acc-59e3-425a-b32c-e1b7e5c8680a

CT Comprehensive Cardiac Analysis (CCA)

- Coronary Artery Disease is one of the leading cause of death worldwide.

- Key driving engines: Cardiac CT has been proven to be an excellent diagnostic test for the assessment of Coronary Artery Disease (CAD), included in clinical recommendations and now in general cardiology guidelines. Guidelines change will drive an increase in number of such analysis.

- CCA offers multiple robust capabilities to visualize and assess disease state via: anatomical changes, stenosis degree quantification, plaque characterization, functional assessment, and heart muscle perfusion.

- Competition: GE, Siemens, TeraRecon, Vital, Circle, Medis.

- Overall, all vendors offers similar functionalities, ISP's CCA is considered as one of the most robust solution for Cardiac CT (specific challenges with low-dose and specific reconstructions techniques).

FEATURE | COMPUTED TOMOGRAPHY (CT) | OCTOBER 17, 2018 | DAVE FORNELL, EDITOR

CT Calcium Scoring Becoming a Key Risk Factor Assessment

Curr Cardiovasc Imaging Rep. 2017; 10(5): 15.
Published online 2017 Mar 27. doi: 10.1007/s12410-017-9412-6
PMCID: PMC5368205

The Updated NICE Guidelines: Cardiac CT as the First-Line Test for Coronary Artery Disease

NEWS | CT ANGIOGRAPHY (CTA) | SEPTEMBER 17, 2019

New ESC Guideline Provides Class 1 Recommendation for Coronary CTA

Continuation of 2013 guidelines recommends coronary CT angiography as initial test to rule out or establish diagnosis of chronic coronary syndromes

CCA – features level comparison

GE Healthcare CardIQ Xpress 2.0
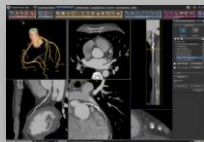
- Automatically segment coronary tree
- Automatically tracks and labels coronary arteries
- Plaque ID tool assists in visualizing and quantifying plaque burden
- Relative perfusion highlights and quantifies hypo-dense areas of myocardium

https://www3.gehealthcare.com/~/media/documents/us-global/products/advanced-visualization/product%20spec%20sheets/cardiq-xpress-reveal/gehc-datasheet-aw-cardiq-xpress-reveal-brief.pdf?Parent=%7B401315DD-912E-4F18-B2E5-E97F7DB2E191%7D

Siemens *syngo*.CT Coronary Analysis + Cardiac Function
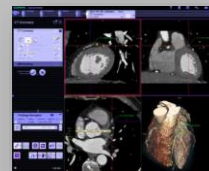
- Automatic segmentation and labeling of the coronary tree
- Calculation of the diameter, area, and length of a stenosis
- Enhanced lesion and stent visualization
- Comprehensive 3D visualization of cardiac and coronary anatomy
- Automatic segmentation of the left and right ventricle
- Highlighting of ischemic areas
- **Overall, perception of non user-friendly UI, cumbersome editing**

https://www.healthcare.siemens.com/computed-tomography/options-upgrades/clinical-applications/syngo-ct-coronary-analysis/features

Vital Images CT Cardiac Analysis
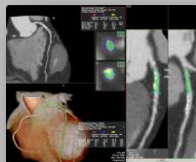
- Automatic extraction of the coronary arteries
- Full vessel probe capabilities for coronary artery analysis
- SUREPlaque™ tool for evaluating the characteristics inside blood vessels

http://www.vitalimages.com/product-information/ct-cardiac-analysis/

Terarecon CT Cardiac
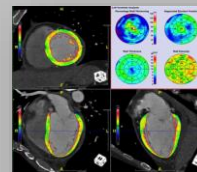
- Vessel Analysis with Centerlining
- Functional Analysis with Mapping
- Region of Interest Analysis
- Calcium Scoring

https://www.terarecon.com/advanced-visualization/ct-cardiac#1_1

MR Cardiac (MRC)

- MR Cardiac is an emerging technique that becomes an increasingly important diagnostic tool.

- Key driving engines: MR Cardiac has been demonstrated as a 'one stop shop' technology for different kind of clinical questions, including cardiac function, congenital heart disease, and cardiac tissue characterization.
MR Cardiac is a continuous evolving field for clinical routine and "academic" use.

- ISP offers a comprehensive portfolio of MR Cardiac capabilities to answer large variety of clinical routine questions.

- Competition: **Circle cvi42**, TeraRecon, Medis, Pie Medical, Siemens (collaborating with Circle & Pie Medical), GE (collaborating with Arterys).

- Currently ISP has some drawbacks in the clinical routine portfolio vs. Circle (gap closure of LV&RV auto segmentation in ISPv12) – however considered equal.
Closing the gap also for "Academic" capabilities (e.g. 4D Flow, Strain in ISPv12) via 3rd parties collaboration (Pie Medical).

- Requires major usability / workflow face lifting – otherwise a risk for the entire cardiovascular portfolio! (ISPv13?)
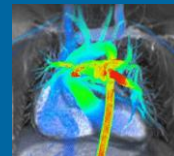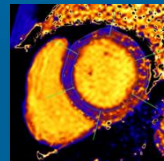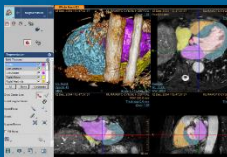
MRC – features level comparison

PHILIPS

GE ViosWorks
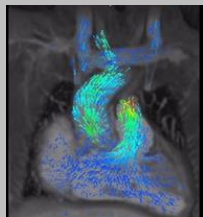
- Powered by Arterys™ (cloud solution)
- Functional – auto LV & RV segmentation, 4D model
- Flow – 2D and 4D
- Perfusion & Scar analysis
- No mapping capabilities

https://www.gehealthcare.com/en/products/magnetic-resonance-imaging/upgrades/viosworks

Siemens syngo.CT Vascular Analysis & & syngo.MR Vascular Analysis

- Functional - auto LV segmentation, auto for RV, 4D model
- Flow – 2D
- Perfusion & Scar capabilities
- Mapping – T1, T2, T2*, motion correction
- Vascular – 2-clicks vessel's segmentation, MPR and 3D MIP

https://www.healthcare.siemens.com/magnetic-resonance-imaging/options-and-upgrades/clinical-applications/syngo-mr-cardio-engine/features

Circle – CVI42 Cardiovascular MRI

- **Considered as a very strong competitor**
- Functional – auto LV & RV segmentation, 4D model
- Flow – 2D and 4D
- Tissue characterization: Perfusion, Scar
- Mapping
- Strain analysis
- Vascular – lumen and stenosis measurements, semi-auto segmentation and centerline, VR and MIP rendering

Announced collaboration with Siemens

https://www.circlecvi.com/cardiac-mri/

TeraRecon – Cardiac MR
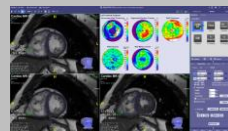
- Relatively new in the CMR arena
- Functional – semi-automatic LV & RV segmentation
- Flow – 2D and 4D
- Mapping – T1, T2, T2*
- No Perfusion & Scar analysis

https://www.terarecon.com/advanced-visualization/mr-cardiac

Structural Heart Disease (SHD) procedures planning

Valvular Heart Disease in the U.S.

8.7 to 11.7 million people in the U.S. have **valvular heart disease.***

Total annual direct healthcare costs of mitral & aortic valvular heart disease: **$23.4 billion**†

Approximately **1.5 million people** have aortic stenosis.**

1/3 have severe aortic stenosis.**

Prevalence by age 70: **2-3%**†

Prevalence by age 85: **8%**

Mitral regurgitation is the **most frequent form of** valvular heart disease in the U.S.** **1 in 40** patients with moderate or severe mitral regurgitation undergo surgery.**

Aortic valve disease costs the U.S. **$10.2 billion** in direct costs per year.†

- **SAVR** (Surgical aortic valve replacement) is still the common treatment for Aortic Stenosis (with the onset of symptoms, 75% of patients with Aortic Stenosis die)
  - Direct visual inspection and access to the valve / implant
  - ~1/3 of patients cannot undergo open heart surgery / denied from surgery (e.g. old age, comorbidities)

- **TAVI / TAVR** – a relatively new procedure where the aortic valve implant is inserted to the body and located in the heart via a **catheterization** (in the Cath-lab)
  - Success heavily relies on the imaging information
  - **CT** is considered as the 'gold standard' for **pre-procedure planning**

- Till recently, the procedure was indicated only for high-risk and intermediate-risk patients, however now **also low-risk patients can undergo this procedure.**

http://tracywestcott.cikeys.com/
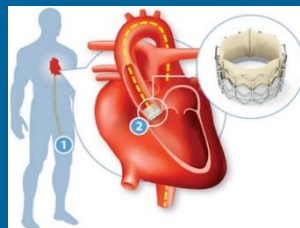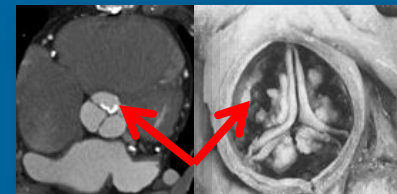
Calcium deposits behind Valve leaflets seen on CT

CT TAVI Planning

- <u>Key driving engines</u>: guidelines change for TAVI → Paradigm shift in Cardiology.
  A relatively rapid moving field. More minimal invasive procedures are in the pipeline..

- IntelliSpace Portal's CT TAVI application is an automated, robust, and well appreciated analysis application, which brings confident and efficient for TAVI pre-procedural planning, and includes automatic segmentation and measurements for patient eligibility and device sizing, together with vascular access route assessment.

- <u>Competition</u>: **3mensio** (joint venture with device companies), Circle cvi42, GE, Siemens (collaborating with Circle, and Pie Medical), TeraRecon, Philips HeartNavigator.

- ISP's CT TAVI Planning has been demonstrated to be faster and more reproducible than 3mensio.
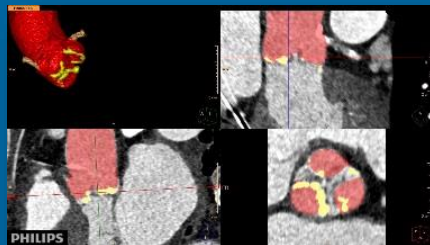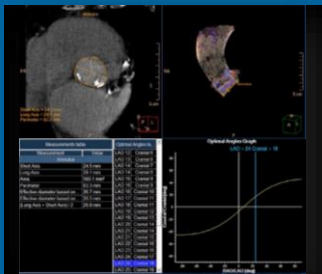
FEATURE | HEART VALVE TECHNOLOGY | AUGUST 16, 2019| JEFF ZAGOUDIS, ASSOCIATE EDITOR, AND DAVE FORNELL, EDITOR

FDA Approves TAVR for Low-risk Patients Creates A Paradigm Shift in Cardiology

FDA Approves Sapien 3, CoreValve Evolut TAVR valves for low-risk patients, TAVR now available for all patients with severe, symptomatic aortic stenosis

https://www.dicardiology.com/article/fda-approves-tavr-low-risk-patients-creates-paradigm-shift-cardiology

CT TAVI Planning – features level comparison

GE Healthcare TAVI Analysis
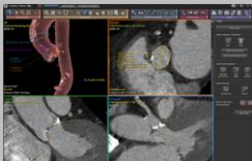
- Automated Aortic segmentation displayed to highlight calcific areas
- Automated orientation to the aortic valve plane
- Guided workflow for valve measurements
- Fast centerline tracking to subclavian and femoral arteries
- Connectivity to the interventional suite

https://www.gehealthcare.com/en/products/advanced-visualization/all-applications/tavi-analysis
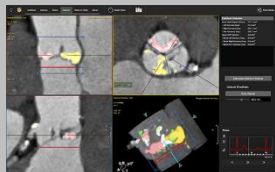
Siemens syngo.via CT Valve Pilot

- Automatic aortic annulus segmentation and measurements not fully automatic measurements
- Minimum, maximum, and effective diameters are provided
- C-arm angles for device placement
- Quick assessment of the peripheral arteries to check for an optimal access path

Announced a recall on Apr- 2019

https://www.healthcare.siemens.com/medical-imaging-it/syngoviaspecialtopics/syngo-via-for-sustainable-cardiovascular-care/valvular-heart-disease

Circle – cvi42 for Interventional Planning

- Assisted annulus detection based on anatomical landmarks – not fully automatic
- Dynamic annulus visualization through multiple phases
- Measurements of aortic annulus, LVOT, sinus of Valsalva, sinotubular junction, etc.
- Femoral access route support
- Offers Mitral valve (TMVI) planning

https://www.circlecvi.com/cvi42/interventional-planning/

3mension (Pie Medical) Structural Heart

- Automatic segmentation of the ascending aorta
- Annulus plane definition – not fully automatic
- Support measurements of: Aortic Annulus, Coronary ostia height, Optimal projection angle, Calcium assessment and quantification
- Valve-in-Valve assessment
- Simulated Angio view
- Femoral and Subclavian access route support
- Direct Aortic and Transapical approach
- Offers Mitral valve , Left Atrial Appendage, and Tricuspid Valve planning

Considered the benchmark vendor

https://www.piemedicalimaging.com/product/3mensio-structural-heart

AI for Cardiovascular analysis
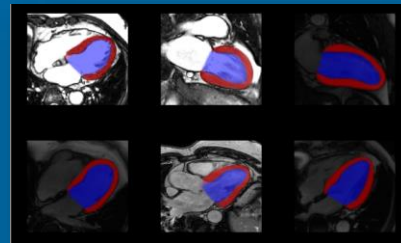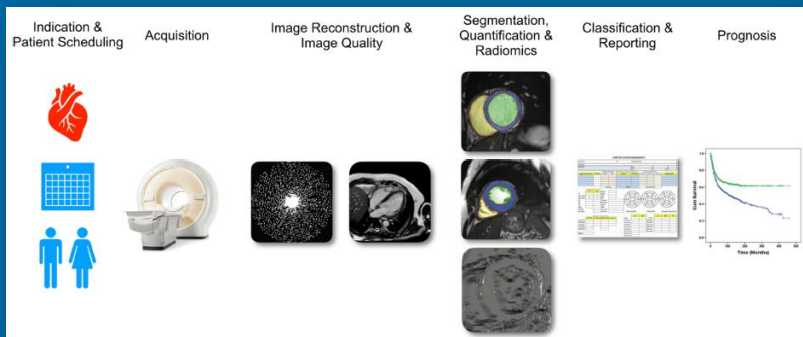
Leiner et al. Journal of Cardiovascular Magnetic Resonance, (2019) 21:61

- Drawing circles - this has to stop!

- ML / DL developed capabilities currently for automatic segmentation (MR Cardiac LV & RV)

https://www.circlecvi.com/whats-new/
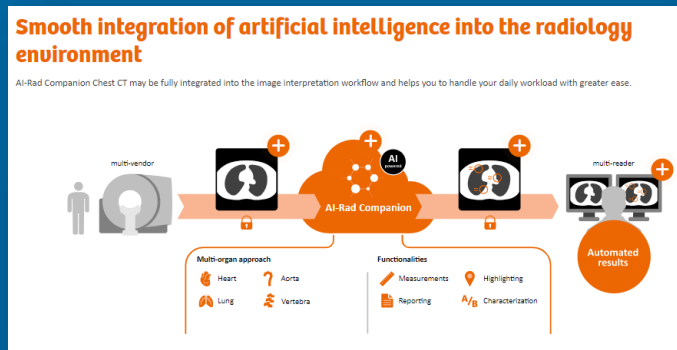
Contouring has never been this easy.

Single Click Contouring

Consistent Reproducability

Physician Accuracy

Our Deep Learning Story

Contour Detection in progress

0:30.4

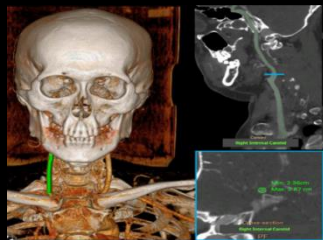# AI for 'light' Cardiovascular capabilities in primary reading

- AI capabilities for highlighting incidental finding ('Ca Scoring', abnormal aorta dilation) in primary reading environment, on regular chest CT scans.

- Mainly rising from medical imaging start-ups (e.g. Zebra Medical), but lately also mentioned by Siemens (AI-Rad Companion Chest CT).

- Not a replacement / competition for "traditional" cardiovascular analysis and quantification, as those require dedicated scans.

https://www.siemens-healthineers.com/digital-health-solutions/digital-solutions-overview/clinical-decision-support/ai-rad-companion

Version 12 development plans in Cardiovascular

More clinical depth, faster results, one-stop-shop

Enhanced multi-modality AVA*

Enhanced cardiac coronaries extraction for CT*

Enhanced cardiac MR functional analysis*

New MR 4D Flow[1]

New Photorealistic Volume Rendering*

- ✓ Enhanced workflow, faster results
- ✓ New user-experience
- ✓ Algorithm and editing tools improvements
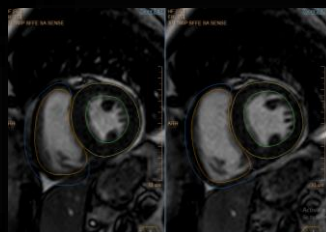- ✓ Results saving automation

Closing gap with competition (GE, TeraRecon)

- ✓ Enhanced algorithm accuracy
- ✓ Faster results

Differentiation..

- ✓ Automatic RV/LV segmentation

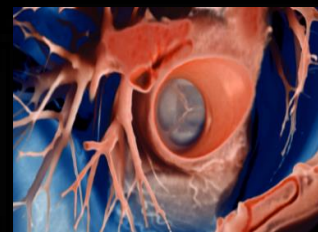*Closing gap with competition for clinical routine use (Circle, Medis)*
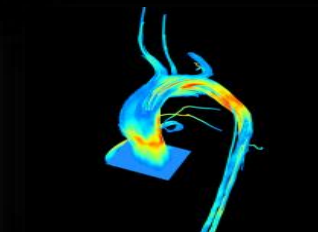
Closing gap with competition for "academic" use (Circle)

Closing gap with competition (Siemens)

*Work in progress and subject to clinical testing, contents might change, not for sale
[1] In collaboration with 3rd party partners