AWS in the Pharmaceutical Industry: Powering Drug Discovery, Development, and Beyond

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aws cloud-computing pharmaceutical drug-discovery clinical-trials manufacturing supply-chain ai machine-learning data-analytics regulatory-compliance

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Introduction

Cloud computing has become a cornerstone of innovation in the pharmaceutical industry. In fact, **40% of pharmaceutical and life sciences executives** report that *all* of their operations already use cloud services, and an additional 55% expect to be fully cloud-operational within two years (How cloud is transforming pharma survey: PwC). Amazon Web Services (AWS), the world's leading cloud provider, is at the forefront of this shift. Virtually all major pharma and biotech companies – including Pfizer, Moderna, Merck, GlaxoSmithKline (GSK), Novartis, and AstraZeneca – are leveraging AWS to accelerate research and development, improve manufacturing efficiency, maintain regulatory compliance, and derive insights from vast datasets. The urgency for speed and agility (especially highlighted by the COVID-19 pandemic) has further catalyzed cloud adoption in pharma, as firms seek to bring new therapies to patients faster and more cost-effectively.

This article provides a deep dive into how AWS is used across the pharmaceutical value chain. We will examine use cases from **drug discovery** and **preclinical research** through **clinical trials**, **supply chain management**, **manufacturing**, and **regulatory compliance**, highlighting the most popular AWS services (such as Amazon S3, EC2, SageMaker, AWS HealthLake, AWS IoT, and more) and real-world case studies. Quantitative outcomes – from faster research pipelines to cost savings – will illustrate the transformative impact of AWS on pharma IT workflows.

Accelerating Drug Discovery with AWS

Discovering new drugs is a data- and compute-intensive endeavor. AWS provides the scalable infrastructure and advanced analytics tools that pharmaceutical R&D teams need to sift through massive biological datasets, simulate molecules, and identify promising drug candidates more quickly. **High-performance computing (HPC)** on AWS allows researchers to run complex simulations and genome analyses in hours instead of months, without investing in on-premises supercomputers. For example, **AstraZeneca** built a cloud-based genomics processing solution on AWS that can run **51 billion statistical tests in under 24 hours** to analyze genetic data for drug discovery (Genomics Data Processing Solution Runs 51 Billion Tests in 1 Day on AWS -

AstraZeneca case study - AWS). This scalable AWS pipeline – using services like AWS Lambda for orchestration, AWS Batch for parallel computing jobs, and Amazon S3 for data storage – enabled AstraZeneca to provide genomics insights to over 40 drug discovery projects in a single year (Genomics Data Processing Solution Runs 51 Billion Tests in 1 Day on AWS - AstraZeneca case study - AWS) (Genomics Data Processing Solution Runs 51 Billion Tests in 1 Day on AWS - AstraZeneca case study - AWS). By automating data processing and analysis, AstraZeneca freed up scientists' time for innovation instead of managing data logistics (Genomics Data Processing Solution Runs 51 Billion Tests in 1 Day on AWS - AstraZeneca case study - AWS).

AWS also empowers drug discovery with **machine learning (ML) and artificial intelligence (AI)**. Services such as **Amazon SageMaker** (for building and training ML models at scale) are widely used to uncover patterns in biological data and predict molecule behavior. **Merck**, for instance, is leveraging AWS's AI/ML capabilities to accelerate early research. Merck uses **AWS HealthOmics** – a purpose-built AWS service for biological data and analytics – and HPC on AWS to scale its protein modeling and genomics analyses, even running deep learning workflows like AlphaFold for structure prediction (AWS and Accenture Help Merck Use Cloud Technology to Reduce Drug Discovery Time and Accelerate Clinical Trial Development). This cloud-based approach speeds up Merck's therapeutic discovery efforts by providing virtually unlimited compute power on demand. In one collaboration with AWS and Accenture, Merck migrated a substantial portion of its research computing to AWS, which contributed to reducing drug discovery time and improving R&D productivity (AWS and Accenture Help Merck Use Cloud Technology to Reduce Drug Discovery Time and Accelerate Clinical Trial Development) (AWS and Accenture Help Merck Use Cloud Technology to Reduce Drug Discovery Time and Accelerate Clinical Trial Development). Similarly, **Novartis** has conducted massive virtual screening campaigns on AWS – in one case compressing what would be 39 years of computational chemistry into just 9 hours – to search 10 million compounds for potential hits (as cited in an AWS re:Invent presentation). These examples show how on-demand compute (e.g. Amazon EC2 high-performance instances, AWS Batch, and scalable storage on S3) allows pharma researchers to explore more compounds and data faster than ever before, ultimately expanding the pipeline of drug candidates.

Another area AWS is transforming is **AI-driven insights** in discovery. Pharma companies are developing generative AI models and analytics platforms on AWS to augment scientists' decision-making. **Pfizer**, for example, created a *"Scientific Data Cloud"* on AWS that aggregates data from hundreds of laboratory instruments, making it simpler and faster for researchers to search experimental data across silos (Pfizer at AWS re:Invent 2023 - Lidia Fonseca, Keynote Speaker - AWS). On top of this data foundation, Pfizer built a generative AI solution called *"VOX"* using large language models via Amazon SageMaker and Amazon Bedrock (AWS's managed service for foundation models). VOX can analyze Pfizer's vast research data to suggest hypotheses, predict drug product yields, and otherwise accelerate R&D cycles (Pfizer at AWS re:Invent 2023 - Lidia Fonseca, Keynote Speaker - AWS) (Pfizer at AWS re:Invent 2023 - Lidia Fonseca, Keynote Speaker - AWS). These AI initiatives are enabled by AWS's ability to securely handle large-scale data and provide ML infrastructure at the enterprise level. In Pfizer's case,

the cloud-based data and AI platform is credited with helping the company pursue an unprecedented goal of launching 19 new vaccines and therapies in 18 months, by providing teams with rapid insights and predictive capabilities (Pfizer at AWS re:Invent 2023 - Lidia Fonseca, Keynote Speaker - AWS).

Enhancing Clinical Trials with Cloud Solutions

Clinical development is another domain where AWS is driving efficiency and innovation. Running clinical trials involves coordinating data from numerous sites and patients, analyzing results, and ensuring compliance – all areas where cloud services shine. AWS's global infrastructure and analytics tools help pharma companies shorten trial timelines and make data-driven decisions in real time. A recent industry study found that cloud adoption led to a **50% average increase in product pipeline throughput**, partly by reducing clinical trial data processing times and speeding decision-making (Link) (Link). Organizations with longer experience on the cloud saw even greater gains – those hosting workloads on cloud for 7+ years reported a **103% increase in pipeline throughput** (Link). One contributor to this improvement is faster patient recruitment and trial setup: cloud-based analytics can quickly sift through electronic health records to find eligible patients, and digital platforms can enroll and monitor patients remotely, reducing delays. According to the Hackett Group, pharma companies that migrated more applications to the cloud achieved a **19% reduction in time to qualify and initiate trial sites**, saving nearly a month per trial on average, versus those with minimal cloud adoption (Link) (Link).

AWS offers specific services that cater to clinical data management. **AWS HealthLake**, for example, is a HIPAA-eligible service that can ingest and normalize health data into the FHIR format, making it easier to query clinical records and glean insights (Healthcare Analytics & FHIR Server Service - Amazon HealthLake). Pharmaceutical firms can use HealthLake to combine data from electronic medical records, lab results, and even patient-reported outcomes into a single, secure cloud repository for analysis. This capability is crucial for **real-world evidence (RWE)** studies, pharmacovigilance, and designing more adaptive trials. **Amazon Comprehend Medical**, a natural language processing service for unstructured text, is another tool being used to analyze clinical notes and reports. For instance, Pfizer's teams are prototyping systems that leverage Comprehend Medical to automatically extract and process data from legacy clinical documents and research reports, uncovering insights that could guide new trials or drug repurposing (AWS Helps Pfizer Accelerate Drug Development And Clinical Manufacturing - Pfizer) (AWS Helps Pfizer Accelerate Drug Development And Clinical Manufacturing - Pfizer). By mining decades of unstructured data (e.g. past trial protocols, lab results, and batch records), ML models on AWS can help identify promising treatment directions or patient subgroups that might have been overlooked.

Speed and scalability are especially vital during public health emergencies. A notable example is **Pfizer's rapid response during the COVID-19 pandemic**. Pfizer credits its cloud foundation with enabling it to stand up the necessary IT infrastructure for COVID vaccine trials and

manufacturing in record time. In early 2020, AWS provided Pfizer with additional on-demand compute capacity within weeks, which the company used to accelerate clinical trial data analysis and scale up vaccine production (Pfizer at AWS re:Invent 2023 - Lidia Fonseca, Keynote Speaker - AWS). Pfizer had embarked on a cloud migration journey in 2019, and by 2020 it had moved roughly 80% of its IT environment (including tens of thousands of applications, databases, and servers) onto AWS (Pfizer at AWS re:Invent 2023 - Lidia Fonseca, Keynote Speaker - AWS) (Pfizer at AWS re:Invent 2023 - Lidia Fonseca, Keynote Speaker - AWS). This massive migration – transforming Pfizer from only ~10% cloud-based to ~80% in just months – paid off by giving the company the agility to conduct trials and regulatory submissions for the COVID-19 vaccine at unparalleled speed. Other pharma companies also leveraged AWS to support remote and decentralized trials during the pandemic, using AWS's secure networking and analytics to collect patient data from wearable devices and telehealth visits.

Beyond speed, cloud tools are improving **data quality and collaboration** in trials. Sponsors and contract research organizations (CROs) use AWS data lakes (Amazon S3-based) and analytics (Amazon Redshift, AWS Glue, QuickSight, etc.) to integrate data from global trial sites and perform interim analyses. Machine learning models can monitor incoming data to detect anomalies or safety signals early. For example, AWS's anomaly detection services like **Amazon Lookout for Metrics** can automatically flag irregularities in trial data (e.g. a site reporting outlying results), enabling quicker intervention. **Deep 6 AI**, a startup in clinical trial matching, uses AWS to apply NLP on medical records and has helped trial sponsors drastically shorten the time needed to find eligible patients (Healthcare & Life Sciences Case Studies - AWS). All these solutions contribute to shorter trial cycles and lower costs per trial, which ultimately means life-saving therapies reach the market sooner.

Supply Chain Management and Distribution on AWS

Pharmaceutical supply chains – from sourcing raw materials to distributing finished medicines – are highly complex and require precision and visibility. AWS is helping pharma companies modernize their supply chain management by providing IoT connectivity, data integration, and predictive analytics on a global scale. A core goal is to achieve an **"end-to-end" visibility of the supply chain**, so that companies can track production and inventory in real time and respond dynamically to demand fluctuations.

One prominent example is the **strategic collaboration between AWS and Novartis** to reinvent Novartis's supply chain and delivery operations. Novartis, which operates more than 60 manufacturing sites worldwide and supplies nearly 1 billion patients annually, partnered with AWS to unify its siloed supply chain data into a single cloud-based "Insight Center" platform (AWS and Novartis: Re-inventing pharma manufacturing - AWS for Industries) (AWS and Novartis: Re-inventing pharma manufacturing - AWS for Industries). Prior to this, Novartis had site-by-site reporting and a Hadoop-based data warehouse for manufacturing metrics that provided only batch updates and limited analytics (AWS and Novartis: Re-inventing pharma

manufacturing - AWS for Industries). With AWS, Novartis is moving to a real-time data architecture: **AWS IoT services** (such as AWS IoT Core, IoT SiteWise for equipment data, and IoT Greengrass for edge processing) connect factory sensors and equipment to the cloud continuously (AWS and Novartis: Re-inventing pharma manufacturing - AWS for Industries). All manufacturing and inventory data streams into Amazon S3 data lakes, where it is available for immediate analysis. Novartis can now monitor production output, supply levels, and quality metrics across all global sites through a unified dashboard (a "single pane of glass") (AWS and Novartis: Re-inventing pharma manufacturing - AWS for Industries) (AWS and Novartis: Re-inventing pharma manufacturing - AWS for Industries). This *holistic view of data* empowers supply chain managers to make data-driven decisions – for example, shifting production to different sites to prevent drug shortages if one facility experiences a slowdown (AWS and Novartis: Re-inventing pharma manufacturing - AWS for Industries) (AWS and Novartis: Re-inventing pharma manufacturing - AWS for Industries).

(AWS and Novartis: Re-inventing pharma manufacturing - AWS for Industries) *Harnessing the power of AI, IoT, and ML to scale production globally.* AWS-enabled pharma supply chains integrate smart factories ("Industry 4.0"), global data networks, and analytics. IoT sensors and computer vision provide granular data on materials and medicines as they move through the production process, while machine learning predicts and resolves issues before they happen. Cloud "insight centers" give real-time views of production and distribution across the network, enabling data-driven decisions to eliminate bottlenecks. The result is an **interconnected global supply chain** with real-time visibility from manufacturing through delivery, so lifesaving treatments reach more patients without delay (AWS and Novartis: Re-inventing pharma manufacturing - AWS for Industries) (AWS and Novartis: Re-inventing pharma manufacturing - AWS for Industries).

Another area AWS improves is **demand forecasting and inventory optimization**. By aggregating data on sales, prescriptions, and epidemiological trends, pharma companies can use AWS analytics to better predict where drugs will be needed. For instance, during the COVID vaccine rollout, vaccine manufacturers and public health agencies tapped cloud-based analytics to manage the complex logistics of delivering doses worldwide. Although specifics are often confidential, one can imagine AWS services like Amazon Forecast (for time-series demand forecasting) or Amazon Quantum Ledger Database (for verifiable supply chain tracking) being applied to ensure the right quantities of vaccines and medications are at the right place at the right time. **Merck** has noted that its cloud transformation is helping improve supply reliability: by using AWS data lakes and AI, Merck can more quickly identify supply bottlenecks or quality issues and adjust production to maintain steady supply (AWS and Accenture Help Merck Use Cloud Technology to Reduce Drug Discovery Time and Accelerate Clinical Trial Development) (AWS and Accenture Help Merck Use Cloud Technology to Reduce Drug Discovery Time and Accelerate Clinical Trial Development). Additionally, cloud connectivity simplifies collaboration with suppliers and distributors – AWS provides secure APIs and data exchange mechanisms that allow pharma companies to share forecasts and inventory data with raw material suppliers or

logistics providers in real time, reducing the bullwhip effect and keeping inventory levels optimized.

Overall, AWS brings the scalability and intelligence needed for modern pharma supply chains. Real-time data integration, predictive analytics, and IoT monitoring in the AWS cloud enable **proactive supply chain management** – companies can predict demand surges, detect disruptions (like a delayed shipment or a temperature excursion in a drug shipment), and take action early. This reduces the risk of stockouts or delays in getting medicines to patients. As pharma moves toward more personalized therapies (which often means smaller batch sizes and more complex distribution), having a cloud-based, flexible supply chain will be even more critical.

Smart Manufacturing and Quality Control with AWS IoT & Analytics

Manufacturing pharmaceuticals is a rigorously controlled process, and AWS is helping modernize pharma manufacturing by introducing IoT connectivity, automation, and advanced analytics on the factory floor. In "smart factories" powered by AWS, equipment is instrumented with sensors that continuously feed data to the cloud for monitoring and optimization. **AWS IoT** services, combined with machine learning, enable predictive maintenance, yield optimization, and higher product quality in pharma plants – all while maintaining compliance with Good Manufacturing Practices (GMP).

Several top pharmaceutical firms have launched digital manufacturing initiatives on AWS. **Pfizer**, for example, worked with AWS to enhance its continuous clinical manufacturing processes by incorporating *predictive maintenance* analytics. By deploying AWS IoT sensors on equipment like centrifuges, mixers, and coaters and analyzing their data with AWS machine learning services, Pfizer can predict failures before they happen and schedule maintenance proactively (AWS Helps Pfizer Accelerate Drug Development And Clinical Manufacturing - Pfizer) (AWS Helps Pfizer Accelerate Drug Development And Clinical Manufacturing - Pfizer). One solution Pfizer prototyped uses **Amazon Lookout for Equipment** (an AWS ML service for detecting abnormal equipment behavior from sensor data) to analyze vibration and pressure readings from production machines (AWS Helps Pfizer Accelerate Drug Development And Clinical Manufacturing - Pfizer). By detecting early warning signs of wear or anomalies, this AWS-powered predictive maintenance system helps **maximize equipment uptime** in Pfizer's drug product facilities (AWS Helps Pfizer Accelerate Drug Development And Clinical Manufacturing - Pfizer). In turn, higher equipment availability means Pfizer can more rapidly and reliably produce new drugs for clinical trials and eventual commercialization. In the Pfizer-AWS collaboration, the companies combined multiple services – Amazon Lookout for Equipment, Amazon **Lookout for Metrics** (for anomaly detection in process metrics), Amazon SageMaker, and Amazon QuickSight for visualization – to build an end-to-end monitoring system that reduced false

alarms and pinpointed relevant signals for engineers (AWS Helps Pfizer Accelerate Drug Development And Clinical Manufacturing - Pfizer) (AWS Helps Pfizer Accelerate Drug Development And Clinical Manufacturing - Pfizer). The result was a system that could detect anomalies in real time, predict maintenance needs, and thereby *reduce potential downtime* in Pfizer's continuous manufacturing of oral solid doses (AWS Helps Pfizer Accelerate Drug Development And Clinical Manufacturing - Pfizer).

Quality control is another critical focus. Pharma manufacturing involves verifying that each batch of medicine meets strict quality criteria. AWS AI services are being used for tasks like **automated visual inspection** and process analytics to improve quality and yield. **Merck** provides a compelling example: Merck built a computer vision system on AWS to improve detection of defects (such as cracks or foreign particles in vials) in its production lines (AWS and Accenture Help Merck Use Cloud Technology to Reduce Drug Discovery Time and Accelerate Clinical Trial Development) (AWS and Accenture Help Merck Use Cloud Technology to Reduce Drug Discovery Time and Accelerate Clinical Trial Development). Using Amazon SageMaker, Merck developed an ML inference pipeline for an inspection platform known as "HawkAVI" that analyzes high-resolution images from cameras on the manufacturing line (AWS and Accenture Help Merck Use Cloud Technology to Reduce Drug Discovery Time and Accelerate Clinical Trial Development). Even with limited training data on actual defects (since serious defects are rare), Merck applied generative AI techniques on AWS to help the model learn to identify anomalies while minimizing false positives. This cloud-based vision solution led to improved detection of issues, **reducing false rejection rates** and thereby increasing yield and product availability (AWS and Accenture Help Merck Use Cloud Technology to Reduce Drug Discovery Time and Accelerate Clinical Trial Development). Fewer good products being misclassified as defective means more medicine reaches patients and less waste is generated. Merck's use of AWS for this application demonstrates how **AI at the edge**, powered by cloud-trained models, can significantly enhance quality assurance in pharma manufacturing.

AWS also enables **integrated manufacturing data platforms** that break down silos between equipment, labs, and enterprise systems. For instance, **Novartis's "Insight Centers"** initiative (discussed earlier in the supply chain context) deeply integrates manufacturing operations with cloud analytics. At each site, AWS IoT Greengrass and IoT SiteWise collect data from shop-floor historians and even machine vision devices (like Amazon DeepLens cameras) (AWS and Novartis: Re-inventing pharma manufacturing - AWS for Industries). Data from production processes, environmental sensors, and even manual inputs are streamed into AWS where it can be analyzed jointly. Novartis uses Amazon SageMaker to build models like a computer vision algorithm for verifying **line clearance** (ensuring a production line is clear of any materials from a previous batch) – a task traditionally done manually between batch runs (AWS and Novartis: Re-inventing pharma manufacturing - AWS for Industries). AWS's suite of fully-managed AI services (including SageMaker, Amazon Textract for document scanning, and Amazon Comprehend for text) also allows Novartis to automate other labor-intensive GMP workflows. For example, Novartis is using Textract and Comprehend to digitize and analyze data from printed batch records and manufacturing documents, making it easier to review and audit them (AWS and

Novartis: Re-inventing pharma manufacturing - AWS for Industries). These kinds of innovations improve compliance and release times by catching deviations or issues faster.

Importantly, AWS's cloud infrastructure for manufacturing is designed with the **strict regulatory requirements** of pharma in mind (discussed more in the next section). Many pharma companies are migrating their core manufacturing IT systems (like MES and ERP) to AWS to gain flexibility. A common move is hosting **SAP S/4HANA (ERP)** on AWS – something companies like Moderna, Amgen, and Bristol Myers Squibb (BMS) have done while meeting GMP validation requirements (Pharma Manufacturing Use Cases - Amazon Web Services) (Pharma Manufacturing Use Cases - Amazon Web Services). By running SAP and production planning in the cloud, pharma manufacturers can scale computing resources as needed (for example, during end-of-quarter production peaks or product launches) and more easily roll out updates. AWS even provides a *GxP Installation Qualification (IQ) template* to help validate SAP on AWS according to regulatory expectations (Pharma Manufacturing Use Cases - Amazon Web Services) (Pharma Manufacturing Use Cases - Amazon Web Services). The payoff is greater agility: Moderna's fully cloud-based manufacturing facility (integrating SAP S/4HANA on AWS) was recognized with an *"ISPE Facility of the Future"* award for its innovative approach (AWS Innovator: Moderna - Case Studies, Videos and Customer Stories). That facility implements a "batch of one" concept – highly flexible production – by marrying traditional biotech equipment with AWS cloud services for data and automation.

In summary, AWS is enabling **smart pharma factories** that are more predictive, efficient, and connected. Industrial IoT data, when combined with cloud-scale analytics and AI, helps companies like Pfizer, Merck, and Novartis move from reactive to proactive operations. They can predict equipment failures rather than just respond to them, adjust processes in real time to maintain quality, and harmonize production across global networks. These improvements not only lower manufacturing costs and downtime, but ultimately ensure patients get high-quality medicines without delay or interruption.

Ensuring Regulatory Compliance and Security in the Cloud

Pharmaceutical and biotech companies operate in one of the most heavily regulated environments, with strict rules (from agencies like the FDA) governing data integrity, patient privacy, and product quality. A common question has been: *Can cloud computing be used while maintaining compliance with GxP (Good Practice) regulations and electronic record rules like FDA 21 CFR Part 11?* Today, the answer is a resounding yes – and AWS has developed a robust framework to help life sciences customers run validated, secure workloads in the cloud.

First, AWS itself supports a wide range of **compliance certifications and controls**. AWS is a **HIPAA-eligible** platform (offering signed Business Associate Agreements for handling protected health information) and conforms to high security standards (ISO 27001, SOC, etc.), which

provides a baseline for handling sensitive clinical data. For life sciences specifically, AWS has published guidance on complying with **21 CFR Part 11** (which sets requirements for electronic records and signatures in FDA-regulated industries) in the cloud (GxP Compliance - Amazon Web Services (AWS)). The AWS shared responsibility model means AWS manages the security and integrity of the cloud infrastructure, while the pharma company is responsible for validation of their specific applications/configurations. To ease this process, AWS offers tools like **AWS Audit Manager** with a Part 11 control framework (Title 21 CFR Part 11 - AWS Audit Manager), and maintains *"GxP compliance"* whitepapers and templates. For example, AWS provides an **SAP HANA Deployment Guide with GxP qualification** to help companies document their cloud installations of ERP systems for FDA compliance (Pharma Manufacturing Use Cases - Amazon Web Services). This has enabled companies like **Amgen** and **BMS** to migrate critical systems to AWS while remaining in compliance with GMP requirements (Pharma Manufacturing Use Cases - Amazon Web Services) (Pharma Manufacturing Use Cases - Amazon Web Services).

A key aspect of compliance is **validation** – proving that a system does what it's intended to do, consistently. Pharma companies have applied their validation methodologies to cloud deployments. Moderna's cloud-based manufacturing IT environment was fully validated as per FDA guidelines, demonstrating that an AWS environment can be qualified for GMP operations (Pharma Manufacturing Use Cases - Amazon Web Services). In practice, this involves using Infrastructure as Code (IaC) to deploy environments in a controlled, repeatable way (often leveraging AWS CloudFormation or similar), then executing qualification test scripts to verify the system's performance. Many companies are finding that once the base cloud environment is qualified, they can much more rapidly deploy and validate new systems on top of it – accelerating projects rather than hindering them. Additionally, AWS's ability to **segregate and secure data** (through VPC isolation, encryption, IAM access controls, etc.) often **improves the security posture** compared to legacy on-prem systems. For instance, AWS's granular Identity and Access Management can enforce least-privileged access to sensitive data, and services like Amazon Macie can automatically detect any accidental storage of personal data in the wrong location.

Another regulatory consideration is **data residency and global compliance**. AWS's worldwide regions allow pharma companies to keep data in specific geographic jurisdictions to meet local regulations (e.g. keeping EU clinical trial data in EU-based AWS regions for GDPR compliance). At the same time, AWS enables centralized governance – using tools like AWS Organizations and Service Catalog, IT departments can ensure that all cloud deployments adhere to corporate compliance standards (for example, ensuring all data is encrypted at rest and in transit, and all changes are tracked in AWS CloudTrail logs for audit purposes).

Finally, AWS has a growing ecosystem of **validated ISV solutions** available in its marketplace that address compliance needs. For example, there are laboratory information management systems (LIMS), electronic quality management systems (eQMS), and clinical data management tools that run on AWS and come pre-validated or with compliance packages. Companies can leverage these to avoid reinventing the wheel for common functions. AWS's own services are

continually being enhanced to meet life sciences needs: Amazon Comprehend Medical, mentioned earlier, is HIPAA eligible and can assist with tasks like redacting patient identifiers from documents. AWS's managed databases (like Amazon Aurora and Amazon DynamoDB) offer features like backup retention and audit logging that facilitate 21 CFR Part 11 compliance for data systems (e.g., ensuring electronic records are securely retained and auditable).

In summary, pharma companies have demonstrated that **AWS can be used in a compliant manner for even the most sensitive and regulated workloads**. With proper controls, documentation, and use of AWS's compliance toolkits, firms like Moderna, Pfizer, and others are comfortably running GxP systems in the cloud. In fact, by using AWS, they often achieve **better compliance outcomes** – such as improved data integrity and traceability – than was possible in fragmented legacy IT environments. The combination of AWS's security features and the ability to automate compliance (through infrastructure as code and monitoring) means fewer manual errors and a stronger overall quality system. As regulatory agencies have grown more cloud-aware, they too have embraced the idea that cloud infrastructure can be validated and compliant. This has opened the door for widespread cloud adoption without compromising on patient safety or data integrity.

Data Analytics and AI at Scale in Pharma

Data is often called "the new oil" in pharma – and AWS provides the refinery. Pharmaceutical companies generate and consume enormous amounts of data: research experiments, clinical trial results, genomic sequences, real-world patient outcomes, sales and health economics data, and more. Harnessing this data deluge requires robust storage, analytics, and machine learning capabilities, exactly what AWS offers as a comprehensive platform. Many pharma organizations have built **enterprise data lakes** on Amazon S3 to democratize access to data and enable advanced analytics across R&D, clinical, and commercial domains.

A powerful illustration is **Pfizer's centralized data strategy**. Pfizer worked with AWS to **centralize the company's scientific and business data** into a secure global cloud foundation (Pfizer at AWS re:Invent 2023 - Lidia Fonseca, Keynote Speaker - AWS) (Pfizer at AWS re:Invent 2023 - Lidia Fonseca, Keynote Speaker - AWS). By aggregating data from previously isolated systems (spanning research labs, manufacturing sensors, clinical databases, and commercial operations), Pfizer created a "single source of truth" in AWS. This not only broke down data silos but also reportedly helped Pfizer save *tens of millions of dollars annually* through IT simplification and legacy system retirement (Pfizer at AWS re:Invent 2023 - Lidia Fonseca, Keynote Speaker - AWS). With data in one place, Pfizer could apply uniform analytics and AI on top. As mentioned, their Scientific Data Cloud and AI initiatives (like the VOX generative AI) leverage this foundation to speed up querying of experiment data and derive predictive insights (Pfizer at AWS re:Invent 2023 - Lidia Fonseca, Keynote Speaker - AWS) (Pfizer at AWS re:Invent 2023 - Lidia Fonseca, Keynote Speaker - AWS). The outcome is a more data-driven culture: Pfizer's researchers and analysts can find and analyze information in minutes, where it used to

take days or weeks combing through disparate systems. This data-to-insights acceleration was crucial in Pfizer's ability to advance many projects in parallel (e.g., launching **19 new products in 18 months**, a goal tied directly to leveraging data and AI) (Pfizer at AWS re:Invent 2023 - Lidia Fonseca, Keynote Speaker - AWS).

Smaller but equally data-intensive biotech companies have also leaned on AWS for analytics. **Moderna** is a prime example of a "digital native" biotech that built its data infrastructure on AWS from day one. Moderna uses AWS to support every aspect of its data-driven operations, from early research to manufacturing. The company collects massive scientific datasets (for instance, high-throughput screening results or real-world evidence on disease outcomes) and needs to analyze them rapidly to inform its mRNA drug development. Moderna decided to standardize its entire **real-world data (RWD) platform on AWS**, using services like Amazon S3 for storage, AWS Glue and Lambda for data processing, and AWS Data Exchange to source external datasets (Streamlining Real-World Data Extraction and Analysis by 70% Using AWS Data Exchange with Moderna - Moderna Case Study - AWS) (Streamlining Real-World Data Extraction and Analysis by 70% Using AWS Data Exchange with Moderna - Moderna Case Study - AWS). By using **AWS Data Exchange**, Moderna can subscribe to curated healthcare data sources and ingest them directly into its analytics environment without lengthy procurement and ETL processes. In fact, Moderna achieved a **70% faster extraction and analysis of real-world data** after implementing this AWS-based strategy (Streamlining Real-World Data Extraction and Analysis by 70% Using AWS Data Exchange with Moderna - Moderna Case Study - AWS). Data onboarding that used to take 8–10 days was reduced to just 3 days, vastly speeding up their ability to generate insights from external health data (Streamlining Real-World Data Extraction and Analysis by 70% Using AWS Data Exchange with Moderna - Moderna Case Study - AWS). This is critical for Moderna to, say, analyze real-world vaccine effectiveness or disease prevalence as they develop new vaccines. The improved data visibility and single entry point also means their data scientists spend less time wrangling data and more time on analysis.

Popular AWS analytics services in pharma include **Amazon Redshift** (a petabyte-scale cloud data warehouse) for structured data analysis, **Amazon Athena** (which allows SQL querying of S3 data lakes without servers), and **Amazon QuickSight** for business intelligence dashboards. For example, in the AWS-Novartis manufacturing project, data from IoT streams lands in S3 and can be queried by Amazon Athena and visualized in QuickSight to provide operational dashboards to engineers (AWS and Novartis: Re-inventing pharma manufacturing - AWS for Industries) (AWS and Novartis: Re-inventing pharma manufacturing - AWS for Industries). Similarly, **AstraZeneca** built analytics solutions using **Amazon SageMaker** to automate machine learning model development for commercial analytics in just a couple of months (AstraZeneca Accelerates Time to Insights Using Amazon SageMaker). Across the board, pharma IT teams are using these tools to enable self-service analytics, where researchers or business users can run queries or train models on vast datasets without needing heavy IT support.

Crucially, AWS's analytics and AI at scale translate into measurable outcomes. The Hackett Group's analysis of life sciences firms showed that after cloud adoption, companies saw a **33%**

decrease in unplanned laboratory downtime (since experiments and data processing tasks can be run more reliably on cloud) and spent **20% less time on data analysis post-trial**, thanks to more efficient cloud-based analytics pipelines (Link) (Link). They also noted a **17% reduction in full-time equivalents (FTEs) required to manage data**, indicating that automation and better tools free up staff from manual data chores (Link). Most strikingly, organizations reported a **75% improvement in the ability to match disparate data sets** after migrating to cloud (Link). This speaks to the power of centralized data lakes: data integration – linking, for example, genomic data with phenotypic data with clinical outcomes – becomes far easier, unlocking new insights. More spending can then be directed to actual R&D; surveyed companies boosted annual R&D spend (as a % of revenue) by 4% on average after cloud adoption, reinvesting efficiencies back into science (Link).

Many are now layering advanced AI on top of their cloud data. Natural language processing (NLP) helps extract insights from scientific literature and internal reports. Computer vision models help analyze microscopy or pathology images. And increasingly, **generative AI** (like large language models and protein-folding AIs) are offered via AWS to pharma. AWS's new service Amazon Bedrock provides access to foundation models which pharma can use securely on their data – Pfizer's VOX system is one such use of Bedrock for life sciences (Pfizer at AWS re:Invent 2023 - Lidia Fonseca, Keynote Speaker - AWS). We can expect drug discovery teams to use generative AI to propose novel molecular structures, or clinical teams to use it for drafting study reports by synthesizing data, all within AWS's secure environment.

In essence, AWS has become the **analytics backbone** for data-driven pharma. It not only stores and processes data but provides higher-level services to derive meaning from it – whether through interactive dashboards or cutting-edge AI. This capability is transforming how decisions are made in pharma: researchers can iterate faster, executives can get real-time insights into portfolios, and even sales/medical affairs teams can better understand patient needs through data. As pharma continues to accumulate big data (genomic data, real-world patient data, etc.), the scalability and machine learning capabilities of AWS will be ever more crucial in translating that data into the next generation of therapies.

Major Pharma Case Studies and Outcomes

To appreciate the impact of AWS in pharma, it's worth looking at some **concrete case studies** and the outcomes achieved:

- **Pfizer** – *Global Data Cloud and AI Transformation*: Pfizer chose AWS as the core of its digital transformation, migrating ~80% of its applications to the cloud (Pfizer at AWS re:Invent 2023 - Lidia Fonseca, Keynote Speaker - AWS). Together, Pfizer and AWS built the Scientific Data Cloud to aggregate R&D data, and developed AI tools like the VOX generative AI platform to boost research productivity (Pfizer at AWS re:Invent 2023 - Lidia Fonseca, Keynote Speaker - AWS). This enabled Pfizer to *launch products faster* and respond rapidly to COVID-19 with on-demand computing for trials and manufacturing (Pfizer at AWS re:Invent 2023 - Lidia Fonseca, Keynote Speaker - AWS). Pfizer reports saving tens of millions of dollars via cloud efficiencies while empowering scientists with instant data access (Pfizer at AWS re:Invent 2023 - Lidia Fonseca, Keynote Speaker - AWS). The CIO of Pfizer noted data and AI on AWS were *"critical to our ambitious goal to launch 19 medicines and vaccines in 18 months"* (Pfizer at AWS re:Invent 2023 - Lidia Fonseca, Keynote Speaker - AWS).

- **Moderna** – *"Born in the Cloud" Biotech*: Moderna has used AWS since its inception to run virtually all operations. It leverages a broad range of services (EC2, S3, SageMaker, AWS IoT, etc.) to reduce the time and cost of bringing new mRNA therapies to market (AWS Innovator: Moderna - Case Studies, Videos and Customer Stories) (AWS Innovator: Moderna - Case Studies, Videos and Customer Stories). Moderna's cloud-native manufacturing facility uses AWS integrated with SAP, enabling flexible production and earning recognition as a model "facility of the future" (AWS Innovator: Moderna - Case Studies, Videos and Customer Stories). By relying on AWS, Moderna was able to **deliver its COVID-19 vaccine from design to deployment in record time**, scaling research and manufacturing globally in months (AWS Innovator: Moderna - Case Studies, Videos and Customer Stories). In data analytics, Moderna standardized its real-world evidence platform on AWS, achieving a 70% improvement in data processing times as mentioned earlier (Streamlining Real-World Data Extraction and Analysis by 70% Using AWS Data Exchange with Moderna - Moderna Case Study - AWS).

- **Merck** – *Cloud Migration and Innovation*: In 2023, Merck (MSD) announced it selected AWS as its preferred cloud provider and was moving a substantial portion of IT to AWS (AWS and Accenture Help Merck Use Cloud Technology to Reduce Drug Discovery Time and Accelerate Clinical Trial Development). This included migrating all its **SAP workloads to AWS** and building new capabilities like the HawkAVI vision inspection on the factory floor (AWS and Accenture Help Merck Use Cloud Technology to Reduce Drug Discovery Time and Accelerate Clinical Trial Development) (AWS and Accenture Help Merck Use Cloud Technology to Reduce Drug Discovery Time and Accelerate Clinical Trial Development). By using AWS's ML services (SageMaker) and HPC with HealthOmics, Merck can run complex simulations and omics workflows faster, helping **speed up drug discovery** and improving manufacturing yield (AWS and Accenture Help Merck Use Cloud Technology to Reduce Drug Discovery Time and Accelerate Clinical Trial Development) (AWS and Accenture Help Merck Use Cloud Technology to Reduce Drug Discovery Time and Accelerate Clinical Trial Development). Early results showed improved product availability (through fewer false rejects) and accelerated root-cause analysis in manufacturing (AWS and Accenture Help Merck Use Cloud Technology to Reduce Drug Discovery Time and Accelerate Clinical Trial Development). Merck also established a cloud training academy internally, recognizing that AWS skills are key to its ongoing innovation (AWS and Accenture Help Merck Use Cloud Technology to Reduce Drug Discovery Time and Accelerate Clinical Trial Development). The company expects significant cost savings and efficiency gains as it modernizes more applications on AWS, freeing resources for new research (AWS and Accenture Help Merck Use Cloud Technology to Reduce Drug Discovery Time and Accelerate Clinical Trial Development).

- **AstraZeneca** – *Data-Driven R&D*: AstraZeneca uses AWS to power various aspects of its R&D and IT. We saw how their **genomics analytics** on AWS can process huge workloads in under a day, feeding into dozens of drug projects (Genomics Data Processing Solution Runs 51 Billion Tests in 1 Day on AWS - AstraZeneca case study - AWS) (Genomics Data Processing Solution Runs 51 Billion Tests in 1 Day on AWS - AstraZeneca case study - AWS). AstraZeneca also built AI solutions on AWS to streamline clinical data analysis and even to improve clinical trial design. In one case, they developed a platform in 2.5 months using Amazon SageMaker to automate ML model development for commercial analytics, drastically reducing development time (AstraZeneca Accelerates Time to Insights Using Amazon SageMaker). The breadth of AWS services (Aurora, OpenSearch, Lambda, EKS, etc.) that AstraZeneca employs shows how deeply cloud is woven into their IT strategy – the company "uses AWS managed services wherever possible" so it can focus on science, not infrastructure (AstraZeneca uses AWS to do the Heavy Lifting While it Focuses on Delivering Business Value - AstraZeneca Video - AWS) (AstraZeneca uses AWS to do the Heavy Lifting While it Focuses on Delivering Business Value - AstraZeneca Video - AWS). AstraZeneca attests that embracing AI on AWS has helped it *deliver medicines to patients more quickly* by speeding up both small-molecule and biologics R&D cycles (AstraZeneca uses AWS to do the Heavy Lifting While it Focuses on Delivering Business Value - AstraZeneca Video - AWS).

- **Novartis** – *Manufacturing and Operations Reinvention*: Novartis's collaboration with AWS is a case of using cloud to re-imagine core operations (manufacturing, supply chain, and even procurement). Through the "Insight Centers" project, Novartis is implementing real-time data visibility and machine learning in all its production sites via AWS IoT and analytics (AWS and Novartis: Re-inventing pharma manufacturing - AWS for Industries) (AWS and Novartis: Re-inventing pharma manufacturing - AWS for Industries). Though still ongoing, the vision is already yielding benefits like predictive maintenance and better capacity utilization across 60+ plants (AWS and Novartis: Re-inventing pharma manufacturing - AWS for Industries) (AWS and Novartis: Re-inventing pharma manufacturing - AWS for Industries). Novartis also applied AWS ML in procurement – using SageMaker and Amazon Neptune (graph database) to build a knowledge graph that improved how it analyzes procurement data (as detailed in an AWS blog series). Early wins include better forecasting (using AWS's GluonTS library for time-series) and more efficient operations. Overall, Novartis expects to achieve a more agile supply chain, able to handle even personalized therapies, with AWS enabling small-batch production and quick scaling of treatments as needed (AWS and Novartis: Re-inventing pharma manufacturing - AWS for Industries).

These case studies underscore common themes: **speed**, **scale**, **cost efficiency**, and **innovation**. By adopting AWS, pharma companies have dramatically increased the speed of research (e.g. cutting analysis times from months to days), scaled up resources on demand (critical for peaks like a pandemic response or a large clinical trial), and often reduced IT costs through pay-as-you-go pricing. The cloud also served as a catalyst for innovation – enabling things like enterprise-wide data science platforms or digital twins of manufacturing lines that were difficult to achieve in legacy environments.

From a quantitative perspective, the industry-wide trends are compelling. Besides the 50%+ improvements in R&D throughput mentioned earlier (Link), pharma companies are seeing tangible efficiency gains: **33% less lab downtime**, **17% less effort on data management**, and significant improvements in data analysis and collaboration post-cloud (Link) (Link).

Furthermore, as per a PwC survey, the "cloud-powered" top 10% of pharma companies were realizing value at double the rate of others and even expecting 15%+ revenue growth, attributing this to their cloud-driven reinvention (How cloud is transforming pharma survey: PwC) (How cloud is transforming pharma survey: PwC). While cloud is not the only factor in success, it's clearly a foundational one.

Conclusion

The pharmaceutical industry's embrace of AWS reflects a broader digital transformation aimed at making drug development faster, more efficient, and more data-driven. AWS provides the technological backbone – from unlimited storage and compute to advanced AI services – that allows pharma IT teams to reimagine traditional workflows. Drug discovery researchers now deploy massive cloud HPC clusters to screen compounds or analyze genomes in hours, uncovering insights that lead to new therapeutics. Clinical development teams integrate and analyze trial data in real time, accelerating decisions and reducing the cost per new drug. Manufacturing engineers tap into IoT sensors and machine learning to ensure every pill and vaccine is produced with quality and with minimal downtime. And all of this is done under the watchful eye of compliance and security teams who, with AWS's tools, can maintain or even strengthen regulatory compliance and data security.

For IT professionals in pharma, AWS offers not just infrastructure, but a rich toolset tailored to industry needs: **data lakes for research**, **AI services like Comprehend Medical for text mining**, **HealthLake for health records**, **SageMaker for modeling**, **IoT and edge computing for factories**, and much more. The case studies of Pfizer, Moderna, Merck, AstraZeneca, Novartis and others show that these tools are delivering real value – whether it's shaving years off discovery timelines, saving millions in costs, or enabling breakthroughs like mRNA vaccines.

The trajectory is clear: cloud computing is becoming an integral part of how therapies are discovered, developed, and delivered. As we move forward, emerging technologies such as **generative AI**, **digital twins**, and **precision medicine** will further increase the reliance on cloud-scale computing and data management. AWS, continually expanding its services (over 200 fully featured services as of now (AWS Helps Pfizer Accelerate Drug Development And Clinical Manufacturing - Pfizer)), is well-positioned to support these evolving needs. For pharma companies that harness AWS effectively, the payoff is measured in more than just IT metrics – it's in **lives saved and patients helped** through faster availability of new, effective treatments. The cloud is enabling pharma to innovate at a pace never before possible, marking a new era where life-saving breakthroughs are limited less by technology and more only by our scientific imagination.

Sources: The information and examples above were drawn from a variety of reputable sources, including official AWS case studies and whitepapers, press releases from pharmaceutical companies, and industry analyst reports. Key references include AWS's documented

collaborations with Pfizer (AWS Helps Pfizer Accelerate Drug Development And Clinical Manufacturing - Pfizer) (Pfizer at AWS re:Invent 2023 - Lidia Fonseca, Keynote Speaker - AWS), Moderna (AWS Innovator: Moderna - Case Studies, Videos and Customer Stories), Merck (AWS and Accenture Help Merck Use Cloud Technology to Reduce Drug Discovery Time and Accelerate Clinical Trial Development) (AWS and Accenture Help Merck Use Cloud Technology to Reduce Drug Discovery Time and Accelerate Clinical Trial Development), AstraZeneca (Genomics Data Processing Solution Runs 51 Billion Tests in 1 Day on AWS - AstraZeneca case study - AWS), and Novartis (AWS and Novartis: Re-inventing pharma manufacturing - AWS for Industries), as well as data on industry-wide cloud adoption benefits from the Hackett Group (Link) and survey insights from PwC (How cloud is transforming pharma survey: PwC). These cases collectively demonstrate how AWS is transforming pharma operations in practice, with quantifiable improvements in speed, cost, and outcomes.

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