**Artificial Intelligence in the Healthcare Industry**

**Overview**

Artificial Intelligence (AI) is currently being discussed in nearly every domain of science and engineering. All these advances open questions about how such capabilities can support, or even enhance, human decision making in health and healthcare. Currently the most vibrant part of AI, machine learning (ML), is tightly coupled to the availability of relevant data sets. In the health domains, there is an abundance of data - in a variety of formats. However, the quality of, and accessibility to, these data resources remain a significant challenge WW. On one hand, health data has privacy requirements associated with it, making the collection, sharing, aggregating or analyzing of health data particularly cumbersome compared to other types of data. In addition, health data are expensive to collect initially, so it tends to be tightly guarded once it is collected. Further, the lack of interoperability of electronic health record systems impedes even the simplest of computational methods and the inability to capture relevant social and environmental information in existing systems leaves a key set of variables out of data streams for individual health.

At the same time, there is wide private-sector and government interest in health data collection and AI applications as in most nations the public health market is usually the largest or second largest budget line in a country, often growing faster than other major indicators. Large, currently untapped opportunities exist, to leverage AI to extract insights from the aggregation of patient-specific data sets for improving public health. The upcoming GDPR has an explicit article on processing of health data for research purposes (art 98).

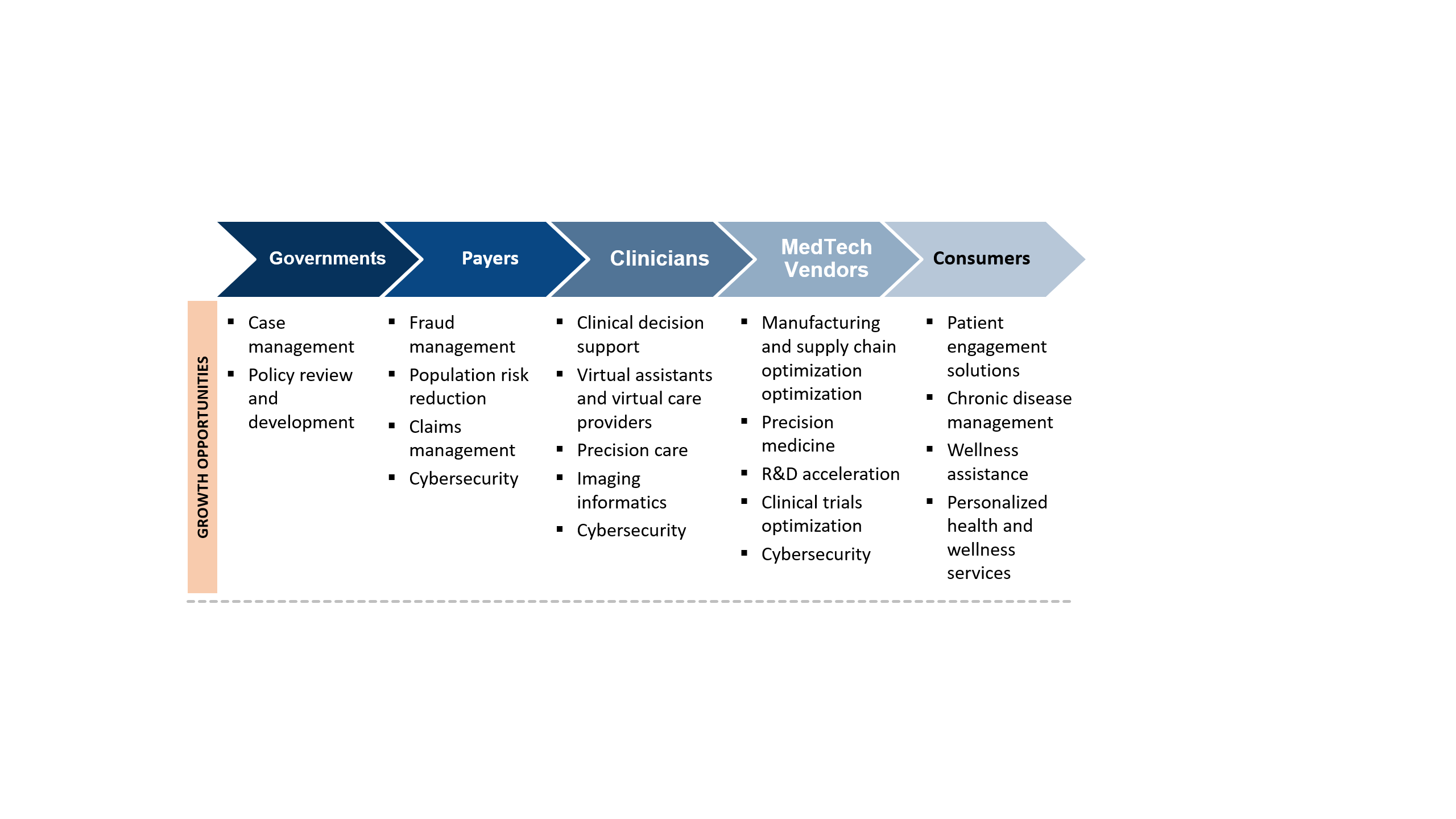
Due to the sensitive nature and special legal protection of health data, countries are still evaluating how to balance multiple fundamental rights simultaneously, like data protection and to live healthy. Countries started to deeply investigate how the ethical implications in a data driven and AI supported health system will unfold (i.e. Germany) and Microsoft is supporting the work of leading experts at Oxford University to contribute to this debate. Further leading work: [Healthcare NExT](https://www.youtube.com/watch?v=H6wI20T8y6o), [Partnership for AI](https://www.partnershiponai.org/) and [Democratizing AI for Health](http://democratizing-ai-in-health.azurewebsites.net/) or Aether.

In general, health leaders today recognize that innovation requires moving beyond the use of Electronic Medical Records (EMRs) to embrace key principles of Digital Transformation (DT). This trend creates opportunity for IT industry to serve the health segment through its DT strategy. Within the health segment, the area of Data & AI is a top focus for health decision-makers making investments in Health Information Technology (HIT).

As we move into FY19, new offerings like Microsoft Genomics, the closer collaboration with MSR and the upcoming engineering investments to enhance our data platform for health data insights, support health frontline workers with better targeted tools and improve the foundations necessary for precision medicine - all supported by advanced AI/ML capabilities - will help us to accelerate our inroads into the large health market.

# Healthcare Market Trends

* The global healthcare industry will register a stable growth rate of 4.82% during 2018.
* The global healthcare cloud computing market will hit $35 billion by 2022, with a compound annual growth rate of 11.6%. Of that amount, the network technology sector is expected to generate $4.2 billion in 2022, up from $2.6 billion last year.
* 84% of healthcare executives believe AI will revolutionize the way they will gain information
* Potential benefits gained from AI Solutions in Health will exceed $150 billion annually by 2025
* Potential revenue from AI in Health solutions will exceed $40 billion by 2025
* Barriers surrounding the cloud include patient privacy and data security concerns. Still, more than 80% of healthcare IT organizations use cloud computing to store and manage data in their networks.
* Growth opportunities are in:

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**Why Microsoft**

Despite overall very strong competition in the health and healthcare industry, Microsoft is well positioned. Assets range from the superior economics of our cloud model (vs. i.e. IBM), to comprehensive compliancy certifications, a broad set of data collection and curating tools (*like the ML supported DLP*), a broad partner ecosystem and a comprehensive AI “toolbox” ranging from dedicated AI hardware offers to end2end ML workflows, partners and health customers can leverage to address their business and medical challenges as well as a unique position with the intelligent -and trusted – edge. Customer compliancy manager and Service Trust Portal.  
There is a broad set of partner AI solutions available, like from KenSci, ProperPay,Cambio, AiFloo, Epimed, Interknowlogy, CoxHealth and many more.

**Top Healthcare Industry Scenarios**

Clinical and operational analytics solutions are the two groups of Healthcare Industry scenarios, where AI usage will demonstrate the most significant impact. In these scenarios, we gather and use the massive amounts of information available in healthcare to improve processes and outcomes.

1. **Clinical Analytics Scenarios** – here, we focus on the use of data and analytics to improve clinical treatment processes and outcomes and AI will help us transform data into prescriptive insights.
2. **Operational Analytics Scenarios** – here, we focus on the use of data and analytics to improve the efficiency or effectiveness of systems used to provide and manage care processes.

The following are some of today’s and future clinical and operational analytics scenarios:

1. **Predictive Care Guidance**Thisinvolves analytical solutions that search through massive amounts of information to predict outcomes for individual patients. Predictions include determining likelihood of disease, assisting clinicians with determining a diagnosis, and predicting future wellness or illness. Most predictive care guidance relies on AI learning models that grow in precision with additional data and cases

**Value Proposition**

* Provides clinicians with answers they’re seeking for individual patients.
* Focuses on increasing the accuracy of diagnoses.
* Can be used by payors to improve outcomes and reduce cost of care
* Is used by pharmaceutical companies to best meet the needs of the public for effectiveness of medications.
* Leaves patients better informed and able to assume more responsibility for their own care

**Examples**

* **Health risk prediction**: Predicting the likelihood that a patient presenting a certain set of symptoms is at risk for an adverse health event.
* **Predictive risk scoring:** Assessing which patients may be at risk for readmissions, hospital acquired infections, etc.
* **Clinical pathway predictions:** Assessing and predicting which treatment option will likely produce the best outcome for a patient.
* **Drug effectiveness**: Predicting which drug will produce the best effect for a patient.
* **Disease progression prediction:** Predicting the likely path and progression of a disease

1. **Behavior Analytics – Prescriptive Intelligence**The definition of “behavior analytics,” a term widely used in consumer engagement, covers analysis of a consumer’s behavior pattern that informs how to market/deliver an action to increase the odds of adoption. While clinical analytics can identify a next best clinical action, also applying behavior analytics increases the likelihood of the action being taken. This is sometimes called nudging the patient/care provider, etc…

**Value Proposition** - Incomplete application or conformance of evidence-based medicine is a leading cause of poor outcomes and increased overall cost of care. Care providers are increasing their risk posture when it comes to driving conformance in populations that provide care and those that receive care. Understanding how to specifically engage the patient, member, care provider, etc., to ensure conformance increases the potential of complete/best possible care

**Examples** - Some industries use behavioral analysis to inform actions like suggesting add-on sales or displaying content based on previous usage patterns. This is how Amazon recommends complementary products or Netflix recommends movies or shows a customer might like. The method of deriving suggestions is particularly key in healthcare, because suggestions will be delayed or ignored if they’re not natural and easy to execute

* **Nudge platforms such as one from** [**NextHealth**](http://nexthealth.org/)an Azure partner, that delivers recommendations to health plans to increase member conformance.
* **Microsoft Finds Cancer** Clues in Search Queries ([article](https://www.nytimes.com/2016/06/08/technology/online-searches-can-identify-cancer-victims-study-finds.html)) describes an application of behavior analytics that aids early detection of pancreatic cancer to improve outcomes and life expectancy.

1. **Population Health**   
   The term “population health,” which is widely used in the healthcare world, covers a variety of topics. Population health strives to impact the delivery of care to a group of individuals with similar healthcare needs, versus the traditional focus of evaluating and treating medical conditions “one patient at a time.”

**Value Proposition** - Payment systems are moving from a fee-for-service business model to one that incorporates value into the payment equation. Meeting payor requirements during this transition requires greater use of data and analytics, including better data on patient-reported outcomes, social determinants of health, patient and member risk stratification, and activity-based costing. The goal of population health analytics is to manage health of populations by creating better patient outcomes at an efficient cost.

**Examples**

* **Specialty-care populations:** Individuals with chronic conditions such as diabetes consume more than 75 percent (https://www.cdc.gov/chronicdisease/pdf/2009-power-of-prevention.pdf ) of healthcare spending. Population health analytics uses data to determine how best to manage health needs and outcomes for the entire population of diabetics or people suffering from other chronic conditions.
* **Integrated care:** Coordinating treatment across care team members, including clinicians, social workers, physical therapists, and behavioral health care professionals is an approach that lowers the cost per service. Analytics can   
  **help identify and measure the effectiveness of care across all care settings.**
* **Increased patient engagement:** Empowering patients to better self-manage their health and participate in the decision making process improves outcomes.

1. **Medical Image Intelligence**  
   Medical Image Intelligence includes the embedding analytical capabilities in images to augment or improve diagnostic and treatment planning processes.

**Value Proposition** - Medical images represent one of the largest categories of unstructured data used in healthcare. Specialists such as radiologists, oncologists, ophthalmologists and others are trained to evaluate medical images to assess medical conditions, make diagnoses and deliver treatments based on their “reading” of these images. The goal of embedding intelligence into the imaging process is to assist specialists in making diagnoses, improve treatment planning or increase the efficiency of these processes (e.g. Specialists ability increase number of readings or treatments plans)

**Examples**

* **Radiation Treatment Planning** - The Microsoft InnerEye Healthcare NExT research project uses state of the art artificial intelligence to build innovative image analysis technologies that our ISV partners can leverage in tools that help doctors treat diseases such as cancer in a more targeted and effective way. InnerEye builds upon many years of research in computer vision and machine learning at Microsoft . It employs decision forests and deep neural networks to enable medical software providers to deliver tools that radiation oncologists can use in planning radiotherapy treatment. The cloud-based radiomics service is intended to enable the development of third-party products that better assist radiation oncologists and dosimetrists with some of the work, allowing the medical experts to focus on more detailed tasks such as editing and refining results.

1. **Readmission Management**  
   A hospital readmission is when a patient who had been discharged from a hospital is admitted again within a specified time interval. Some readmissions are unnecessary, and signal lower quality that produces higher treatment costs. Analytic solutions are designed to evaluate/predict which patients are at risk so hospitals can create a plan to reduce the likelihood of their being readmitted.

**Value Proposition** - Avoidable readmissions are a strong, costly indicator of a fragmented health care system that too often leaves discharged patients confused, and consumes additional resources that are already stretched thin. The issue of unnecessary hospital readmissions is now front and center in the United States and other countries. Many countries are publicly reporting readmission rates and penalizing providers whose rates are high.

**Examples**

* **Prehospitalization**: Using predictive analytics to “risk rate” patients in advance of a hospital stay helps determine their likelihood of being readmitted following discharge.
* **During Hospitalization:** Using predictive analytics to risk rate patients as they go through the treatment and recovery process helps determine likelihood of readmission.
* **Post-discharge**: Using predictive analytics as part of the discharge process helps assess which patients are at higher risk for being readmitted.
* **Emergency Department “Bounce Backs.”:** Similar to an inpatient readmission, a ”bounce back” is when a patient seen in an Emergency Department returns after discharge because the condition does not improve.

1. **Throughput Management**  
   The collective process known as “throughput management” includes systems and processes used to manage the “cycling” of patients through a health organization’s physical facility. Scenarios include moving an inpatient through the hospital, or moving an urgent care or trauma case through the Emergency Department to either discharge or admission to the hospital.

**Value Proposition** - With increasing patient demand and constrained physical resources, optimizing throughput is an essential operations management strategy. The use of data and analytics to optimize inpatient throughput enhances patient access, reduces unit cost, and improves service levels, leading to measurable value in metrics like reduced wait times, better use of capital, and an increased Return on Assets (ROA). The management of facilities and care processes is typically a provider organization’s second highest cost. Improving throughput allows more patients to receive care at the same facilities, reducing the need to add expensive new facilities or beds.

**Examples**

* **Hospital bed optimization:** Analytics can help determine/predict the flow and progression of inpatients through a system, thereby maximizing use of patient rooms and facilities.
* **Reducing wait times:** Predicting and managing variables like staffing improves efficiencies in care delivery in emergency departments.
* **Improving patient transfer process:** Throughput management helps staff spot and resolve “bottlenecks” in patient transfers within a facility (e.g., a patient waiting to be admitted to Intensive Care where a bed is available but not yet cleaned).
* **Improving patient satisfactions scores (HACPHS):** Analytics can help correlate outcomes and experience data to patient journey paths. Providers can identify reengineering opportunities from observing correlations, etc.

1. **Staffing** **Management**  
   Today, data and AI systems allow healthcare organizations to model and predict optimal staffing levels based on factors such as predicted patient volume, and type and complexity of patients being treated.

**Value** **Proposition** - Staffing is the single largest expense of any medical organization delivering services to patients and consumers. In most hospitals, staffing represents more than half of all total expenses. Optimized staffing helps provide better care, as well as reduce expenses, by better matching level and type of staffing to current and future patient volumes.

**Examples**:

* **Predicting optimal staffing levels:** a way of optimizing staffing levels and skills sets to the number of patients and the level of acuity for care to be provided.
* **Improving Staff Retention:** for hard-to-find specialty clinicians helps organizations maintain sustainable teams. Utilizing predictive analytics to understand when an employee is at risk to resign is crucial to reducing staff turnover rates and workforce management.

1. **Claims Management**  
   Claims management is the organization, billing, filing, updating, and processing of medical claims related to patient diagnoses, treatments, and medications.

**Value Proposition** - For providers, claims management is at the heart of identifying, managing, and collecting patient service revenue. For payors, claims management is key to assessing the appropriateness of a claim and whether to pay or deny it, and to determining the rate of payment for services a health provider bills to the payor.

**Examples**

* **Claims management uses analytics to predict hidden patterns** and anomalies within the entire claims data universe to identify high-potential claims in order to reduce denials and prevent fraudulent activities.
* **Denial management** uses analytics to track the number of claims filed by providers that a payor denies. Denied claims represent extraordinary administrative costs to health providers and payors. For hospitals and medical organizations, denied claims are a primary contributor   
  to bad debt, which represents millions in lost net patient revenue every year. For payors, denied claims create large overhead costs.
* **Claims fraud, waste & abuse** is a significant issue worldwide. It encompasses a wide spectrum of activities, from deceptive billing for services not rendered, to performing unnecessary medical services, to abusing payment rules by coding services at higher levels than actually performed.

1. **Cost** **Management**  
   Cost management is a broad category relevant to all aspects of care delivery. It encompasses evaluation of all major provider and payor systems that determine the eventual cost of providing and paying for health and medical services.

**Value** **Proposition** - Most provider and payor organizations today exist on razor thin operating margins. In most countries, the cost of providing and paying for care is rising faster than reimbursements increase. To continue operations, health providers and payors are seeking solutions that improve the management of costs while maintaining quality of services provided. This effort involves two parts: improving the planning and execution of current operations, and attacking overhead costs along with other costs that are "flying below the radar.”

**Examples**: Cost management initiatives use analytics to evaluate and improve the efficiency of major “systems” used in providing health and medical services.

* **Provider Examples**
  + **Staffing optimization**: Predictive analytics can help match staffing requirements—typically the largest single cost—to the current and future mix of patients.
  + **Throughput management**: Predictive analytics can help optimize the flow of patients through facilities—typically the second highest cost—including hospitals, emergency departments, operating theaters, and imaging departments.
  + **Supply costs**: Analytics can evaluate which supplies are most cost effective.
  + **Denials management**: Analytics can help predict which claims will be denied to reduce the number of denials as well as the cost of managing them.
* **Payor examples**
  + **Fraud detection:** Predictive analytics can spot potentially fraudulent claims, including those miscoded to generate higher payments.
  + **Length of stays**: Predicting length of stays for covered services can help payors estimate and minimize costs.

**Competitive Landscape**

Microsoft has been constantly out-marketed by competition, specifically to AWS, Google and IBM-Watson. A few examples:

**AWS** – aggressive partner investments in HC market as well as [announcement from AWS regarding adoption of their Machine Learning Platform](https://www.businesswire.com/news/home/20180404006122/en/Tens-Thousands-Customers-Flocking-AWS-Machine-Learning) and the introduction of two new cognitive services.

While much of the announcement amounts to media “peacocking” there are a few noteworthy observations:

* ML growth rate of 250 percent in last year (yes, a number easily gamed but impressive nonetheless).
* Introduction of two new services - AWS also announced the general availability of two new machine learning services, Amazon Transcribe and Amazon Translate.
* Social media “amplifying” the news (yes, certainly part of a coordinated effort).

**Google** – we are often loosing to Google due to (perceived or even real) inferiority of our AI services. Examples:

* Feb 15th, 2018 - We lost Insurance Card OCR scanning workload to Google with Digital Innovation Group at Sisters of Providence. They were no longer going to wait for Microsoft and did decide to proceed with the Google API as it is currently covered by the Google agreement
* Feb 12th, 2018 – Hackensack Meridien Health – although Microsoft started a PoC with the customer and KenSci, the customer decided to review Google AI and ML due to a clear internal insights starting higher quality and capability of Google services
* Feb 23rd, 2018 – eClinicalWorks – the customer had a strong desire to use Bing Translator and incorporate it into their virtual assistant. They were disappointed. Our solution was lacking the ability to address medical terminology. Google solution did an excellent job and the customer decided to move forward with Google as a result

**IBM/Watson** – IBM leads often mindshare by the strong marketing umbrella for its Watson-based cognitive services.

As Microsoft, we have an excellent set of AI solutions that are more than adequate to compete and win against AWS. Yet, we need to better amplify our communication and marketing efforts to better match the awareness and mindshare lead Amazon and Google are currently enjoying in the HC industry.

However, we also lack sometimes product capabilities in certain areas. Engineering and MSR need to define a clear, competitive and commercial oriented roadmap in order to ensure better Microsoft competitiveness in AI in Healthcare space. With the current approach, we are running the danger to loose market share in a rapidly growing market.

**What we need to make it happen (A) – inside Microsoft’s Sales Organization**

1. Familiarize your local industry sales team with available AI solutions, scenarios and partner capabilities.
2. Get team clarity, what AI/ML can do, and where the limitations are to set customer expectations properly. It is “relatively” easier to get a commitment for a PoC, versus a properly set up AI/ML solution intended to add value to the customer over the course of its lifetime. Examples:
   1. Are sufficient and quality data available? Properly labeled? Does the customer have the proper skills available? *(not only for building the model, but more importantly to train, calibrate and upgrade the model over the expected lifetime, or to curate the data set(s) – our focus is sustainable customer satisfaction)*. This can also be used as an upselling opportunity for MCS services to train customers employee’s.
   2. Similar to the benefits in having early trusted cloud conversations, engaging the customer early in how to address bias in models or datasets and leveraging this opportunity for thought leadership and helping the customer to minimize his risk while maximizing the benefit of the AI solution.
3. In addition to existing AI solutions, leverage the BOM of the CommercialAI initiative to identify additional early leads and opportunities in your local markets
4. Embed industry AI solutions into your health DT narrative.
5. Cloud and AI are economic game changers in the health sector. Learn, build and communicate economic benefits for retail customers.

# A big gap for Microsoft right now is end-to-end compliance, particularly in the area of advanced workloads such as cognitive services and competitors are outpacing us. We are working to accelerate the compliance timeline for non-core Azure engineering workloads.

1. Sales readiness: We have great field team members who are insufficiently trained or equipped for a complete solution selling conversation with clinical and business decision makers, on the value and benefits of AI from MSFT.
2. Market visibility and mindshare: We are virtually invisible to decision makers when it comes to their understanding that we are heavily focused on AI for health.

**What we need to make it Happen (A) – preparing and activating health customers**

1. Health is a highly regulated industry and due to its importance to society, collection of data, its processing and the impact of AI will be closely guarded.
2. While partners come often up with innovative ML based solutions, data ownership is usually with health organisations under regulatory supervision.
3. As ML models can degenerate over time, customers need to have the proper resources, skills and processes in place to maintain the ML model at the required accuracy level.
4. Microsoft’s own experience with large models, its ethical principles with regards to AI and ambition to deliver responsible AI is a great asset in customer engagements and projects.

**Risks of AI in Health Industry**

Given the ubiquitous nature of healthcare in people’s live, inappropriate use of AI/ML solutions and automated decision making might cause harm to individuals *(examples: wrong image enhancement processing in MR, inaccurate prediction on diagnosis presented to doctor, …).*The sensitive use workgroup in the Aether committee established 4 questions which should be looked at by Microsoft’s sales teams, if an AI project might be subject to such an use case. Like in other industries, this should not be seen as an impediment in Ai projects per se, but as an excellent opportunity to lead the customer more responsible into this new world and help him to establish the proper governance model in his organization:

1. Will the technology be used to augment the abilities of individuals and result in a positive impact on people and society? *(i.e. what is the acceptable false-positive rate?)*
2. Are the AI technology and people capable of performing the tasks that the AI system should do?
3. Will the technology be effectively designed, operated and maintained by a responsible party? (*i.e. are clear guidelines available about the storing, processing and re-using of data?)*
4. Will the AI system be deployed in sensitive categories which require special attention because the create higher risk? (*i.e. a false diagnosis might impact a patient’s ability to get affordable insurance)*

For further guidance on how to prepare for, assess and utilize these kind of questions to positively differentiate, feel free to send mail to [askaether@microsoft.com](mailto:askaether@microsoft.com)

Further risks in AI in HC:

* Compliance by design is a MUST
* Data security and data privacy are one of the highest areas of exposure in HC.

**Healthcare Industry – Point of View on AI through the lens of DT**

Due to the nature of AI being a “horizontal technology” crossing into most processes and technologies healthcare customers operate, it can enhance projects in all 4 existing DT pillars for the Health industry. Those are:

* Engage patients in their health
  + Create digital assistants to give patients instant access to their health information and care plans
  + Enable intelligent search to find providers and schedule care appointments
  + Provide personalized care notifications and recommend preventive actions
* Empower care teams
  + Enable intelligent tools to recommend next best actions for individual care plans
  + Engage digital assistants to record and transcribe patient history and chart notations
  + Provide remote patient monitoring while applying analytics to generate care team alerts
* Optimize clinical operations
  + Apply advanced analytics to identify chronic diseases, prevent readmissions and drive efficient staff allocation
  + Employ intelligent search models to track and predict public health epidemics
  + Enable connected devices to monitor condition of critical care equipment and recommend preventive maintenance
* Transform the care continuum
  + Enable virtual nursing assistants to remotely assess patient symptoms and decrease unnecessary visits
  + Employ advanced learning models to expedite the medical imaging workflow and identify potential findings
  + Combine cognitive robotic capabilities with medical records to guide and enhance physician instrument precision
* Enhance security and compliance – in addition to all the above and very specific to Microsoft
  + Employ advanced analytics and predictive models to identify and prevent regulatory and compliance risks
  + Augment existing security authentication with advanced facial and speech recognition
  + Analyze and monitor enterprise-wide access logs and flag suspicious cases for administrator review

The above AI based digital transformation pillars in healthcare industry let us build the solutions that enable systems that assist and support the wisdom and experience of well-trained clinicians in making better data-driven decisions and taking actions that best support the needs of those they serve. This is done by gathering and crunching massive amounts of data quickly and intelligently to identify patterns often overlooked or undiscovered in the traditional practice of care. The opportunity for AI in healthcare isn’t just about making doctors and healthcare providers more efficient in their work; it’s about making the lives of the patients better and saving lives.