A Personal Journey: Understanding the Value of Medical Analytics

Dr. Thomas Novicki shares his newfound appreciation for medical analytics as well as results of successful pilot analytics projects at Marshfield Clinic Laboratory.

Dr. Thomas Novicki, PhD, DABMM, shares his journey in learning to appreciate the value and power of medical analytics. In addition, he outlines the details of building a medical analytics program, and highlights results of successful medical analytics pilot projects at Marshfield Clinic Laboratory. This white paper is based on Dr. Novicki's presentation given at the 2016 Orchard Software User Group & Symposium and teachings of Dr. Bradley Brimhall at the Orchard School of Medical Analytics.

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ORCHARD Software

Table of Contents

Dr. Thomas Novicki, PhD, DABMM, hails from Chicago, but for the last 13 years has worked in the heartland of Wisconsin as a clinical microbiologist at Marshfield Clinic. Dr. Novicki's laboratory medicine roots date back to the early '80s when he was a Medical Technologist. Until early 2016, medical analytics (MA) was relatively low on Dr. Novicki's radar. After learning more about the changes taking place in healthcare and how MA can help with that transition, and participating in successful analytics projects, Dr. Novicki is now an MA team leader and advocate. He has learned the power of MA.

Dr. Thomas Novicki, PhD, DABMM

If you are a Star Trek fan, you may remember Dr. Leonard "Bones" McCoy saying to Captain Kirk, "I don't know, Jim. This is a big ship. I'm just a country doctor."[1] Dr. Novicki paraphrases Bones when he says, "I'm just a country microbiologist," his humble point being that if he can be an MA leader, so can anyone involved in laboratory medicine. This white paper will share the path of "one simple country microbiologist" down the MA highway, as well as the results of initial MA pilot analytics studies performed at Marshfield Clinic.

Healthcare Terrain

To help understand why MA has become so important, think about the fast-paced changes taking place in our healthcare system. The sea of acronyms—MACRA, MIPS, APM, ACO, BCPI, OPPS, PAMA, and on and on—is enough to make your head spin. What do these changes in healthcare terrain mean for the laboratory? And how can MA help?

DHHS Goals for Transition to APMs

Using a clever depiction of a tombstone labeled "FFS," Dr. Novicki explains that fee-for-service (FFS) reimbursements are dying.[2] Though not quite dead yet, they are quickly being replaced by bundled and capitated payment plans and other value-based alternative payment models (APMs) that are incentivized by positive patient outcomes. The U.S. Department of Health & Human Services (DHHS) has defined specific goals for this payment transition. DHHS expects 50% of Medicare payments to be associated with APMs by 2018 (see Figure 1)[3].

MACRA QPP

Released in October 2016, the final Medicare Access and CHIP Reauthorization Act (MACRA) defines the Quality Payment Program (QPP) framework that offers two pathways for provider reimbursements. MACRA's QPP is a bigger push away from FFS to value-based payment models. The QPP default path is the Merit-based Incentive Payment System (MIPS). Beginning January 2017, providers who bill more than $30,000 a year to Medicare or treat a minimum of 100 Medicare patients will be subject to MIPS payment guidelines. Initially, there is a phase-in for the categories of costs and resources; however, once MIPS is in full swing, providers are evaluated on four categories: 1) quality (replaces Physician Quality Reporting System [PQRS]), 2) advancing care information (replaces Meaningful Use), 3) cost (replaces Value Modifier [VM] Program), and 4) clinical improvement activities (new category).[4]

DHHS Goals for Medicare Payments by 2018

- 50% value-based APMs
- 42.5% value-based FFS
- 7.5% traditional FFS

Figure 1: DHHS expects 50% of Medicare payments to be associated with APMs by 2018.

Healthcare organizations (HCOs) further down the value-based path may be eligible for the Advanced APM track and can receive a 5% incentive payment. To be eligible, providers must receive 25% of their Medicare-covered services through Advanced APMs or see 20% of their Medicare patients through an Advanced APM in 2017. For 2017, the following models qualify as Advanced APMs: the Comprehensive End-Stage Renal Disease Care Model, the Comprehensive Primary Care Plus (CPC+) model, the Next Generation ACO model, and Medicare Shared Savings Program (MSSP) Tracks 2 and 3.

CMS Innovation Models

The Centers for Medicare & Medicaid (CMS) Innovation Center has a multitude of various value-oriented payment and service delivery models that are being tested. These models are focused on the Triple Aim goals of healthcare reform: better care, smarter spending, and healthier communities. These innovative models range from Accountable Care Organizations (ACOs) and episode-based payment initiatives to primary care coordination and initiatives specific to cardiac care or diabetes.[5] No matter which models are successful and end up being adopted, there is no longer any doubt that FFS is on its way out and that this transition is happening sooner rather than later.

DHHS HCP LAN

To support the transition to value-based payment models, the DHHS has also developed the Healthcare Payment Learning and Action Network (HCP LAN) with the goal of including private, public, and non-profit sectors in the shift from volume to value. The HCP LAN has a long list of collaborative committed partners (e.g., Aetna, BCBS, UHC).[6] Private payers are eager to continue the value-based movement as many of them have focused on medical necessity for years.

This transition to value-based models means HCOs have to use money more wisely. In capitated plans and bundled payment models, HCOs have to survive on a fixed amount of dollars. No longer can the bottom line be moved by doing more procedures. This is where MA comes into play. MA seeks to leverage data to inform spending decisions and improve outcomes.

Getting to the Gold

Dr. Novicki explains that MA can not only help laboratories work through the reimbursement changes in healthcare, but can also "lead us to the gold." In addition to discovery of savings opportunities, MA can help HCOs use their resources more efficiently, identify waste, and improve patient outcomes. These benefits are what Dr. Novicki refers to as "gold."Analytics allows us to look across data to see patterns. This information can be used to answer questions that can help us make data-informed decisions. In the lab, these questions may start with: Are we doing the right tests? Are we doing the wrong tests? Are we underutilizing or overutilizing certain tests?

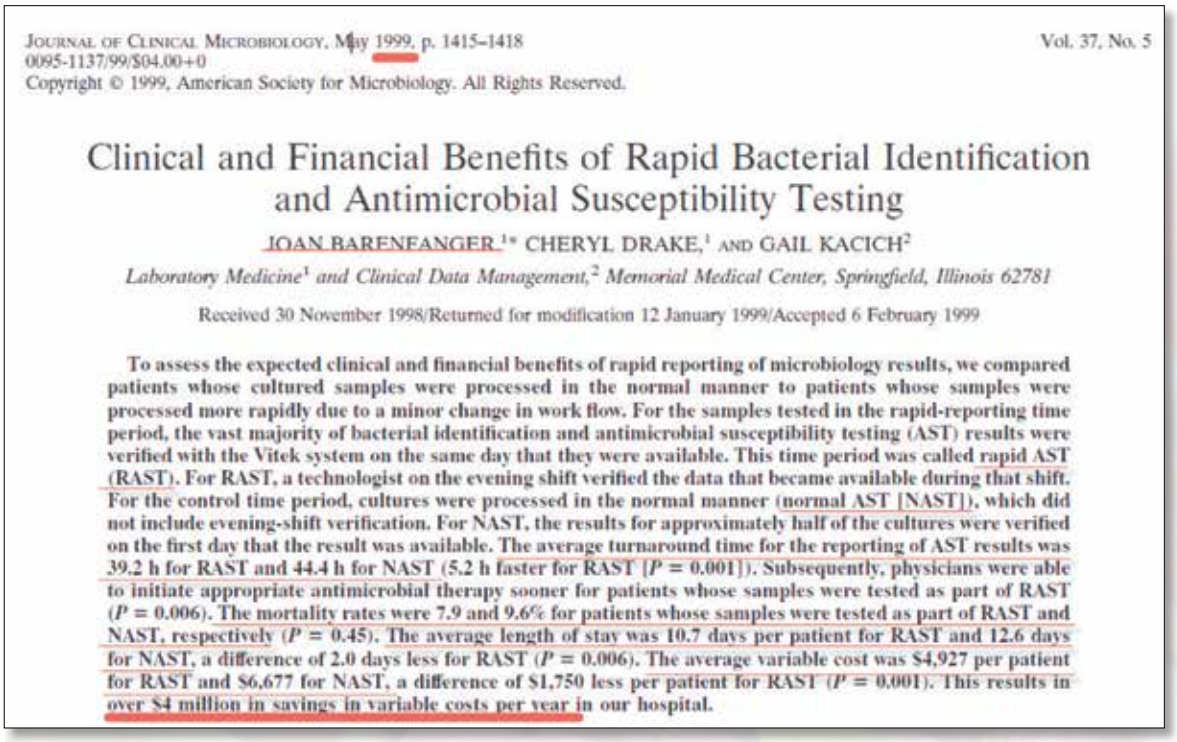
Medical analytics seeks to leverage data to inform spending decisions and improve outcomes.

Dr. Novicki's Analytics Journey

Even though MA has only recently moved more to the forefront in healthcare because of value-based models, MA has been around for quite some time.

MA Back in 1999

Working as a PhD clinical microbiologist in Illinois, Dr. Novicki became intrigued by a scientific study by Dr. Joan Barenfanger and colleagues in 1999. Little did he know at the time how his appreciation for MA would grow by 2016.



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Clinical and Financial Benefits of Rapid Bacterial Identification and Antimicrobial Susceptibility Testing

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To assess the expected clinical and financial benefits of rapid reporting of microbiology results, we compared patients whose cultured samples were processed in the normal manner to patients whose samples were processed more rapidly due to a minor change in work flow. For the samples tested in the rapid-reporting time period, the vast majority of bacterial identification and antimicrobial susceptibility testing (AST) results were verified with the Vitek system on the same day that they were available. This time period was called rapid AST (RAST). For RAST, a technologist on the evening shift verified the data that became available during that shift. For the control time period, cultures were processed in the normal manner (normal AST [NAST]), which did not include evening-shift verification. For NAST, the results for approximately half of the cultures were verified on the first day that the result was available. The average turnaround time for the reporting of AST results was 39.2 h for RAST and 44.4 h for NAST (5.2 h faster for RAST [$P = 0.001$]). Subsequently, physicians were able to initiate appropriate antimicrobial therapy sooner for patients whose samples were tested as part of RAST ($P = 0.006$). The mortality rates were 7.9 and 9.6% for patients whose samples were tested as part of RAST and NAST, respectively ($P = 0.45$). The average length of stay was 10.7 days per patient for RAST and 12.6 days for NAST, a difference of 2.0 days less for RAST ($P = 0.006$). The average variable cost was $4,927 per patient for RAST and $6,677 for NAST, a difference of $1,750 less per patient for RAST ($P = 0.001$). This results in over $4 million in savings in variable costs per year in our hospital.

Figure 2: Dr. Barenfanger and colleagues (1999) used MA to demonstrate how rapid bacterial ID saved $4 million by decreasing LOS.

Dr. Barenfanger was quite the trendsetter, using MA involving laboratory data before it became popular. In one of her papers, she and her colleagues describe how the use of rapid bacterial identification and susceptibility testing resulted in decreased hospital length of stay by two days, and, in doing so, improved patient care and saved more than $4 million (see Figure 2).[7] Dr. Barenfanger was looking beyond the cost of the lab tests and their reimbursement to the overall savings and improved patient outcomes. What is of particular note is that she was not just drilling down into lab data; she sought to look outside the lab and connect those lab results to patient outcomes and total costs savings.

Dr. Novicki was intrigued, but it was not clear how to initiate these types of studies. How do you do this type of MA? Where do you start?

Analytics Timeline

With this study sticking in the back of his mind, Dr. Novicki received an email from his lab administrator, Pam Carter, MT(ASCP), Director of System Labs, about the Orchard School of Medical Analytics; his interest was piqued. "My mind went back to Dr. Barenfanger's work. Could we use MA to add value to our institution?" thought Dr. Novicki.

After initial discussions with Orchard Software, Dr. Novicki became excited about the possibilities and was able to gain approval for several pilot projects to demonstrate proof of concept. Amazingly, brainstorming about analytics with his lab team resulted in about a dozen different ideas for projects. He simply initiated the conversation and asked, "What ideas do you have?" The lab had quite a few great suggestions.

Site Visit

Shortly after these discussions, a team of analytics specialists from Orchard, including Dr. Brad Brimhall, visited Marshfield Clinic to begin work on the initial pilot projects. The team spent two days on-site with the clinic team to build a SQL database of lab values, run two MA pilot projects, and begin planning an MA program at the clinic. Dr. Novicki was pleasantly surprised to see results of the pilot projects during this meeting.

OSMA Training

The next step in Dr. Novicki's MA journey was a trip to Carmel, Indiana, to attend the Orchard School of Medical Analytics (OSMA) in the spring of 2016. "The four-day course is a time commitment, but if you are serious about MA, no one is thinking about this in the concrete terms of how you actually do it like Dr. Brad Brimhall [OSMA Instructor]." Orchard, in conjunction with Dr. Brimhall, introduced the Orchard School of Medical Analytics to help clients better understand the importance of medical analytics.

MA Program Components

Once Dr. Novicki's training was complete, he returned to Marshfield Clinic eager to begin his own MA projects. After the OSMA course, he understood what was necessary for an MA program and became a true advocate for MA. Below are the base components of an MA program.

MA Team Leader

MA projects need a team leader, like Dr. Novicki, who understands the value of MA and is excited about the potential. You can call this your MA champion—maybe it can be you! The OSMA training is set up to develop such leaders who can then reach out and find colleagues within their organizations and start conversations about what questions can be answered with MA. IT departments in HCOs tend to be very busy and may not have the clinical knowledge to determine what analytics projects would be most beneficial. Once the MA champion finds colleagues to brainstorm ideas with, the MA program begins to build on itself.

Organizational Leadership & Culture

Key to any change within an HCO is support from administrative leadership and an accepting, open-minded medical staff. Change can be difficult for all, yet the U.S. healthcare environment is complex and in constant flux, causing a continuously changing environment. Having an organizational culture that understands this shift in dynamic and supports change is a boon for any project.

Technology: Relational Databases

In order to perform MA, you need a well-maintained relational database and a database analyst to help with the data extraction. In our day-to-day work with information systems, we are typically working transactionally (patient by patient), but when we begin to use MA, we use data relationally. Relational access is a different way to think about accessing and using data. For example, Microsoft® Excel® is a series of tables with tabs at the bottom that parse information into manageable chunks using minimal tools that link data across sheets. MA, using a relational database, does this on a much bigger scale, where there are individual data tables (lab, imaging, finance) that are linked. Users can query broad data sets by traveling through those table links using tools such as Microsoft Access or SQL to "ask questions" of the data. In order to do this, you need a well-maintained relational database, integrity of data, and a knowledgeable database analyst.

Marshfield Clinic Information Systems Data Warehouse

Dr. Novicki knew that Marshfield Clinic had a data warehouse, but he did not realize the value of having data stored this way until he delved into MA. Marshfield Clinic's data warehouse was a gem that had not previously been leveraged for this specific type of data analysis. Its data warehouse, created in 1999, contains 2,200 reporting tables, data for 2.7 million patients, and is queried up to 35,000 times per day!

Data comes into the warehouse from different silos (EHR, pharmacy, claims, etc.) and extract, transform, and load (ETL) processes are used to normalize and standardize the data in a uniform way. Once the data is properly stored in the data warehouse, data integrity must be maintained; rule of thumb is not to allow direct access. Marshfield Clinic uses shared tenant segregation/replication, where each user only uses the portions of the data that they need. Users define what is needed, and required tables are then replicated (in near real-time) so as not to corrupt the main data repository.

The Pilot Projects

From the lab's perspective, an easy place to start with analytics is looking at test utilization and using evidence-based guidelines to uncover areas of overutilization or underutilization. Following is a discussion of the initial analytics pilot projects at Marshfield Clinic Laboratory involving test utilization.

Project 1: Thyroid Function Test Utilization

One of the most recognized areas of test overutilization is in thyroid testing, where often a "thyroid panel" with some combination of thyroid hormones is run as a screening for hypothyroidism. Laboratorians know that, according to the latest scientific publications, the recommended screening test for hypothyroidism is a thyroid-stimulating hormone (TSH), and *only* a TSH.

TSH is a hormone that is not produced by the thyroid gland but by the pituitary gland. Thyroxine (T4) is produced in the thyroid gland from iodine in the body. Basically, the level of T4 and TSH are inversely related, so if your thyroid is not producing enough T4, the pituitary indicates that your body needs more and makes more TSH in an effort to stimulate T4 production. This imbalance makes TSH levels increase, indicating hypothyroidism. Conversely, if there is too much T4, the pituitary decreases TSH production and TSH levels decline, indicating hyperthyroidism. There are several confirmatory tests, but in most cases, these should only be ordered after the TSH is found to be abnormal; however, we know from ordering practices that this is often not the case. Dr. Novicki and his laboratory colleagues decided to ask their data: Are our thyroid function tests being used appropriately? If not, how often and at what cost?

Project 1 entailed pulling data with all combinations of normal TSH accompanied by confirmatory thyroid tests, along with the variable costs such as reagents and consumables (costs did not include overhead, labor, etc.). This ensured that the results would be on the conservative side. Results of this pilot study uncovered more than 1,600 unnecessary thyroid tests performed at a variable cost of more than $54,000 in 2015 (see Figure 3).

Test Scenario	Annual Volume			Variable Materials Cost		
	Clinic	MSJH	Total	Clinic	MSJH	Total
FT4 given normal TSH; same req	8,835	715	9,550	$26,770.05	$2,166.45	$28,936.50
FT4 given no TSH	2,041	599	2,640	$6,184.23	$1,814.97	$7,999.20
FT3 given normal TSH	2,235	143	2,378	$8,805.90	$563.42	$9,369.32
FT3 given no TSH	650	323	973	$2,561.00	$1,272.62	$3,833.62
FT3 given high/low TSH and high/low FT4	584	40	624	$2,300.96	$157.60	$2,458.56
TT4 given normal TSH; same req	169	67	236	$469.82	$186.26	$656.08
TT4 given no TSH	49	105	154	$136.22	$291.90	$428.12
TT3 given normal TSH	8	2	10	$17.84	$4.46	$22.30
TT3 given no TSH	1	1	2	$2.23	$2.23	$4.46
TT3 given high/low TSH and high/low FT4	1	1	2	$2.23	$2.23	$4.46
Reverse T3 (all)	79	4	83	$395.00	$20.00	$415.00
Total			16,652			$54,127

Figure 3: The initial pilot study uncovered more than 1,600 unnecessary thyroid tests performed at a variable cost of more than $54,000.

What was of further interest was that about a year ago, Marshfield Clinic Laboratory initiated a thyroid screening cascade; when ordered, providers only get the confirmatory tests if indicated. This project has shown that the cascade test option was not being fully utilized during the 2015 study period. So not only can MA be used to demonstrate test utilization and guide you to decide if you need a reflex panel, but it can also be used as a follow-up to determine if such interventions are successful.

Project 2: Lab Test Utilization Quality Audits

For a second project, the lab decided to look at MA data to determine if it could improve on its manual internal test utilization quality audits. These audits are part of good lab practice and part of an ongoing quality assurance program. Typically, the lab manually pulls a random "convenience sample" for analysis.

In this study, it turned out that, yes, by using MA, the lab could gain better quality data using a statistically more significant data pool. Also, the manual process could be streamlined and performed more quickly. From there, the lab could conceivably build that project in its SAP®BusinessObjects or other report generator tool in order to get automated periodic detailed reports.

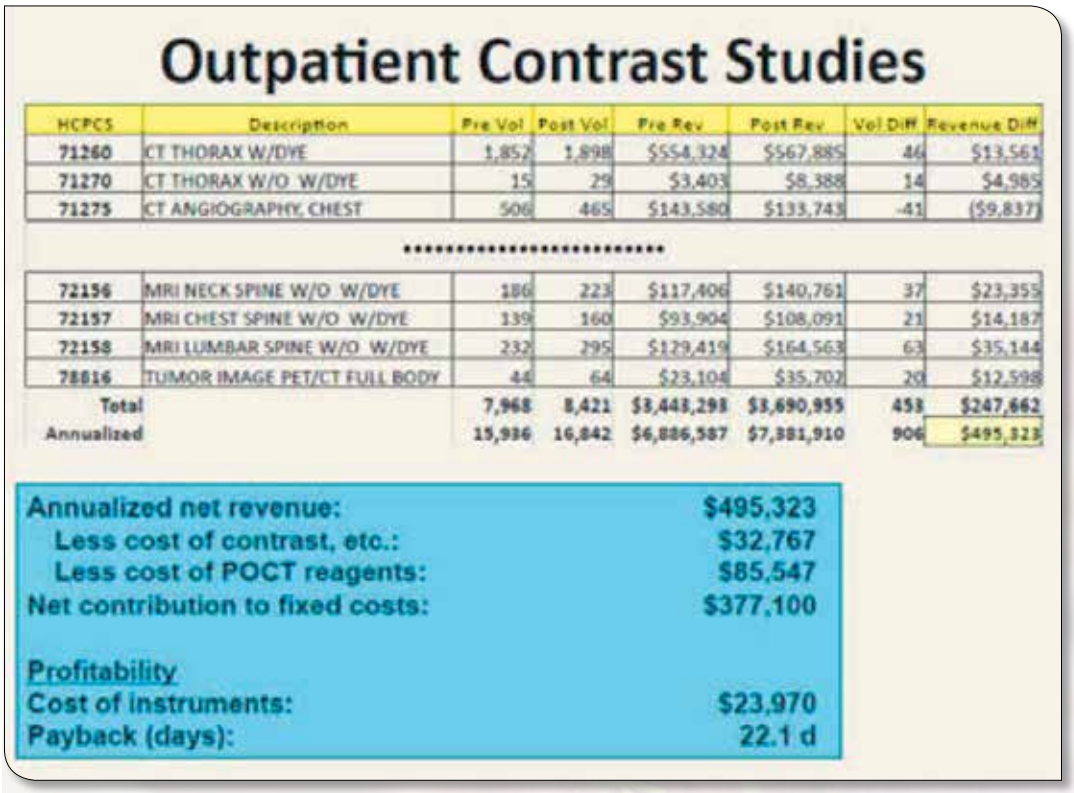
A secondary project stemmed from this initial utilization study. The lab continued this process looking at utilization patterns for vitamin D, pancreatic, and liver function tests compared with evidence-based recommendations and found similar results (annual variable material costs exceeding $100,000). "That's one of the greatest side benefits about MA. You don't know what's going to come out of it and what other discoveries it can lead to—it's a question generator," says Dr. Novicki.

MA Beyond the Lab

These initial projects were targeted at lab utilization. But what about the bigger picture? MA can be used organization-wide to guide business decisions and uncover opportunities for costs savings.

Dr. Brimhall shared a successful MA project that he and his colleagues at the University of Mississippi Medical Center implemented involving lab and imaging collaboration. Patients receiving contrast for an imaging procedure need a creatinine to ensure adequate kidney function. In this project, the imaging department was experiencing delays getting creatinine results for pre-contrast imaging. The lab was not located in the same building as the imaging department, causing delays; patients were walking out without getting their imaging study. Not only was this a patient satisfaction problem, but also a safety concern because patients were not getting the treatments they needed in a timely manner. Also, radiology resources were not being efficiently utilized.

To address this problem, point-of-care testing (POCT) creatinine was implemented in the radiology department, bringing the "gold" that Dr. Novicki referred to—improvements not only in savings, but also in lab efficiency, ability to care for more patients, and increased patient and radiologist satisfaction. Because of the ability to perform more imaging studies (patients were not leaving disgruntled), the annualized net contribution to fixed costs (after you remove the costs of the added contrast and POCT reagents) was $377,100, and the POCT devices were paid for in only three weeks (see Figure 4)!



Outpatient Contrast Studies

HCPCS	Description	Pre Vol	Post Vol	Pre Rev	Post Rev	Vol Diff	Revenue Diff
71260	CT THORAX W/DYE	1,852	1,898	$554,328	$567,885	46	$13,561
71270	CT THORAX W/O W/DYE	15	29	$3,403	$8,388	14	$4,985
71275	CT ANGIOGRAPHY, CHEST	506	465	$143,580	$133,743	-41	($9,837)
72156	MRI NECK SPINE W/O W/DYE	186	223	$117,406	$140,761	37	$23,355
72157	MRI CHEST SPINE W/O W/DYE	139	160	$93,904	$108,091	21	$14,187
72158	MRI LUMBAR SPINE W/O W/DYE	232	295	$129,419	$164,563	63	$35,144
78816	TUMOR IMAGE PET/CT FULL BODY	44	64	$23,104	$35,702	20	$12,598
Total		7,968	8,421	$3,448,293	$3,690,955	453	$247,662
Annualized		15,936	16,842	$6,886,587	$7,381,910	906	$495,323

Annualized net revenue:	$495,323
Less cost of contrast, etc.:	$32,767
Less cost of POCT reagents:	$85,547
Net contribution to fixed costs:	$377,100
Profitability	
Cost of instruments:	$23,970
Payback (days):	22.1 d

Figure 4: A collaborative lab-radiology MA project resulted in increased revenue and greater patient satisfaction.

Why Should You be Interested in Medical Analytics?

If you work in healthcare, medical analytics should interest you. FFS payment models are being replaced by value-based bundled and capitated payments, and healthcare systems need to rapidly adapt to this new environment to stay viable. If your organization does not act on this and it is forced on you, you may not be able to adapt fast enough. HCOs and laboratories need to proactively think about these changes and formulate a plan.

MA offers a powerful way to help with this transition by leveraging all your institutional data to improve outcomes and inform spending decisions. Laboratories have large amounts of data available; MA is a great tool to address the changes taking place in healthcare and help find the "gold" in that data.

The laboratory sits on the hub of clinical data that feeds diagnostics decision making. The changes taking place in the healthcare system offer great opportunities for the lab, as the lab holds the bulk of the diagnostic information that will change how we deliver and pay for care. We want to encourage laboratorians and other healthcare leaders to become active participants in the way lab information is used. The goal is to empower laboratory leaders to see the value of the information they are processing and to believe in it—to learn to articulate value in a positive and powerful way and to move from departmental thinking to system-wide thinking. This requires thinking about the future, not just how things have been done to be successful in the past, and learning to find new analytic opportunities to share within your organization.

Why should I use MA to reduce my test volume (and revenue) when FFS is still here?

- It ensures the most appropriate testing for the patient.
- Test utilization committees are demanding it.
- Payers are denying "unnecessary" claims.
- Bundled payments have begun.
- Outcomes data objectively demonstrates lab value, justifies lab expenditures, and solidifies the lab's position on the healthcare team.

MA Increases Lab Value

If you think of the lab as a tool instead of as its own entity, and think of the lab's value to the overall healthcare system, what the lab brings to the table is tremendously powerful in regards to patient risk stratification and population health management. The information from the lab, combined with other clinical and financial data sets, is worth much more than the value of the tests themselves. As we move toward population health and bundled payments, it will be essential for labs to be involved in helping clinicians direct patient care.

About Marshfield Clinic Health System, Inc.

Marshfield Clinic Health System, Inc. (MCHS), formed in 1916, is a large rural integrated healthcare network centered in Marshfield, Wisconsin, with more than 50 other locations. The HCO is affiliated with several hospitals, and includes an outpatient care research facility, its own regional health insurance payer, and the subsidiary Marshfield Clinic Information

Systems, Inc. The organization employs 6,800 people, with more than 700 physicians in 86 medical specialties. Marshfield Labs is a subsidiary of MCHS and provides clinical and anatomic pathology services for hospitals, outpatient sites, and veterinary clients nationwide.

Dr. Thomas Novicki's Biography

Dr. Novicki, a native of the Chicago metro area, has had a long interest in microbiology and mycology. He is a board-certified medical technologist, having practiced in the areas of chemistry and microbiology. He has a BS in biology and a PhD in molecular microbiology from Loyola University of Chicago. Following graduation from Loyola, Dr. Novicki completed a post-doctoral fellowship in medical and public health microbiology at the University of Utah in Salt Lake City, Utah. He is certified in medical and public health microbiology by the American Board of Medical Microbiology.

Dr. Novicki practiced doctoral medical microbiology at the Fred Hutchinson Cancer Research Center and the University of Washington Medical Center in Seattle, Washington, before joining Marshfield Clinic in 2003, where he currently serves as its PhD clinical microbiologist. Dr. Novicki is now an OSMA-certified MA champion.

Acknowledgements

A special thank you to Dr. Thomas Novicki for sharing his journey and allowing this white paper to be published.

Additional thank yous are sincerely expressed to Kevin Jordan and Dave Hebert with Marshfield Clinic Information Systems; to Dr. Thomas Fritsche, MD, PhD, Pam Carter, MT(ASCP), and Barb Wirkus with Marshfield Labs; and to Dr. Brad Brimhall, MD, MPH, Matt Modleski, and Ryan Howard from Orchard Analytics. Without this collaborative team, these pilot projects would not have taken place.

Dr. Bradley Brimhall's Biography


Dr. Brad Brimhall, MD, MPH

Dr. Brimhall developed the Orchard School of Medical Analytics' curriculum and led the class. About MA, Dr. Brimhall stresses, "Everybody starts somewhere. I've made just about every mistake you can make. That's how we learn."

Dr. Brimhall is currently Clinical Professor of Pathology, Staff Pathologist, and Medical Director of Integrated Healthcare Analytics and Bioinformatics, Department of Pathology, at the University of Texas Health Science Center in San Antonio.

He was formerly Professor of Pathology, Medical Director of Clinical Laboratories, and Enterprise Data Warehouse/Integrated Analytics Senior Consultant at the University of Mississippi Health Care System in Jackson, Mississippi. Prior to his work in Mississippi, Brimhall was Chief Medical Officer at TriCore Reference Laboratories in Albuquerque, New Mexico. While there, he also served as Interim Chief Executive Officer and Interim Chief Operating

Officer and worked with his colleagues and outside vendors to develop its enterprise data warehouse. Before his work at TriCore, Dr. Brimhall was an Associate Director of Laboratories and Medical Director of the Laboratory IT group at the University of Colorado Hospital. With the IT group, he designed and built a SQL-server laboratory data repository integrating both laboratory and administrative data. At the University of Colorado, he and a colleague developed and taught the first evidence-based medicine course at the university, which they continued teaching for eight years.

Dr. Brimhall received his medical degree from Stanford University School of Medicine in Palo Alto, California. During that time, he was awarded a Howard Hughes Medical Student Research Fellowship for molecular and regulatory biology research. After medical school, he trained as a resident in Anatomic and Clinical Pathology at Brigham and Women's Hospital and Harvard Medical School in Boston, Massachusetts, where he also completed specialized training in blood banking/transfusion medicine. While in Boston, Dr. Brimhall completed a Master of Public Health degree (MPH) in Healthcare Policy and Management at the Harvard School of Public Health. His master's thesis work was carried out with the executive team at HealthShare Technology, Inc., in Acton, Massachusetts, an early healthcare database firm (sold to WebMD in 2005). For his thesis, he designed and validated analytical methods to compare laboratory costs and selected patient outcomes between hospitals adjusted for case mix and severity of disease. In 2006, Dr. Brimhall was awarded a postgraduate certificate in bioinformatics representing work done at the University of British Columbia in Vancouver, British Columbia, and the Canadian Genetic Diseases Network. Dr. Brimhall is board-certified in Anatomic and Clinical Pathology and Clinical Informatics.

Dr. Brimhall's primary interest is integrated medical analytics. This work leverages data warehousing, big data, and statistics to merge clinical diagnostic data from pathology and laboratory medicine and other clinical areas (as well as more detailed operational and financial data) to make the most cost-effective use of diagnostic information. He has worked with friends and colleagues in finance, IT, and research to plan and develop a large-scale enterprise data warehouse. He has used analytics to work on predictive models for non-medical areas (e.g., financial markets), and would like to apply similar techniques to work with other disciplines to develop and launch predictive models that optimize medical care.

About the Author

Kim Futrell, BS, MT(ASCP), with more than 20 years of laboratory management experience, is the Products Marketing Manager at Orchard Software. In her role, she is an advocate for laboratory, lab informatics, and all of Orchard's products. Kim works with product development, marketing, and sales to research and publish relevant material to arm Orchard employees, clients, and the industry with knowledge through communication and education. Kim also assists with Orchard Analytics, a business unit of Orchard focused on helping healthcare organizations use analytics (including lab data) to improve patient care and reduce healthcare spending.

Prior to joining Orchard in 2012, Kim's role was Operations Manager of a multi-specialty physician's office in North Carolina. Kim is currently pursuing a Master of Science in Health Informatics at the University of Illinois at Chicago.

About Orchard Software & the Orchard School of Medical Analytics

Orchard Software, headquartered in Carmel, Indiana, and founded in 1993, is a leader in the laboratory information systems industry. Orchard offers a variety of lab system solutions to handle each laboratory's unique testing, workflow, and business situation. In 2013, Orchard celebrated its 20th anniversary, and currently serves more than 1,500 laboratories across the country, helping them to improve efficiency, reduce errors, and enhance integration.

Over the last two years, Orchard offered the Orchard School of Medical Analytics to help our clients gain a greater understanding of the value of laboratory data and advanced medical analytics projects. For more information on Orchard or feedback regarding this white paper, email **news@orchardsoft.com** or call **(800) 856-1948**.

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