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Predictive Modeling NEWS

Journal Scan

AJMC Managed Markets Network

Hopkins Research Finds Analytic Value in Lab Test Results

"The addition of laboratory risk markers can significantly improve the identification of high-risk patients using models that include age, gender and a limited number of morbidities; however, models that use comprehensive risk measures may be only marginally improved."

Jonathan Weiner DrPH, professor of Health Policy & Management and of Health Informatics and director of the ACG R&D Team at the Johns Hopkins University Bloomberg School of Public Health, Baltimore, and a *Predictive Modeling News* Editorial Advisory Board member, reports that the team at The Johns Hopkins Center for Population Health IT has just published research – in the *American Journal of Managed Care* -- on the impact of lab tests on predictive modeling. The takeaway points, the article notes, are these:

- Frequently ordered lab tests in outpatient practices "contain valuable data for individual risk assessment."
- Ranges of blood chemistries and hematology results "define a set of model markers that have clinical face validity and potential utility for care management."
- Adding lab-based markers to risk levels from claims, prescriptions and enrollment data "improves the prediction of individual cost and inpatient admission and the prospective identification of high-cost patients."

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In This Issue

Actuaries: Healthcare Companies Have High Hopes for Predictive Analytics

"58% of healthcare executives anticipate dedicating 15% or more of their budgets to predictive analytics in 2018, a five-point increase from 2017. The increase spans both payer and provider organizations."

Each year, the Society of Actuaries surveys payer and provider executives for insights into future predictive analytics trends in the healthcare industry, the organization reports. This year's survey found a majority of users expecting predictive analytics to save their organizations more than 15% over the next five years -- but with significantly more provider executives, 75%, doing so than payers, 44% -- and a huge majority touting analytics' importance to the future of their businesses. The survey also turned up a slight majority saying cost reduction is analytics' most important outcome and giant majorities reporting use – or planned use in the near term. Here are details from *2018 Predictive Analytics in Healthcare Trends*:

- 16% of organizations that currently use predictive analytics don't expect to increase the PA budget at all over the next five years; 13% won't up it more than 5%; and 14% plan to increase PA spending by 10%. 22% see a 15% rise; 19% see a 20% jump; and 17% expect to spend at least 25% more. That means 58% expect to spend at least 15% more and 43% plan on a 0% to 15% increase. 15% don't know what they'll spend.
- Interestingly, the survey this year found "a notable seven-point year-over-year decline in the overall number of executives currently using predictive analytics, driven primarily by payers," the report says. "However, 26% of payers anticipate using predictive analytics in the next year, a 10-point increase from last year, which indicates the potential for future growth."

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Journal Scan...*continued*

- "A simple model that includes demographics and lab information" may provide a basic tool to evaluate patient panels.

The article, "Assessing Markers From Ambulatory Laboratory Tests for Predicting High-Risk Patients," is available online at www.ajmc.com/journals/issue/2018/2018-vol24-n6/assessing-markers-from-ambulatory-laboratory-tests-for-predicting-highrisk-patients. Here are additional excerpts:

- An observational study of a patient cohort at an integrated health system – all of whom had at least one ambulatory visit during the first year -- over two years was analyzed to "develop risk markers from frequently ordered outpatient laboratory tests."
- Researchers then added those markers to demographic and Charlson Comorbidity Index models – as well as three models from the Johns Hopkins Adjusted Clinical Groups system -- to predict individual cost, inpatient admission and high-cost patients.
- Then they evaluated "the predictive and discriminatory performance" of the five lab-enhanced models.
- Adding lab markers improved R^2 predictions of costs by up to 3.7%, high-cost patient ID by up to 121% and inpatient admits by as much as 188%.
- The markers added to comprehensive risk models "resulted in smaller improvements in predictive power."

"Although claims remain an important source of risk data," the article explains, "the widespread implementation of EHRs and other clinical information technology systems offers a new source of data on disease severity and health status, as most EHRs contain information not captured in claims, such as laboratory values, vital signs and clinical assessments." Lab tests "can be powerful predictors among certain patient populations," it adds, so researchers set out to "transform them into risk measures that could be useful when added to population-level predictive models." Interestingly, the researchers add, "some tests that are commonly used to stage disease or guide treatment were not predictive of prospective cost in our analysis."

The bottom line: "Organizations that apply strategies for high-risk case finding may want to consider adding laboratory-based risk markers to their models," the article notes. "Those data may prove useful for a range of applications in the population health surveillance and care management domains."

Predictive Modeling News talked to three of the paper's authors at CPHIT -- Klaus Lemke PhD, biostatistician; Kimberly Gudzune MD MPH, assistant professor of medicine; and Weiner --- about adequate data and the impact of "missing" tests.

Predictive Modeling News: *Which type of model is more common now, models that "include age, gender and a limited number of morbidities" or models that "use comprehensive risk measures"? Do the comprehensive types of models benefit enough from adding lab data to make the integration requirements cost-effective?*

Klaus Lemke PhD, Kimberly Gudzune MD MPH & Jonathan Weiner DrPH: For established populations, where retrospective analyses are done using full claims or interoperable EHRs, the standard is comprehensive models using comprehensive risk adjusters like HCCs or ACGs. But for some standalone organizations -- like ACOs or PBMs or doctor groups -- or for health plans in some situations, such as when a patient is new to the system, their context is analogous to the more limited data availability model we included in our analysis. When calculating the ROI of including lab results data into a predictive modeling program, one needs to consider how easy it is to get these data and what else you might do with them if they are categorized in a cogent risk stratification system -- as we did. For example, even if an organization is using advanced ICD PM models, and if lab data are easily accessible, then a lab stratification system such as ours would help to add cogent information for a care manger. In such a situation, then, for sure it will be worth adding lab information as we did for reasons beyond just the modest bump in a model's predictive power.

PMN: *Could physicians change their lab ordering habits to produce more useful data for future analytics? Do they provide all the information possible with each order?*

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Journal Scan...continued

KL, KG & JW: In our analysis, only 49% of individuals in our general enrolled population had results for at least one of the 23 common lab tests we examined during the study period. This lack of laboratory data for many patients may impact lab-oriented predictive modeling.

While encouraging physicians to order these tests would improve data completeness, prompting them to order tests that may not be clinically warranted could also lead to increased costs with limited benefits for the population overall. Along these lines, we are currently exploring how "missing" lab tests -- when they are, in fact, clinically indicated -- may play a role in predictive modeling and care management decisions.

Of course, the impact of clinicians ordering labs appropriately (and, for that matter, ordering drugs or assigning diagnoses) goes well beyond implications for improved predictive modeling or risk adjustment. But, yes, if lab-based analytics became more commonplace, lab ordering and the subsequent results might get more scrutiny and might factor even more strongly into care management decisions than they do today.

Furthermore, lab classification frameworks like the one we developed will help clinicians and others cut through their information overload situation related to routine lab results data, just as other aspects of our ACG System help cut through the "noise" associated with the multiple diagnoses and medications that can have billions of unique combinations for each patient.

PMN: *Does "a simple model that includes demographics and laboratory information" exist? Could it become a standard part of patient onboarding?*

KL, KG & JW: Yes, exactly. For new enrollees or in organizations where comprehensive electronic data are not yet available, the first round of lab tests will provide one more piece of information to help assess the risk and needs of the patient.

PMN: *What should readers do first, based on your findings? What operational change will be most important in implementing analytics models that incorporate EHR-derived lab data?*

KL, KG & JW: We have a few thoughts on this. First, within an organization, a model upgrade using previously untapped data sources should involve multiple parties, including the end users, the analytic team that will embed the model into workflows and data administrators. On the technical side, a fundamental requirement for making lab data useful for analytics is the need for standardization.

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Hopkins Researchers' Prediction Work Widely Published

Research by teams at the Johns Hopkins Bloomberg School of Public Health has been published in more than just the *American Journal of Managed Care* lately. Their work has also appeared in *Annals of Internal Medicine*, *JAMA Network Open, Cancer Causes & Control* and *Toxicological Sciences*. Here's a look:

- Diagnosing type 2 diabetes may require a single blood sample, says a study published in *Annals of Internal Medicine*. Researchers "found evidence that a positive result for two standard diabetes markers in a single blood sample is a highly accurate predictor of diabetes and of major diabetes complications such as kidney disease and heart disease," a statement says. Clinical guidelines recommend dysfunction confirmation with another blood test; the research could thus "allow major simplification," according to the researchers, who note that physicians already often order tests for glucose and HbA1c from a single sample, but that guidelines "don't clearly let you use the tests to make the initial diabetes diagnosis." Some people with positive results on only one test are diagnosed with diabetes, so a repeat test may still be appropriate, the statement adds, but "the study findings could lead to changes to make it possible for diabetes to be diagnosed more quickly based on the two positive results in one blood sample."
- Insurers "haven't done enough to combat the opioid epidemic," says a statement reporting on a study in the journal *JAMA Network Open* that looked at 2017 coverage policies for drugs to treat chronic lower-back pain and concluded that "those policies missed important opportunities to steer patients towards safer and more effective treatments than prescription opioids." Both public and private insurers are guilty, at least unwittingly, the statement adds; the study, it says, "provides one of the most comprehensive looks ever at insurers' pain coverage policies." The researchers analyzed plan details and conducted in-depth interviews with executives, focusing on 62 prescription drugs, including 30 opioids and 32 others, such as non-steroidal anti-inflammatory drugs, muscle relaxants and topical analgesics. They determined that "many insurers failed to apply evidence-based utilization management rules to discourage opioid overuse" and that "many of the utilization management rules in place were applied as often to non-opioids as to opioids" – but they acknowledge that "every health plan was actively trying to combat the epidemic." Their focus was generally on utilization management and identifying high-volume prescribers and patients, though, instead of "comprehensive strategies to improve the treatment of chronic pain."
- Breast cancer risk and treatment outcomes studies don't take sufficient account of ethnicity, economic status, education level, health insurance status and other social factors, according to commentary in *Cancer Causes & Control* that "points to evidence that social factors help determine people's vulnerability to cancer and argues that those factors should be considered routinely in studies and risk assessments that bear on clinical care." A statement adds that "it should be obvious that neglecting social factors can mask important drivers of bad outcomes." Breast cancers are "the principal research focus" for the team, it says, because "standard risk assessment tools haven't always taken race into account, even though there are significant racial disparities in the risks and mortality rates for certain types." Clinical trials and population studies "should be powerful tools for uncovering links between social factors and cancer vulnerability," the statement notes, "which in turn should lead to better risk reduction and treatment strategies."
- Advanced algorithms using large chemical databases "can predict a new chemical's toxicity better than standard animal tests," suggests a study in *Toxicological Sciences*. Hopkins researchers "mined such a database to map the relationships between chemical structures and toxic properties," a statement says, "then used the map to automatically predict the toxic properties of chemical compounds more accurately than animal tests would." A process called read-across, in which researchers predict a compound's toxicity based on the properties of chemicals with similar structures, is the most common alternative to animal testing and is much less expensive. But it requires "expert evaluation and subjective analysis," the statement adds. "As a first step towards optimizing read-across, the researchers assembled the database that gave them the information they needed to develop a benchmark for the new approach." The statement emphasizes: "It's big news for toxicology."

Visit www.jhu.edu.

Journal Scan...continued

Most clinical labs send their results electronically directly from their lab assay computer systems to the provider. And data from multiple labs will need to be collated on an interoperable basis within the patient's EHR. Like other EHR data, lab data in its raw form may or may not be standardized. The so called "LOINC" coding system is a leading standard for lab data exchange, but its use within EHR systems is not completely universal. We are pegging our future ACG development work re: labs to the LOINC standard.

Ranges of Laboratory Values Associated With Low and High Annual Healthcare Cost

Test	Units	Low Risk		High Risk		Patients With Test
		Range (% of patients)	Mean Cost[a]	Range (% of patients)	Mean Cost[a]	
Basic Metabolic Panel						
Sodium	mmol/L	≥136.5 (95)	$10,249	<136.5 (5)	$16,801	25,142
Chloride	mmol/L	≥98.5 (95)	$10,586	<98.5 (5)	$18,199	21,885
CO_2	mmol/L	23.25-35.5 (94)	$10,627	<23.25 or ≥35.5 (6)	$17,175	21,797
Glucose	mg/dL	<113.5 (89)	$16,935	≥113.5 (11)	$14,494	38,955
Calcium	mg/dL	≥8.85 (88)	$27,869	<8.85 (12)	$18,531	18,674
Liver Function Tests						
TP	g/dL	≥6.55 (89)	$13,486	<6.55 (11)	$27,848	6903
Albumin	g/dL	≥3.95 (79)	$12,752	<3.95 (21)	$24,243	7807
Complete Blood Count						
Hgb	g/dL	≥9.95 (98)	$8740	<9.95 (2)	$26,280	39,786
Hct	%	≥30.85 (99)	$9203	<30.85 (1)	$32,695	34,515
Platelets	1000/mcL	≥136.5 (98)	$9229	<136.5 (2)	$21,475	34,610
Lipid Panel						
TC	mg/dL	≥129.5 (95)	$7051	<129.5 (5)	$12,656	37,178
LDL-C	mg/dL	≥75.5 (86)	$6955	<75.5 (14)	$11,898	36,060

CO_2 indicates bicarbonate; Hct, hematocrit; Hgb, hemoglobin; LDL-C, low-density lipoprotein cholesterol; TC, total cholesterol; TP, total protein.
[a]Costs were calculated from claims incurred during the calendar year after the laboratory test was performed.

Comparison of Model Performance With and Without Enhancement With Laboratory-Based Risk Markers: Predicting Future Total Healthcare Costs and Prospectively Identifying Inpatient Utilization and Top 5% Cost Claimants

Model	Total Costs	Inpatient Identification			Top-Cost Claimant Identification		
	R^2, % (95% CI)	Sensitivity, % (95% CI) Specificity, % (95% CI)	AUC (95% CI)	IDI, % (95% CI)	Sensitivity, % (95% CI) Specificity, % (95% CI)	AUC (95% CI)	IDI, % (95% CI)
Demographic	2.2 (1.9-2.6)	6.52 (6.30-6.82) 97.88 (97.85-97.92)	0.661 (0.657-0.666)	-	8.22 (8.03-8.55) 96.92 (96.88-96.97)	0.659 (0.655-0.662)	-
Lab-enhanced demographic	5.9 (5.1-7.1)	20.71 (20.29-21.37) 95.82 (95.65-95.87)	0.713 (0.710-0.715)	121.1 (114.2-124.9)	19.86 (19.58-20.16) 95.78 (95.77-95.79)	0.722 (0.718-0.725)	187.7 (177.8-195.5)
Charlson[b]	10.3 (8.8-12.3)	16.56 (16.25-16.98) 95.62 (95.57-95.68)	0.704 (0.700-0.708)	-	25.82 (25.35-26.14) 96.10 (96.02-96.17)	0.732 (0.729-0.735)	-
Lab-enhanced Charlson[b]	11.4 (9.9-13.9)	22.67 (22.14-23.59) 95.90 (95.68-96.00)	0.729 (0.726-0.731)	40.4 (37.9-43.4)	26.53 (25.97-27.15) 96.13 (96.10-96.17)	0.755 (0.751-0.757)	14.2 (13.0-15.1)
ADG[c]	13.4 (12.6-14.2)	31.00 (30.39-31.68) 96.39 (96.35-96.43)	0.789 (0.786-0.791)	-	29.19 (28.66-29.60) 96.27 (96.25-96.30)	0.817 (0.815-0.819)	-
Lab-enhanced ADG[c]	14.0 (13.1-15.0)	31.98 (31.47-32.52) 96.44 (96.40-96.48)	0.789 (0.787-0.792)	8.4 (7.4-8.9)	30.29 (29.92-30.63) 96.33 (96.31-96.35)	0.820 (0.817-0.822)	4.8 (4.1-5.2)
ACG-Dx[d]	22.1 (20.6-24.2)	35.34 (34.96-35.91) 96.62 (96.58-96.65)	0.797 (0.794-0.800)	-	36.41 (35.98-36.82) 96.65 (96.63-96.68)	0.834 (0.831-0.836)	-
Lab-enhanced ACG-Dx[d]	22.2 (20.7-24.4)	35.68 (35.25-36.65) 96.64 (96.61-96.67)	0.798 (0.796-0.801)	3.7 (3.3-4.0)	36.62 (36.06-36.99) 96.66 (96.64-96.68)	0.835 (0.833-0.837)	1.5 (1.3-1.7)
ACG-DxRx[e]	24.6 (23.0-26.4)	35.68 (35.33-36.40) 96.64 (96.61-96.68)	0.797 (0.794-0.801)	-	38.88 (38.11-39.49) 96.78 (96.74-96.82)	0.846 (0.844-0.848)	-
Lab-enhanced ACG-DxRx[e]	24.7 (23.1-26.5)	35.85 (35.42-36.25) 96.65 (96.61-96.68)	0.799 (0.796-0.802)	3.4 (3.2-3.8)	39.09 (38.69-39.72) 96.79 (96.77-96.83)	0.847 (0.845-0.849)	1.0 (0.8-1.2)

ACG indicates Adjusted Clinical Group; ADG, Aggregated Diagnosis Group; AUC, area under the receiver operating characteristic curve; DS, discrimination slope; EDC, expanded diagnosis cluster; IDI, integrated discrimination improvement; IP, integrated 1-specificity; IS, integrated sensitivity.
[a]All models included age and gender and are fitted to the health system's data. Costs were truncated at $250,000 (ie, the 99.9th percentile of annual claimant costs). The number of patients who had all-cause acute care inpatient hospitalizations was 6129 (5.1%). We used custom regression weights to generate individual risk scores. Lab-enhanced versions included laboratory-based risk markers from Table 2. We used the following method to calculate IDI: (1) calculate IS, which is the mean predicted probability in the group of patients with hospitalization; (2) calculate IP, which is the mean predicted probability in the group of patients without hospitalization; and (3) calculate DS as IS − IP for lab-enhanced models and corresponding base models, and (4) calculate IDI as ($DS_{\text{(+laboratory markers)}}$ − DS) / DS.
[b]Charlson models contained 17 Charlson Comorbidity Index morbidity categories.
[c]ADG models contained 32 ADGs from the ACG system.
[d]ACG-Dx models from the ACG system included ACGs and EDCs.
[e]ACG-DxRx models from the ACG system included ACGs, EDCs, and Rx-Defined Morbidity Groups (Rx-MGs).

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PMN: *Any other comments?*

KL, KG & JW: The US healthcare system is moving towards an era in which many new sources of data beyond claims will be available for predictive modeling and other analytics. Perhaps the most important new source is the EHR and other new clinical streams of data. Arguably, the lab results are one of the two or three most prevalent new sources of structured clinical data that we all need to figure out how to use beyond one-patient-at-a-time clinical care.

The researchers add: "The article is available online at https://www.ajmc.com/journals/issue/2018/2018-vol24-n6/assessing-markers-from-ambulatory-laboratory-tests-for-predicting-highrisk-patients. We at the Johns Hopkins Center for Population Health IT (www.jhsph.edu/cphit) are the home of the JHU ACG System's R&D (https://www.hopkinsacg.org/). We are pleased that we have an active portfolio to develop state-of-the-art tools to 'ingest' many new types of data for analytics in support of improved population health. The next release of the ACG System (12.0) will include new approaches for using lab results across large populations to offer new classifiers for care managers and analysts that otherwise would not be feasible with just the raw lab data. Thank you for your interest. We invite readers to contact us if they have any further questions at lemke1@jhu.edu."

== *Am J Manag Care*. 2018;24(6):e190-e195

Science

Study Debunks 'Notion That Large Chunks of Medicare Go to Futile End-of-Life Care'

The 25% of Medicare spending that occurs in the last year of people's lives is sometimes called "a questionable use of resources," says a statement from the Massachusetts Institute of Technology, but a new study co-authored by an MIT healthcare economist offers a rebuttal. "After examining millions of medical records," the statement reports, "the study found that although Medicare spending is concentrated among people who die, there is very little Medicare spending on patients whose death within the year is highly likely." Less than 5% is applied to the single-highest-risk percentile, it adds, "and their predicted one-year mortality rate is still just 46%."

The study, reports Amy Finkelstein, a professor in MIT's Department of Economics and co-author of a paper in *Science*, also "illuminates the general circumstances of late-in-life mortality;" she notes that fewer than 10% of people who die in a given year have a predicted one-year mortality rate over 50% -- and that even of admissions that occur in the last year of life, fewer than 4% have a predicted one-year mortality rate of 80% or higher at the time. "The apparent concentration of spending on last-year-in-life patients is a byproduct of the fact that even relatively low-mortality health scenarios for the elderly will include a certain number of deaths," the statement says, "not the fact that the individual treatment decisions represent longshot cases."

The research team examined spending on survivors for all of 2008 and for the year prior to death for the rest; their analysis produced mortality predictions as of January 1, 2008, "using data on demographics, healthcare use and more." As the paper authors note: "Death is highly unpredictable." For example, 44% of the top percentile of high-risk Medicare enrollees, the group with the 46% mortality prediction, survived for at least a year, while the predicted one-year mortality rate at the 95th percentile of people in the study is just 25%. "We don't know in advance who's going to die this year, and some of the people we spend money on survive," the researchers note. "Let's not get distracted by misleading statistics." Visit mit.edu.

== "Predictive modeling of US healthcare spending in late life." *Science* 29 Jun 2018: Vol. 360, Issue 6396, pp. 1462-1465 DOI: 10.1126/science.aar5045

PLOS ONE

Nursing Notes 'Help Indicate Whether ICU Patients Will Survive'

Researchers at the University of Waterloo have found that "sentiments in the nursing notes of healthcare providers are good indicators" of mortality, according to a statement. "Hospitals typically use severity-of-illness scores to predict the 30-day survival of intensive care unit patients," it says. "Those scores include lab results, vital signs and physiological and demographic characteristics gathered within 24 hours of admission." That information, researchers note, "is really good at predicting 30-day mortality. It turns out that there is some added predictive value to including nursing notes as opposed to excluding them."

The researchers tapped a large publicly available ICU database; "after some inclusion and exclusion criteria were considered, the dataset included details about 27,000 patients and nursing notes," the statement says. They applied an open source sentiment analysis algorithm to extract adjectives in the text "to establish whether it is a positive, neutral or negative statement, then fit a multiple logistic regression model to the data "to show a relationship between the measured sentiment and 30-day mortality while controlling for gender, type of ICU and simplified acute physiology score." The sentiment analysis "provided a noticeable improvement;" indeed, the statement says, "mortality is not the only outcome that nursing notes could potentially predict. They might also be used to predict readmission or recovery from infection while in the ICU."

Here are excerpts:

- Nursing notes "have not been widely used in prediction models for clinical outcomes," but advances in natural language processing "have made it possible to extract information from large-scale unstructured data like nursing notes."

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- Survival is "positively correlated to mean sentiment polarity quartiles," but that relationship is "much more limited in the case of mean sentiment subjectivity quartiles."
- Clinical notes authored by hospital staff are "informative and can serve as indicators of clinical outcomes."
- Clinicians' sentiment includes "their emotions and attitudes toward patients" as well as "their intuition and experience."
- The most important next step is to "translate the knowledge gained into a practical solution to help clinicians make better decisions in the ICU."
- Possible future steps include "automated predictive models that identify high-risk patients so that resources can be diverted to prevent adverse outcomes and incorporating measured sentiment as a routinely monitored variable to serve as an indicator of health conditions for ICU patients."
- It would be "invaluable to further studies of sentiment analysis" if nurses assigned notes a Negative, Positive or Neutral score, "effectively producing a labeled corpus of nursing notes."

Excerpt Text with De-identified Patient Information	Sentiment Polarity	Sentiment Subjectivity
"Pt is alert and oriented, **pleasant**$^{(0.733,\ 0.967)}$, worried about being in the ICU but is comforted by her family. CV: Her SBP has been 70s-90s,per a note from the [**Hospital1 **] she often runs lower that the 90s for a sytolic and her BP on that office visit was in the 70s. Her HR has been 80s-90s, she is mentating well."	0.7333	0.9667
"Extremities mottled. Family **aware**$^{(0.25,\ 0.25)}$ of **grim**$^{(-1.0,\ 1.0)}$ condition-they requested he receive comfort measures **only**$^{(0.0,\ 1.0)}$. MSO4 drip begun and pressors off. Family at bedside."	-0.25	0.75
"Reason for admission: Mr. [**Known lastname 10770**] is a 25 year **old**$^{(0.1,\ 0.2)}$ man admitted to [**Hospital1 1**] on [**2126-2-1**] with 7 gun shot wounds to his torso, R elbow and R wrist. Injuries include: duodenal injury, renal vein laceration, R elbow fx, R wrist fx"	0.1	0.2
https://doi.org/10.1371/journal.pone.0198687.t001		

The bottom line? "Quantitative measures of unstructured clinical notes, such as sentiment of clinicians, can serve as a predictor of patient outcomes in the ICU," the researchers comment, "so further research is warranted to study and make use of the wealth of data that clinical notes have to offer." Visit https://uwaterloo.ca.

== Waudby-Smith IER, Tran N, Dubin JA, Lee J (2018) "Sentiment in nursing notes as an indicator of out-of-hospital mortality in intensive care patients." *PLoS ONE* 13(6): e0198687. https://doi.org/10.1371/journal.pone.0198687

Accolades

HVH PRECISION ANALYTICS

HVH Precision Analytics Named 'Analytics Solution Provider Company of the Year'

Havas Health & You reports that HVH Precision Analytics, which provides advanced analytics and services utilizing real-world data to achieve actionable insights, has been named Company of the Year on *Pharma Tech Outlook*'s list of Top 10 Analytics Solution Providers in the pharmacy and life science field. "The honor was determined by a panel of CEOs, CIOs, VCs and analysts," a statement from HVJ says, "along with *Pharma Tech Outlook*'s editorial board." HVH was built from Perspecta Inc. and Havas Health & You in 2016; the firm works to "shorten the time to diagnosis through the use of a proven and validated methodology to find diagnosed patients, prospective therapy candidates, undiagnosed patients and ideal candidates for clinical trials."

Its cross-functional team of analysts and medical professionals "blend a machine learning approach with analytics and medical expertise to create optimal outcomes for our customers," the statement adds; the company's proprietary artificial intelligence/machine learning and predictive analytics platform and methodology was developed more than 30 years ago, it says, and "is now being used to solve complex problems for US intelligence community agencies and sophisticated global healthcare clients." It's data-agnostic, analyzing "vast amounts of disparate types of real-world data, including claims, EHR, laboratory, -omics, imagery and consumer data." Visit www.hvhprecision.com, www.havashealthandyou.com and www.perspecta.com.

Accolades...continued

SCIO Health Analytics Reports Cites From Veeva, *Healthcare Informatics*

SCIO Health Analytics reports it's certified on Veeva CRM MyInsights, successfully achieving criteria that include "completing a technical demonstration and having a number of SCIO associates pass a business-focused exam." SCIO "provides a unique value-add to users of MyInsights," the company adds in a statement. "By combining the user's CRM and other commercial data with SCIO's predictive and prescriptive advanced analytics insights, we can provide a client's sales and commercial teams with unique insights" – helping customers visualize data at the point of planning and decision making to drive better field execution. SCIO says it has developed a number of value-add offerings accessible via Veeva CRM MyInsights:

- The Patient Persona Dashboard, which "shows the spread of patients by different personas within a therapeutic area, including clinical, demographic/socio-economic and financial attributes." Heat maps show prescription utilization and spend per patient across the country, down to the ZIP Code level, the company adds.
- The Patient Risk Detail Dashboard, which "breaks down patient segment by care gaps and their prospective risk decile by comorbidities and provides total patient healthcare cost and patient count by different risk and comorbidities." Patient details such as city, compliance rate and impactability score are also provided, SCIO notes.

SCIO also notes that it has earned a slot – 95 -- on the *Healthcare Informatics* 100 listing of top US healthcare information technology software vendors by annual revenues, for the second consecutive year. The *Healthcare Informatics* 100 "brings to the healthcare information technology audience key data and information on the leading software vendor companies," a statement from SCIO says. SCIO serves over 100 healthcare organizations, including over 30 providers and health services organizations and 60 health plans, representing more than 130 million members – plus three of the top five PBMs. Its Insights-as-a Service approach supports the shift to value-based care. Visit www.sciohealthanalytics.com.

AMN Healthcare Recognized for Helping Organizations Hire Quality Clinicians

AMN Healthcare (NYSE: AMN) reports being recognized for "advancing a new predictive analytics system that provides unprecedented capabilities for strategically and efficiently finding quality practitioners and matching them with job openings in healthcare." The industry faces "serious shortages of nurses, physicians and a variety of clinicians," a statement from AMN says, so its candidate intelligence processes "provide unparalleled opportunities for hospitals and other healthcare organizations to find the professionals they need." The company received the 2018 Award for Excellence in New Communications from the Society for New Communications Research of The Conference Board in the "Social Data for Customer Experience and Operational Efficiency" category.

The Society for New Communications Research supports advanced study of emerging communications tools and technologies. AMN Healthcare says it "provides the industry's most advanced data-driven ranking system for identifying and matching professionals with jobs and facilities" – and notes that it was recognized alongside Hewlett Packard, Unilever, Cisco and Philips. The company delivers managed services programs, healthcare executive search solutions, vendor management systems, recruitment process outsourcing, predictive modeling, mid-revenue cycle solutions and more. Visit www.amnhealthcare.com.

Health Catalyst Lauded by *Inc.*, KLAS Research

Health Catalyst, which calls itself "a leader in data analytics, decision support and healthcare outcomes improvement," reports being named one of *Inc.* magazine's Best Workplaces for 2018 – "the result of a wide-ranging and comprehensive measurement of private American companies that have created exceptional workplaces through vibrant cultures, deep employee engagement and stellar benefits." Thousands applied, a statement from Health Catalyst notes, and *Inc.* singled out fewer than 300 winning companies; it was one of only seven Utah-based companies to earn the award. The *Inc.* honor is one of over 30 regional and national "best workplace" awards the company has received, the statement adds, including notices from Gallup, Glassdoor, *Fortune*, *Forbes*, *Entrepreneur*, *Modern Healthcare* and the *Salt Lake Tribune*.

The notice it received from KLAS Research, in a new report on healthcare organizations' perceptions of technology vendors, was inclusion on the exclusive A List of IT companies that "combine high customer satisfaction with high rates of customer retention." An inaugural report, *Decision Insights 2018: National Trends & Best Practices* is designed to help providers understand "which vendors have market energy and why other organizations are considering them," KLAS says in a statement. Health Catalyst adds it was the only data analytics company among the eight entities named to the A List – which requires an overall KLAS Score of 86 or higher and a retention rate of greater than 91% of current go-forward customers.

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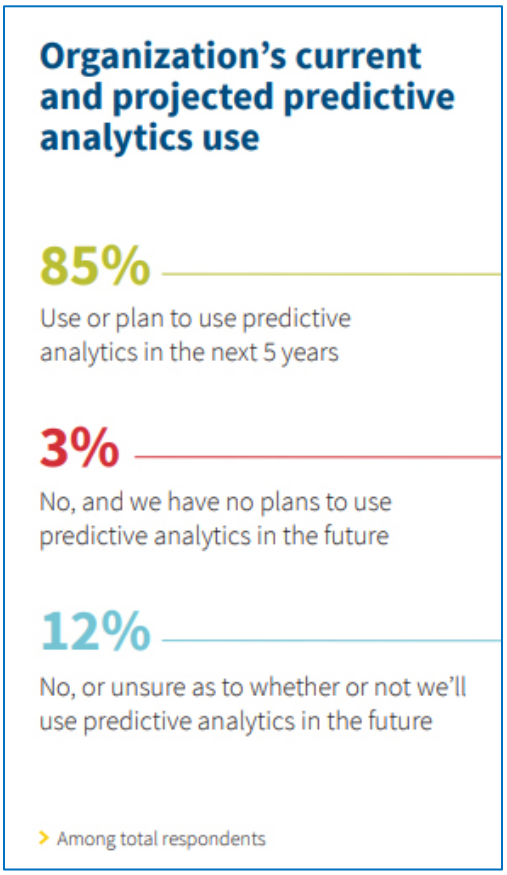
Accolades...continued

The statement adds: "The report is one of several by KLAS to recognize Health Catalyst for its ability to help turn raw data into clear insights that drive improved outcomes in patient care and bottom-line performance." The company also received 2017 and 2018 Best in KLAS rankings for Business Intelligence and Analytics, a designation reserved for solutions that lead the software and services market segments with the broadest operational and clinical impact on healthcare organizations. KLAS collects insights on software, services and medical equipment to deliver reports, trending data and statistical overviews. Visit www.healthcatalyst.com and www.klasresearch.com.

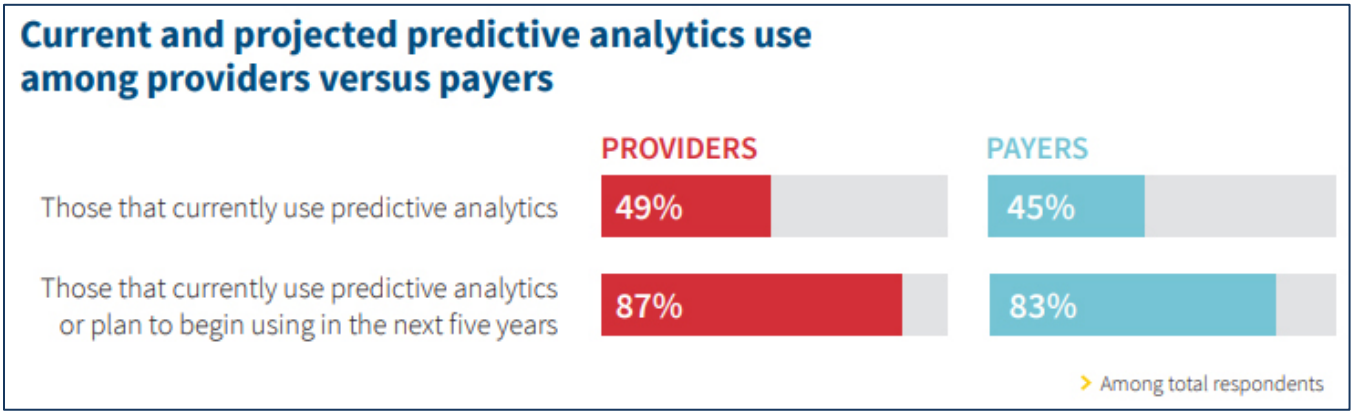
Actuaries: Healthcare Companies Have High Hopes...*continued from page 1*



- A lot of the growth will be in PA to help reduce costs, which is increasingly important in the survey – and which 36% of executives report as "the number one actual outcome they've experienced with predictive analytics." As well, healthcare executives expect predictive modeling to improve patient satisfaction and staffing.
- The top challenges to PA implementation are lack of budget, regulatory issues and incomplete data, which are all "seen as equal challenges," the report says. Additional roadblocks include lack of confidence in analytics' accuracy, insufficient technology and staff skills sets, "too much data" and lack of executive support.

"The future of predictive analytics lies in refining data collection methods to increase security," according to 19% of respondents. Similar percentages cite data visualization, improving process automation and machine learning techniques as key future trends. Here are additional insights in the report from SOA Fellow Lillian Dittrick:

- *The decline in payers' use of predictive analytics stems from their lack of confidence* in "having staff with the right skills to analyze large data sets to spot trends and draw conclusions." Actuaries "can help them become more comfortable with predictive modeling."
- *Perfect datasets aren't required* for actionable modeling. Healthcare organizations should "evaluate the data they have and use supplemental data and techniques to fill any gaps."
- Predictive modeling "has been invaluable for identifying patients at risk for readmission, likely to be high-cost claimants and likely to develop an addiction to opioids."
- "*The value of predictive analytics is realized through data visualization*, which arms providers with actionable insights that can help consumers change the behaviors that put them at the most risk."



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Actuaries: Healthcare Companies Have High Hopes

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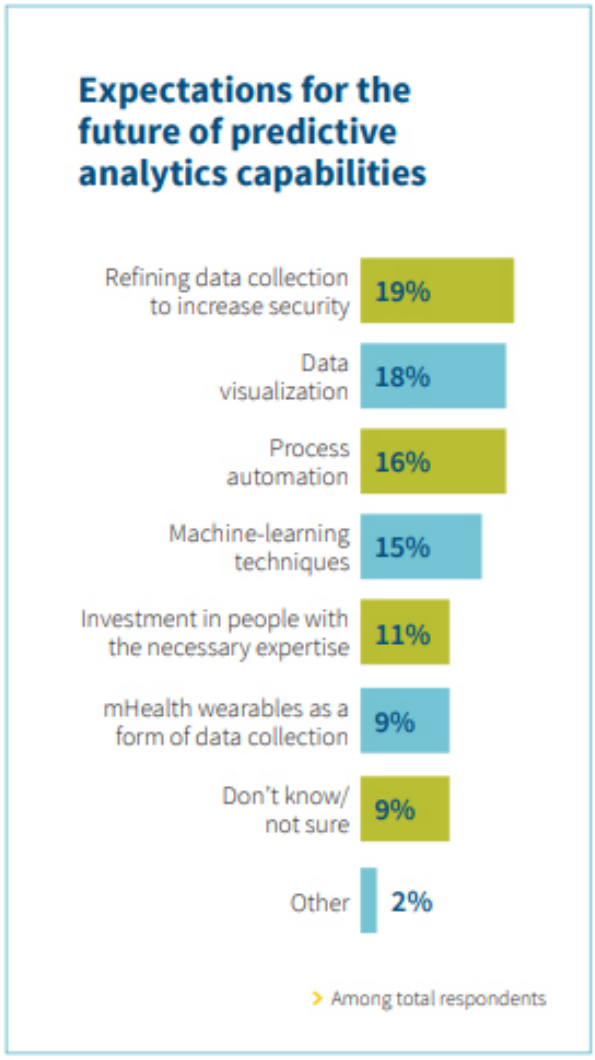

Visit www.soa.org/healthcare-analytics/.

Surveys Highlight Additional Analytics Opportunities

Additional recent surveys detail data inadequacies in patient safety and home health.

- Nearly nine out of 10 respondents to a national survey of physicians, nurses and healthcare executives "say their organizations are successfully improving the safety of patients," a statement says, adding that "real problems remain, and 89% see room for improvement." To make improvements, those executives "say they need better health information technology to warn of impending patient harm as well as more resources and greater organizational focus on the problem." They identified several key obstacles to achieving patient safety goals, including "ineffective information technology and lack of real-time warnings for possible harm events;" "lack of staffing and budget;" "organizational structure, culture or priorities;" "lack of reimbursement;" and "changes in patient population and practice setting." They also said the most common data sources are voluntary reporting, hospital-acquired infection surveys, manual audits and retrospective coding. Says Valere Lemon RN MBA, a senior subject matter expert at survey sponsor Health Catalyst: "Surveilling all-cause harm will aid healthcare organizations in bridging the gap from niche-focused improvements to proactive harm identification and broader patient safety improvement interventions." Visit www.healthcatalyst.com.
- Homestead Health and Accessible Home Health Care – Houston report results from a year-long home health pilot program to test the CareCaller, a nurse call-type device for home health agencies and providers that helps patients call for help, connecting them to their care teams to ask questions, confirm medications or request urgent nurse assistance. The pilot initially consisted of Homestead using a statistical predictive analytics tools to identify candidates with the most critical health conditions and the highest risk of readmission or hospitalization from a group of Accessible Home Health Care patients; Homestead then gave the device to those patients and trained nurses on set-up and testing. Accessible monitored metrics regarding missed appointments, hospital admission rates, patient satisfaction ratings and professional referrals. "Initially, we tried it with our top tier of chronically ill clients and have expanded it to the second level of chronically ill clients," Accessible says in a statement. "Recently we expanded it further with some of our non-medical clients." At the end of the pilot, Accessible "was able to document a 50% decrease in missing visiting home nurse appointments, a significant increase in their Centers for Medicare & Medicaid Services patient satisfaction rating, increased client referrals and a reduction in avoidable hospital admissions." Visit www.homesteadhealth.com.

Movers & Shakers

Medial EarlySign

Medial EarlySign Appoints Chief Medical Officer

Medial EarlySign, a leader in machine learning-based solutions to improve disease management, reports that Jeremy Orr MD MPH has been appointed Chief Medical Officer, "emphasizing the company's commitment to providing precise insights to healthcare organizations, utilizing artificial intelligence and ML algorithms that leverage existing EHR data." Comments Orr: "Predictive analytics provide physicians and healthcare organizations with a powerful tool for early identification and intervention for high-risk patients. EarlySign's technology has been proven to enable more effective care management."

Previous experience includes serving as CMO at clinical decision support company Stanson Health and as CMO at Humedica, an analytics company acquired by Optum that provides clinical business intelligence solutions. Before those jobs, he was a practicing physician at Kaiser Permanente and launched a medical practice that became part of Centura Health. EarlySign says it's developing a suite of AlgoMarker stratification models to address cancers, diabetes and other life-threatening conditions. Visit www.earlysign.com.

Thought Leaders' Corner

Each month, *Predictive Modeling News* asks a panel of industry experts to discuss a topic suggested by a subscriber. To suggest a topic, send it to us at info@predictivemodeling.com. Here's this month's question:

Q "How can predictive analytics be used by health plans to better address premium pricing in the individual market going forward, given the instabilities of the risk pool?"

"As long as risk adjustment is practiced -- not a given anymore -- and underwriting is not permitted, the need for 'accurate' pricing perhaps is moot. Predictive analytics which more accurately predicts the cost of care for a particular patient is therefore redundant as well -- at the individual level. It perhaps has some use at the book-of-business level in coming up with the cost of a block of policies. But the cost of the block depends as much on the reaction of consumers to a number of factors: price increases; plan designs, including networks and copays; competitive offerings, such as the new Association Health Plans; and all the factors that may or may not lead a particular consumer to renew or purchase an alternative policy. There is possibly more use, therefore, for models that predict consumer behavior than there is for models that predict cost."

Ian Duncan FSA FIA FCIA MAAA
Adjunct Professor of Actuarial
Statistics, University of California
CEO, Santa Barbara Actuaries Inc.
Santa Barbara

"Now that the Centers for Medicare & Medicaid Services has reinstated the risk-adjustment program, plans are looking at their pricing models for 2019 with more certainty. Nevertheless, those plans that haven't done so already would be well advised to use data science to help set the premiums, as people in the individual market keep shifting, and claims history and actuarial science aren't enough. Plans ought to adopt a multivariable approach, using epidemiologic data, population modeling and other factors to find unsuspected variations and patterns. Using that pattern analysis, which includes costs, they can associate costs with claims history and other critical contextual information to enable models that help health plans price premiums more accurately."

Alan Spiro
Chief Medical Officer & Senior Vice President of Growth
Blue Health Intelligence
Chicago

"Health plans are currently using predictive analytics to competitively price plans for employer groups based on risk stratification. Applying these same concepts to the individual market is constrained primarily by access to individuals' data and ability to spread risk across a larger group. To overcome these gaps, health plans could get individuals to provide their personal data and agree to join other individuals with similar risk profiles to gain preferred pricing, similar to how Groupon provides preferred pricing to people based on similar buying preferences."

Bob Fuller
Managing Partner, Healthcare
Clarity Insights
Chicago

"This is certainly a timely question, given the recent suspension and then reestablishment of risk adjustment payments by CMS. The latter action helped stabilize individual markets to some extent -- for now. However, given the government's general opposition to the Affordable Care Act's health insurance Marketplaces, the future of the risk-adjustment payments is uncertain. At any rate, health plans must proactively identify and price risk -- i.e., set premiums -- by applying predictive analytics based on whatever medical, social, demographic and economic data they can gather from members. The more, the better."

Ken Perez
Vice President of Healthcare Policy
Omnicell Inc.
Mountain View CA

Industry News

S&S HealthCare Strategies Selects Advanced Plan for Health as PA Solution Provider

Predictive data analytics technology provider Advanced Plan for Health reports that S&S HealthCare Strategies Ltd., which it calls "a well-respected and innovative third-party claims administrator," has added APH's Poindexter analytics to its solution portfolio. S&S will use Poindexter to "deliver longitudinal and predictive health data visibility and insights to its clients for improved performance and more effective population health management," a statement says; S&S adds that "prediction of high-cost events and conditions six to 12 months in advance will support our proactive approach." S&S provides administrative services for self-insured benefit plans and fully insured group health products; clients represent self-funded plan sponsors, provider-sponsored networks, PPOs, Taft-Hartley funds, third-party administrators and insurance companies. Poindexter delivers customized, precise cost-saving visibility and actionable recommendations that help health plans, TPAs, brokers, employers, providers and others reduce the cost and risk of healthcare -- while keeping quality high. Visit www.ss-healthcare.com and www.mypoindexter.com.

Health Catalyst, SCIO Report Acquisition Activity

SCIO Health Analytics reports it completed its sale to EXL Service Holdings. Inc. (NASDAQ: EXLS), an operations management and analytics company, and Health Catalyst, which calls itself "a leader in next-generation data, analytics and decision support," reports completion of its acquisition of Medicity, a major population health management company with solutions for Health Information Exchanges, business intelligence and provider and patient engagement.

For SCIO, the buy by EXL caps "a decade of growth driven by leadership in strategy and innovation around the use of Big Data and analytics to help payers, providers and life sciences organizations improve revenue, quality and operations while solving some of healthcare's greatest challenges." The company, according to a statement, is "excited to combine its analytics capabilities and deep healthcare expertise with EXL's to help customers in the transition to value-based care."

Health Catalyst, SCIO Report...*continued*

SCIO, the statement points out, was "one of the first organizations to create a healthcare analytics delivery center in Chennai, India," resulting in a local talent pool with deep healthcare domain, analytics and technology skills that, the company says, "has always been a key strategic advantage." Significant early investors included Sequoia India, Health Enterprise Partners and Saama Capital. TripleTree LLC served as the exclusive strategic and financial advisor to SCIO in the EXL transaction. Visit www.sciohealthanalytics.com.

The Medicity acquisition adds about 100 new clients to the Health Catalyst customer base, a statement says, including 21 state and regional HIEs, large employers, health plans and 75 health systems. The combination is "positioned to solve many of the most pressing problems of large healthcare delivery networks as they seek to improve the quality and lower the cost of patient care across communities." Indeed, Health Catalyst says in a statement, "the future of healthcare will rely on the broad and more effective use of data;" the acquisition adds information on over 100 million patients, plus "Medicity's experienced team, extensive client roster, expansive data sets and significant transactional capabilities." Together, they're focused on helping clients "apply data-driven insights in a value-based care environment." Health Catalyst brings its Data Operating System, with artificial intelligence-driven analytics and business intelligence and "a broad set of financial, cost, patient outcomes and supply chain data from 400 hospitals and 4,000 clinics and a data set of over 100 million patients."

The integration of Medicity "significantly expands the capabilities of the Health Catalyst DOS," the statement notes, including "the unique ability to receive and analyze data in real time and then embed the resulting insights into the workflow of virtually every EHR on the market." The combined companies "will also have a compelling solution for the loosely affiliated community ambulatory care management space," it adds. Those organizations, it says, "are in dire need of a simple means of integrating data between EHRs at the patient encounter level with enough clinical quality analytics to meet the legal requirements of a Clinically Integrated Network." Health Catalyst says it's the leader in "a new era of advanced predictive analytics for population health and value-based care." Visit www.healthcatalyst.com.

Catching Up With ...*continued from page 12*

PMN: *What can payers do right now to manage the costs associated with interoperability? What can providers do?*

BF: Payers can incent providers financially to provide good quality data with an agreed-upon standard, and they can incent providers by sharing the insights they discover about their patients. Encouraging providers to share standardized data will reduce the costs they're currently facing. Providers, on the other hand, can insist their EMR vendors and partners subscribe to a consistent standard and Application Program Interface. Additionally, they can ensure the patient data they're capturing is conforming to standards and is shared in a secure, but open, fashion with their patients and their patients' health plans. These steps will curb costs to fix data later.

Clarity is the largest onshore US consultancy focused exclusively on data and analytics, delivering enterprise-class full-lifecycle solutions. Clarity Solution Group's healthcare practice deciphers data and provides solutions that address real business issues facing the industry – solutions that become the foundation for making fact-based decisions. Contact Fuller via Marybeth Roberts at 951-553-3343 or at marybeth.roberts@wyecomm.com.

Catching Up With ...

Bob Fuller

Managing Partner, Healthcare
Clarity Insights
Chicago

Fuller has more than 30 years' consulting experience with large healthcare providers, payers and aligned businesses, helping them improve their access to quality data and use analytics to drive business strategy. He's a business-driven technologist and a client-focused professional with passion and persistence -- and a specialization in Big Data, Internet of Things, self-service business intelligence and data discovery & visualization. Fuller focuses on assisting clients in transitioning from traditional data warehouse models to modern data architectures that facilitate collaboration and enable self-service analytics; navigating interoperability standards and establishing effective data architectures; and using analytics to deliver more continuous, connected patient experiences.

Bob Fuller

- Managing Partner at Clarity Insights since October 2017.
- Also has served as Practice Leader: Big Data & Analytics for Clarity Solution Group since June 2016.
- From 2001 to 2016, served as Managing Principal at RCG Global Services.
- From 1997 to 2001, he was a Partner at Whitman Hart/marchFIRST.
- And from 1985 to 1997, he was a Division Manager at Electronic Data Systems.

Predictive Modeling News talked to Fuller about improving interoperability and patients' quality of life.

***Predictive Modeling News*:** *What has your professional journey been like, starting with college or grad school? Has it been anything like the journey you imagined?*

Bob Fuller: I started my career 34 years ago focused on technology and data, and that is what I've been doing for the past three decades. About 20 years ago, I began working in healthcare exclusively and have really worked across the entire ecosystem. I spent a good deal of time initially working in pharma and with Pharmacy Benefit Managers, but then began working with providers and health plans, and eventually added experience with home health and specialty health. I was a managing director or partner at multiple firms before joining Clarity Insights, where I am the Managing Partner of our Healthcare practice. Just as technology has evolved tremendously over the last 30 years, the use of data for healthcare solutions is evolving at an accelerated pace. While I may not have imagined all the changes, they are exciting and one of the reasons I enjoy working with our clients every day.

PMN: *What's the most interesting application of predictive analytics that you've worked on -- or heard about -- recently? What's starting to happen now that could revolutionize the field?*

BF: I find opportunities to improve patient health and enable better lifestyle quality very interesting. We're seeing this happen in a few ways, but one example is the use of data coming from wearables, which we can analyze then leverage to provide real-time feedback to patients or members. These insights can empower the individual to maintain better health and make the right changes. We also see this in the evaluation of clinical data, as patients can elect to make their data available for studies, which can then allow payers or providers to predict outcomes and engage those individuals to improve their health outcomes. We'll see this field further revolutionized as technology solutions like blockchain continue to evolve and are applied to improve the integration and accuracy of healthcare data.

PMN: *Will interoperability issues ever be overcome in predictive analytics? Can the technology be developed to cross seamlessly from one data architecture to another, no matter what standards have been used? Will there ever be a single set of standards?*

BF: Interoperability is certainly possible, but it's not going to happen overnight. The number of players and key challenges -- such as adoption of standards and coordination of stakeholders -- are roadblocks, but are not insurmountable. The technologies to address interoperability, and even the standards themselves, exist today, but we need to align incentives for payers and providers to encourage adoption.

(continued on page 11)