Executive Summary

Downstream Benefits of a Network for Fast, Cost-Effective Cardiac Diagnosis With Clinical Decision Support

With special expertise in chest pain diagnosis by Cardiac CT safely through the night, IHS is a physician-owned national service network of imaging cardiologists, cardiac radiologists, and technologists together providing cardiovascular diagnostics with clinical decision support, at a fraction of the cost of full-time equivalent physicians, with redundancy and extended hours. Spread amongst U.S. time zones, embracing the best technologies, we are the premier physician team committed to definitive, cost-effective diagnostics for value-based cardiovascular management, enabling risk-bearing payments by leaner processes: fast and more accurate cardiac diagnosis leading to faster discharges – and chest pain episode closures - in 3.5 hours with lower costs, spared telemetry beds, and improved metrics such as ED time to discharge, ED waiting time, length of stay, lower repeat evaluations for chest pain, lower normal cath rates, improved patient experience, and better event-free patient survival as shown in multiple studies. The ROMICAT2 clinical trial showed a decrease in hospital admission by 40% and length of stay by 25%; ACRIN-PA, a decrease in hospital admission by 35% and length of stay by 27%; BEACON, a decrease in downstream testing by 62% and costs by 34%. The ACC/ACR/ACEP guidelines endorse Rapid Assessment with Cardiac CT given near zero undetected coronary problems over five years after normal scans. The United Kingdom’s National Institute for Health and Care Excellence (N.I.C.E) guidelines now recommend Cardiac CT as the first line test before any consideration of invasive cath or stress testing.

The IHS network’s value proposition to regional cardiologists and radiologists is to support local imaging programs by offering Cardiac CT service lines deep into the night, complementing local resources and providing redundancy. Local imagers can also enhance their skillsets and local programs by joining our community of colleagues dedicated to cardiac imaging mastery: interpreting Cardiac CT at network hospitals while maintaining each physician’s own regional first right of refusal, via a smartphone application that communicates their scheduled or instantaneous availability to a dispatch algorithm, and can also request diagnostic backup from IHS colleagues with specialized mastery in areas such as adult congenital heart disease, aortic disease, and structural intervention imaging. IHS physicians nurture career-long relationships to refine best practices at our yearly meetings, over operational teleconferences, and by daily collaboration for complex diagnoses, service coverage, and mentorship to build downstream local programs in aortic disease, structural heart, cardio-oncology, and congenital heart clinics. For fellows, IHS remits the tuition for Level II Cardiac CT training after working with the IHS network after fellowship. Long term physicians are offered ownership in IHS based on service and colleague recommendations.

Our principle is to make onboarding of hospitals and imagers frictionless by orchestrating the best technologies, ease of credentialing and contracting, and long-term quality curation, with shared data analytics to benchmark and enhance processes for patients with potentially life-threatening problems.

The Benefits

- Improved Patient Event-free Survival
- Lower Costs
- Shorter Time-to-Diagnosis
- Fewer Unnecessary Admissions
- Fewer Repeat Evaluations
Care for the Vulnerable

IHS physicians hold as their highest value the practice of medicine: service to vulnerable patients with potentially life-threatening causes. We deliver peace of mind through diagnostics and decision support, extending expertise on a national scale into the night. Chest Pain is a high risk complaint and the most common presenting symptom to emergency departments after abdominal pain. IHS physicians care for patients regionally and from afar with greater precision, better outcomes, faster diagnoses, and lower costs than usual care. We are a network of advanced cardiovascular imaging specialists in a premier team committed to definitive cardiac imaging throughout the United States. Cost-effective, rapid diagnostics drive value-based management for independent hospitals, critical access hospitals, freestanding emergency departments, as well as quaternary cardiovascular programs requiring advanced imaging for electrophysiology, structural heart intervention, aortic disease clinics and adult congenital heart programs.

A Premier Cardiovascular Imaging Team

We are a team of Level III and Level II-trained imaging cardiologists and cardiac radiologists interspersed throughout the country with a collective passion for advanced cardiovascular imaging. Since 2006, IHS founders have trained over 500 adult cardiologists, radiologists, and pediatric cardiologists through intense cardiothoracic imaging courses in Virginia, endorsed by the Society for Cardiovascular CT (SCCT). Our educational programs have been lauded for vessel-walking cognitive algorithms maximizing accuracy, minimizing time to diagnosis, and breadth of pathology, while minimizing liability in aortic syndromes, congenital heart disease, iatrogenic complications, pulmonary vascular disease, and electrophysiologic procedural imaging. We conducted over 30,000 tertiary cardiac CT and MRI exams across multiple hospitals via a hub-and-spoke model during this period.
IHS Core Service: Rapid Assessment with Cardiac CT, Endorsed by the ACC/ACEP/ACR

IHS imagers prioritize patient outcomes above all, working with regional physicians based on needs identified during initial program planning with stakeholders. Our IHS core service is to provide comprehensive Cardiac CT acquisitions and interpretations in the emergency department after EKG re-review, then phone or video explanations of the findings and recommendations as needed to assist patient management. IHS-certified cardiologists and radiologists collaborate across time zones in real time. As diagnosticians we understand the system-wide best practices to improve patient experience, lower costs of entire episodes of care, avoid lengthy observations, reduce length of stay, nuclear radioisotopes, and unnecessary physician and nursing time, while focusing on improved patient outcomes compared to old care pathways. Because of emergency department overcrowding and limited chest pain observation beds, evaluations that include stress testing often involve unnecessary hospital admissions and 24 hours to complete workups. In free-standing EDs, transfers are often required. In most settings stress testing is not performed after 4:00pm due to safety concerns and radioisotope availability. The American College of Cardiology (ACC) endorses Rapid Assessment with Cardiac CT, with rapid time to diagnosis, reduced hospital stays, unnecessary admissions, total costs, and repeat evaluations for recurrent chest pain, with at least 5-year warranty period for adverse cardiac events when scans are negative. Better Long-term Outcomes, Speed, and Cost versus Stress testing – Safely into the Night

Although subjective data assists in the evaluation, patient chest pain history has proved unreliable in clinical studies. New-onset chest pain is a common clinical problem that results in 4 million stress tests annually in the United States. At the same time, patients diagnosed with ‘noncardiac’ chest pain account for one-third of patients who subsequently die from cardiovascular disease or have an acute coronary syndrome during 5 years of follow-up. Cardiac CT is the most sensitive and rapid noninvasive test available to detect CAD, including nonobstructive plaque undetectable by stress testing, as well as high risk plaque features, and is most effective in patients with low to intermediate pretest likelihood (15%-85% pretest probability) of acute coronary syndrome (ACS), which is well over half the patients presenting to emergency departments. The epidemiology of chest pain reflects selection biases, with the rate of serious cardiovascular disease (stable CAD, unstable CAD, myocardial infarction, pulmonary embolism, congestive heart failure, and acute aortic syndrome) in the U.S. primary care setting of only 16%, increasing in emergency departments to 54%. Both sites of care benefit from definitive, rapid noninvasive diagnosis. In multiple trials and registries nearly zero patients with a normal Cardiac CT developed ACS over years of follow-up.
In the randomized, controlled CATCH trial,\textsuperscript{13} assessing long-term clinical impact of Cardiac CT in 600 patients with acute-onset chest pain, event-free survival was significantly better over 21 months than stress testing pathways. Similarly, the SCOT-HEART trial demonstrated a 38\% reduction in fatal and nonfatal MI when Cardiac CT was used to evaluate patients with stable chest pain compared to standard care\textsuperscript{14}, and resulted in a significantly lower rate of death from coronary heart disease or nonfatal MI after 5 years than standard care alone.\textsuperscript{15} Costs to Medicare for MI treatment surpassed $6 billion in 2014.\textsuperscript{16} If this testing pathway were a device or medication most community hospitals would feel compelled to consider it.

Cardiac CT is essentially a three-vessel noninvasive intravascular ultrasound (IVUS) showing extra-luminal plaque (benefiting from medical therapies) as well as stenosis (benefiting potentially from revascularization if confirmed by fractional flow reserve) and, if normal, carries a 5-year warranty for freedom from coronary events.\textsuperscript{6} IHS physicians are mindful that acute chest pain of coronary etiology can occur with a near-normal Cardiac CT in patients that may benefit from admission in certain rare scenarios (plaque rupture that washes down the epicardial vessel leaving a nonobstructive plaque proximally, true Prinzmetal’s vasospasm, coronary embolism) mandating a second troponin/EKG after the Cardiac CT for any evolution, thus a minimal ED observation of 3 hours.

Because Cardiac CT does not provoke ischemia and directly visualizes the coronaries, it is ideal for sites that benefit from rapid assessment and discharge through the night, such as emergency departments, as well as hospitals wishing to lean processes and improve outcomes for outpatients with chest pain, curbing costs of radioisotopes given the nuclear shortages forecasted. Beta-blockers and nitroglycerin administered during Cardiac CT for chest pain patients are safe and even beneficial as anti-ischemics in the setting of borderline elevated cardiac enzymes. Unlike stress testing, borderline troponinemia without EKG changes is not a contraindication to Cardiac CT per ACC/ACEP guidelines given its safety.\textsuperscript{1}

Numerous high quality randomized trials comparing Cardiac CT with stress testing and/or invasive coronary
angiography now support widespread utilization.\textsuperscript{10,13,14,17,29} Cardiac CT costs have been shown in the NIH-sponsored PROMISE study economic analysis to be less than half the cost of nuclear stress testing, with less radiation than nuclear studies with modern scanners.\textsuperscript{18,30} Biomarkers for radiation effects on DNA and lymphocytes have been evaluated with multiple CT scanners and shown no increases with radiation doses less than 7.5 mSv. Over the last decade, CT radiation doses have plummeted with modern scanners using new dose-reduction strategies such as high-pitch helical, prospective scanning, iterative reconstruction, low kV imaging, and ECG-based dose modulation.\textsuperscript{31} Radiation doses from typical nuclear stress tests remains considerably higher than Cardiac CT as noted by the ACC Expert Consensus guidelines on Optimal Use of Ionizing Radiation in Cardiovascular Imaging.\textsuperscript{32}

**Identification of Unexpected Cardiothoracic Disease with Cardiac CT -- Unlike Stress Testing**

Cardiac CT benefits patients with cardiopulmonary symptoms by identifying unexpected non-coronary etiologies for chest pain\textsuperscript{33}, which is not possible with stress testing. Approximately 1% of patients undergoing coronary CT for suspicion of CAD prove to have otherwise unsuspected, but clinically relevant,cardiothoracic abnormalities unrelated to coronary plaque. Almost one-third have clinically significant disease with major implications for subsequent therapy, including acute aortic syndrome, coronary anomalies, pneumothorax, and pneumonia. The recent PESIT trial\textsuperscript{34} demonstrated nearly 17% of patients evaluated for syncope were ultimately diagnosed with pulmonary embolism, mostly by CT, and less commonly by V/Q scan, with one by autopsy. Compared to stress testing for syncope, the ability of Cardiac CT to rapidly identify unexpected extra-cardiac disease in patients with cardiopulmonary symptoms underscores its value.

Cardiac CT also offers added value for preventive cardiology beyond traditional strategies. Unlike stress tests which can only detect obstructive coronary artery disease, coronary CT can detect both obstructive and non-obstructive plaque – identification that has been proven to lead to intensification of preventive medical therapy, including statins, resulting in lower low-density lipoprotein cholesterol levels. Identification of non-obstructive plaque on coronary CT is associated with greater medication compliance and lifestyle modifications. Collectively, this has contributed to the significantly lower rates of cardiovascular death and myocardial infarction among patients undergoing coronary CT.\textsuperscript{35}
From an accountable care viewpoint, stress testing provides only a medicolegal stamp—excluding the worst ischemia of left main (though often missing three vessel disease due to balanced ischemia). In the PICTURE trial\(^{10}\) the diagnostic sensitivity and specificity for nuclear perfusion SPECT was 55% and 78% as compared to 92% and 87% for Cardiac CT. Almost all stress tests in the ED setting are negative as the test is insensitive, despite a prevalence of CAD in the ED higher than negative stress tests belie -- at about 30%. By Cardiac CT, high risk CAD has been shown to be present in 4% of patients after normal nuclear stress tests -- well above the 1% post-test probability of life-threatening disease -- the numerical risk tolerance -- acceptable to most ED physicians. When patients are discharged from ED observation and follow-up with their PCP after stress testing, doubt remains as to whether they could have CAD deserving aggressive medical management or cardiology referral, and what the workup should be, if any, if chest pain returns.

**Multiple scenarios for a normal nuclear stress test:** including normal Cardiac CT, diffuse non-obstructive disease, and non-obstructive disease with high-risk plaque. From Villines, TC. (2018) acc.org

**Rapid Diagnostic Backup for Cardiac CT: Quality Assurance in Real time for Potential Life-threatening Diagnoses**

IHS embraces multi-frame group decision-making as recommended by the Institute of Medicine. Quality is continuously curated in real time by collaboration to refine diagnoses by Level III cardiologists and radiologists, with specialized mastery in aortic disease, congenital heart disease, pulmonary vascular disease, electrophysiology and structural heart interventions including left atrial appendage occlusion devices, transcatheter aortic valve implantation (TAVI), and left ventricular assist devices (LVADs). Quality assurance by diagnostic backup with colleagues as well as retrospective peer review achieves the excellent outcomes demanded in cardiac care.
Trust by Cardiologists and Trust by Hospitals

IHS curates the protocols and safety parameters for scanner acquisitions at hospitals via an on-site acquisition team that works closely with local CT technologists and applications specialists. We seek and provide continuous feedback on image quality and radiation exposure at each institution to optimize local operations and ensure best practices. Our process data helps hospitals and emergency departments refine their operations to maximize efficiency, metrics, and patient outcomes, enabling risk-bearing. IHS seeks long-term relationships, trust, and collaboration, intangible capital in cardiology that propels service quality and consistency, requisite for strategic shifts.

Local Adaptation by Patient-centric Redesign

Protocols are adapted to local resources during planning with IHS for program development, technical training, acquisitions, and pathway design. With some studies performed in the emergency setting, communication is imperative. Our default is to discuss every patient physician-to-physician, followed by a structured written report and recommendation to the electronic medical record. Within 72 hours the final report is communicated to the patient for their PCP, delivering peace of mind and patient satisfaction. As clinicians, we understand our role in definitive diagnosis, minimizing risk, and communication directing appropriate management and improving the patient experience.

IHS Dispatch Coordinates the Process

Between 0700 and 2300 EST (IHS Phase I; IHS Phase II 24/7) within 10 minutes of arrival with a history of chest pain, triage patients receive the usual
EKG excluding STEMI, and a first troponin. If the patient has no prior stents or CABG, staff write on the EKG the patient’s cellphone (for any clinical questions from IHS dispatch or IHS cardiologists) and the patient’s email address (for the final report for PCPs), then via HIPPA-compliant smartphone app secure-text or email the EKG to IHS dispatch noting the plan for Cardiac CT or, less commonly, Triple Rule-Out CT, per the evidence-based algorithm below.\(^{36}\) A borderline initial troponin is not a contraindication to Rapid Assessment with Cardiac CT per the ACC/ACEP guidelines.\(^{3}\) Regional clinical practice is enhanced by the dispatch algorithm automatically selecting IHS imagers within their region who indicate availability on their IHS smartphone app.

Not every patient will be a candidate for a CT cardiac. Some patients may get a recommendation from a cardiologist based on the first EKG for an alternative – for example, additional observation with early repeat EKG in 20 minutes, typically if the first ECG is unclear or equivocal. EKG patterns that can inform management include right-axis deviation, Wellen’s pattern, PR depression with chest pain, delta or epsilon waves with syncope, and RBBB/LBBB with dyspnea, among others.

Order sets direct the administration of oral and IV beta blockers, ivabradine and nitroglycerin per established guidelines\(^ {37}\) based on a patient’s heart rate and BP and determine the acquisition and reconstruction parameters. IHS dispatch alerts imagers to report, who provide a clear recommendation. The final structured written report is then transferred to the hospital electronic medical record. A final EKG for any pattern evolution is recommended. Current best practice is to draw a second troponin after the Cardiac CT, but prior to discharge. Push-alerts of troponin results from the local lab directly to the discharging physicians’ smartphone has been proven to reduce ED discharge times by 25 minutes.\(^ {38}\)

Feedback is elicited from the patient and providers to continuously hone local processes and for data analytics and benchmarking.

**Emergency Department Benefits**

Rapid and definitive cardiovascular evaluation, for patients with chest pain, syncope, and angina-equivalent dyspnea, has multiple benefits. Improved
throughput by rapid discharge leads to ED decompression, reducing the waiting times for all patients, as well as the cognitive and resource load on physicians and staff. Identification of minor CAD that can be treated as an outpatient, with exclusion of life-threatening thoracic causes, spares telemetry beds and provides a definitive diagnosis to the patient, PCP, and effectively concludes the episode of care, unlike probability scores for chest pain. Multiple ED trials demonstrate up to a 40% reduction in hospital admissions, 34% reductions in length of stay, 62% reduction in downstream testing, and a 38% reduction in ED costs with Cardiac CT.\textsuperscript{19-22} One CMS quality measure is Median Time from ED Arrival to ED Departure for Discharged ED Patients, a process metric based on the rationale that in recent times EDs have experienced significant overcrowding. According to a national U.S. survey of more than 90 percent of large hospitals report EDs operating at capacity.\textsuperscript{39} Safety of Cardiac CT pathways, well into the night past usual stress testing hours, is important in times of ED overcrowding when ED physicians may have less time to probe chest pain histories. Despite high-risk chief complaints such as chest pain, shortness of breath, and syncope, rapid evaluation by IHS is safe at all hours, allowing ED physicians time to evaluate sicker patients and achieve the best possible outcomes.

**Downstream Benefits of Regional IHS Cardiologists**

**The Regional Aorta Clinic**

Local aortic clinics critically depend on accurate serial 3D measurements standardized per the ACC/ACR/STS Guidelines on Thoracic Aortic Disease.\textsuperscript{40} Careful measuring indexed to height and BSA is time-consuming but is, beyond symptoms, the best intervention criterion. Guidelines recommend yearly serial imaging of the unrepaired and repaired thoracic aorta, a source of liability and an identified gap in chronic cardiovascular care. IHS imagers with specialized aortic expertise collaborate with regional physician champions by sharing best practices for patients with acquired and inherited aortopathies. In acute and chronic aortic syndromes, patients scanned by gated cardiac CT get the benefit of immediate CAD identification before surgery.

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<tr>
<th>Aortic Location</th>
<th>Diameter (orthogonal to axis of flow)</th>
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<tr>
<td>Aortic Annulus</td>
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<td>Sinotubular Ridge</td>
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<td>Distal Ascending prior to 1.5 inch vessel</td>
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<td>Proximal Descending after last arch vessel (intima)</td>
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<td>Mid descending at level of left atrium</td>
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<td>Maximum Aorta Diameter:</td>
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<td>Descending Aorta</td>
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<th>Maximum aortic cross-sectional area (cm(^2))</th>
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<tr>
<td>Ratio of maximum aortic cross-sectional area (cm(^2)) to patient height (m)</td>
<td>cm(^3)/m</td>
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<td>Body Surface Area (BSA)</td>
<td>m(^2)</td>
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<tr>
<td>Aortic Size Index (ASI)</td>
<td>cm(^2)/m(^2)</td>
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<th>Risk Category (combined endpoint of rupture, dissection, or death)</th>
<th>Aortic Size Index (ASI)</th>
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<tr>
<td>Low-risk (1% per year)</td>
<td>&lt;2.35 cm(^2)/m(^2)</td>
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<td>Moderate-risk (5% per year)</td>
<td>2.35-4.34 cm(^2)/m(^2)</td>
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<tr>
<td>High-risk (20% per year)</td>
<td>&gt;4.35 cm(^2)/m(^2)</td>
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*\textsuperscript{*}\textsuperscript{40} Novel Measurement of Relative Aortic Size Predicts Rupture of Thoracic Aortic Aneurysms" Derksen, et al. \textit{Am J Cardiol} 2006;97:189-195

**Adult Congenital Heart Disease**

Adults with congenital heart disease represent the fastest-expanding patient population segment within adult cardiology, numbering greater than 1.2 million in the U.S. alone, and yet many do not have ready access to centers with congenital cardiac imaging expertise.\textsuperscript{41} Furthermore, many patients do not remember their history, leading to an information vacuum surrounding highly complex scans with a potential for misdiagnosis. Other times, congenital lesions may not have been recognized in childhood. Our adult congenital IHS
cardiac imagers have years of clinical and imaging experience and provide primary imaging interpretation with diagnostic backup for patients with known or previously unrecognized congenital problems such as various forms of septal defects, systemic or pulmonary arterial anomalies, congenital coronary anomalies, in addition to those with prior complex surgical and catheter based palliative repairs.

**Electrophysiology, Structural Heart, and Advanced Heart Failure**

IHS founders have special expertise in EP Imaging providing CT & MR imaging support for pre-planning & post procedure troubleshooting of pulmonary vein ablation, left atrial appendage occlusion devices, coronary venous mapping for pacemaker lead placement and follow-up, and aortic root mapping for TAVI. For advanced heart failure programs, we provide imaging evaluation of left ventricular assist devices (LVAD), with clinical decision support as needed.

**Cardio-Oncology Clinics**

The American Cancer Society predicts that by 2024, there will be 19 million long-term survivors of cancer in the United States.\(^4^2\) Relationships with oncologists, serving cancer survivors, is the cornerstone of cardio-oncology. Cardiovascular disease is the leading cause of late morbidity and death among cancer survivors after secondary malignancies.\(^4^3\) New therapeutics besides anthracyclines and radiation cause myocardial toxicity resulting in LV dysfunction and heart failure, accelerated coronary atherosclerosis, pericardial disease, and valvular dysfunction. Some patients who receive these agents with risks of unstable angina or MI may benefit from a baseline evaluation for the presence and severity of CAD before initiation of therapy, even in the absence of symptoms.

Patients with prior chest radiation are at high risk for CAD, as well as stenosis of subclavian and internal mammary arteries, and recommendation suggest noninvasive detection for CAD 5-10 years after exposure.

**Coronary Functional Evaluation by CT-FFR**

Emerging methods of determining ischemia by CT-FFR by analysis of intermediate lesions on the resting Cardiac CT dataset, without vasodilators or exercise stress, holds promise for even further time and cost benefits, obviating additional tests or invasive strategies. In the PLATFORM (Prospective Longitudinal Trial of FFRCT Outcome and Resource Impacts) trial,\(^4^4\) web-based FFRCT technology resulted in the safe cancellation of 61% of planned invasive catheterizations and a lower rate of catheterizations that found no obstructive CAD.\(^4^5\) In an analysis of outcome and resource impacts in the PLATFORM trial, among patients in a group planned for invasive coronary angiography, mean costs were $4,112 higher in the patients who underwent usual care vs. those who received FFRCT-guided care.\(^4^4\) IHS physicians are actively evaluating these techniques and ongoing trials, for the potential benefit of developing this expertise within our community.

**Business Aspects**

IHS physicians are a team of cardiologists and radiologists in a community built on long-term relationships, working together and meeting yearly to refine operations and best practices. Physicians who
value collaboration join the IHS network to enhance each other’s service hours — caring for each other’s patients as their own — while enhancing their own skillsets and directing downstream programs for the benefit of their regions. Each physician interprets locally as the first-call imager when available on the smartphone app via our proprietary dispatch algorithm, whether scheduled weekly or instantaneously, given they are most likely to manage regional patients. IHS colleagues provide the diagnostic backup and service hours extension. IHS physicians credential in hospitals to be able to provide explanations of the imaging and recommendations, based on the Cardiac CT and EKG quality assurance. We do not engage in arrangements to compete with local imagers, choosing to empower and enhance regional subspecialty service and clinical practice as a sustainable extension, not as a replacement. All physicians train in our 3D navigation software, structured reporting, and best practices. For fellows, IHS remits the tuition of initial Level II Cardiac CT training in our courses after a period working within the IHS network after fellowship. Weekend immersion refresher courses are also available. Long term physicians are offered ownership in IHS based on service and colleague recommendations. IHS physicians commit to provide services to patients in the developing world on a charity basis, with a current partnership in Goa and Haiti.

IHS in most agreements assigns third-party billing to hospitals contracting for our services. We understand the importance to hospital partners of a fully redundant network and enroll exclusively U.S. board certified physicians with the highest professional standards and training, often referred by other IHS colleagues or after training in our courses in Virginia.

IHS is guided by an advisory board of doctors and other stakeholders to ensure physician values guide decision-making for our community, to craft transparent policies for self-governance, and to solicit viewpoints from organizations and agencies to shape its design.

Regulations Promoting Telemedicine

During 2015-2018 over a dozen states and the federal government passed laws or rules favorable to telemedicine.

The AHA in 2016 urged CMS to consider telemedicine solutions to solve the upcoming cardiologist shortage and maldistribution, including telehealth interventions for all Medicare beneficiaries for cardiovascular disease and stroke. CMS created the Next Generation accountable care organizations program which allows providers to waive geographic limitations on telehealth reimbursement. Opportunities for payment within Medicare are increasing, as the CMS Innovation Center announced more test models which embrace the value of telehealth.

The Interstate Medical Licensure Compact (IMLC) mission is to increase access to health care for patients by allowing them to connect with medical experts through the use of telemedicine. This agreement between an initial 18 states has created an expedited pathway to multi-state licensing for physicians seeking to practice medicine across state lines. As a result nearly 80% of physicians licensed in the United States could be eligible for expedited licensure via the Interstate Medical Licensure Compact.

Compact Commission centralized mechanism.
Unlocking Efficiencies

Only 37 advanced cardiovascular imaging fellowships exist in the United States and only three CT training courses exist outside universities. Our model economizes matches of valuable expertise with need, avoiding idle supply (imager expertise and time) and avoids unfulfilled demand (vulnerable patients needing fast, accurate diagnostics), while adding critical collaboration, diagnostic backup, data analytics for improving performance, speed, and outcomes by regional benchmarking, with agile long-term strategic partnerships with scanner and software manufacturers, and other stakeholders toward a transformation from old care models.

Accountable Care and Cost Savings

IHS represents a true operational improvement rather than an iteration of payment reform, a leaner process enabling risk-bearing given sustainable reduced costs, improved speed and accuracy, improved efficiency, metrics, and patient event-free survival as demonstrated in multiple trials. Health systems capable of mastering new pathways will thrive at the expense of competitors mired in older diagnostic pathways. The recent Congressional Budget Office estimate of 10-year savings associated with only $5.3 billion for ACOs. IHS streamlines the chest pain bundle by care redesign toward internal efficiency in a coherent strategy that has already met a high burden of proof.

Value is defined as outcome achieved per dollar spent. U.S. accountable care organization can look to established accountable care evidence-based health systems such as the United Kingdom’s National Health Service. The NICE (National Institute for Health and Care Excellence) Updated 2016 guidelines favor Cardiac CT as the first line test before consideration of any invasive cardiac catheterization or stress testing.\textsuperscript{46} The NICE guidelines note “[Cardiac CT] has almost 100% accuracy in excluding significant coronary artery disease and when compared with functional imaging tests or invasive angiography is the lowest cost technique. The rapid technological advances that allow Cardiac CT to be delivered at a low radiation dose and the substantial amount of new scientific evidence published support its widespread use in clinical practice and provide the backdrop to the recent review. The evidence has brought about the new recommendations that propose Cardiac CT as the most clinically and cost-effective diagnostic first line test for all patients presenting with stable chest pain. The new guidelines present considerable delivery challenges in the short term.”

Given the only nuclear reactor in North America (Chalk River, Canada) ceased production of Tc-99m for nuclear stress tests, a 40% future increased price is
forecast to coincide with value-based healthcare payment demands. Global supplies of molybdenum-99 are produced at six other reactors worldwide; most of these facilities are old and some are prone to unscheduled shutdowns, as in 2018.

CMS has proposed multiple quality measures for consideration for Medicare value-based care purchasing programs. Many measures improve with definitive, rapid diagnostics. CMS believes these measures help patients and families choose the best hospital and clinician. The list will inform major Medicare initiatives including the Medicare Shared Savings Program, the EHR Incentive Programs for hospitals and critical access hospitals, and the Merit-Based Incentive Payment System (MIPS). CMS Physician Compare plans to publicly display costs and quality, similar to CMS Hospital Compare. The measures will also be applicable to other patient safety and data reporting programs, including the Hospital Value-Based Purchasing Program.

IHS core service can reduce the number of expensive cardiac catheterizations, costs of nuclear radioisotopes, and reduces overall costs—important for chest pain bundle payments, ACO savings, and out-of-pocket high deductible consumers in any evolution of the payment landscape. Commercial payers aim to tie 75% of payment to value by 2020. Strong clinical leadership and substantial investments are needed to successfully redesign care processes, improve quality, and decrease costs. IHS was conceived to partner for the lean redesign necessary ahead.

The US health care system is in a time of historic change as participation in APMs and bundled payments will be unavoidable. Physicians and hospital administrators who understand these emerging models must lead their development to ensure that they are clinically driven, patient-centered, and to avoid unintended consequences such as restricted access to services. Patients are best served when they have a team of clinicians with aligned processes grounded in best practices.

**Program Launch**

After initial consulting with stakeholders to develop a shared understanding of regional needs, technology capabilities, and best practices for downstream programs, IHS in conjunction with local champions implements a phased action plan to include education, ordersets, imaging and medication protocols, and credentialing. Identification of staff includes CT technologists and lead nurses with cardiac experience. Together a timeline is developed with the steps needed to put a shared vision into practice, including milestones. Quality assurance goals include achieving a diagnostic scan proportion of >95%, quarterly median radiation dose rate <7.5mSV, and a quarterly comparative review of any patients with CAD requiring invasive angiography that demonstrates an accuracy of >90% per-patient accuracy, as well analysis of CMS Time to Discharge, among other key metrics. Optimization then continues moving forward, with a focus on outcomes.
About IHS

IHS is the premier team founded by tertiary physicians to innovate health care delivery with practical tools and solutions, analytics, and education. We form coalitions that identify gaps in healthcare delivery, then bridge them. Since 2006 IHS cardiology and radiology founders have interpreted over 30,000 complex Cardiac CT & MRI imaging studies, provided clinical decision support for management, and trained over 700 physicians, both adult and pediatric cardiologists and radiologists, through intense cardiothoracic imaging courses in Virginia endorsed by the Society for Cardiovascular CT (SCCT) and recommended by the Certification Board of Cardiovascular Computed Tomography (CBCCT). Our educational programs have been lauded for cognitive algorithms for accuracy, minimizing time to diagnosis and minimizing liability in aortic syndromes, congenital heart disease, pulmonary vascular disorders, iatrogenic complications, and electrophysiologic imaging.

We are practicing physicians with a mission: to innovate care for the vulnerable.

Contact us at ihsmd.org or email executiveteam@ihsmd.org.
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