

Secure Lab Informatics in the Cloud

Climb™ Lab 360° Collaboration Suite



Digitalizing Research and Accelerating Discovery!

Table of Contents

SUMMARY	3
ELIMINATING DATA CHAOS	4
IN VIVO WORKFLOWS FOR DRUG DISCOVERY	5
INFORMATICS IN THE ANIMAL ROOM	6
LABORATORY ANIMAL HEALTH	7
MANAGING RESOURCES, ACTIVITIES, AND SCHEDULING	8
TRACKING SAMPLES	9
MICROINJECTION	10
MANAGING STUDIES	11
FEDERATED RESEARCH AND CONTRACT RESEARCH ORGANIZATIONS	13
REGULATORY REPORTING AND IACUC INSPECTIONS	14
ADVANTAGES OF LAB INFORMATICS IN THE CLOUD	14
IOT SENSOR SYSTEMS FOR ANIMAL LABS	16
SUMMARY AND CONCLUSIONS	17

Summary

Climb™: A Lab Informatics Platform for Pharmaceutical and Biotech Companies, Contract Research Organizations, and Academic Research Laboratories.

Biomedical research is process and data intensive. Study and discovery teams typically include staff from across the education and skill spectrum working in different departments, at different sites, and external organizations. This broad collection of people, skills, departments, sites, and contractors working together on regulated, technical, and expensive research creates an enormous challenge to effective management.

According to RockStep surveys, over 70% of pre-clinical research and development (R&D) still rely on paper, spreadsheets, share folders, or homespun solutions, creating data silos and fragmented analytical environments. In these environments, data are difficult to locate and compile for analysis, QC checks, and regulatory reporting. Small one-off studies may be able to navigate the data chaos, but research programs operating at scale or those heading for an investigational new drug (IND) submission, for example, suffer in quality and efficiency. According to Jack W. Scannell and Jim Bosley's [research article](#) published in Plos One, *"R&D costs per drug approved roughly doubled every ~9 years between 1950 and 2010, with costs dominated by the cost of failures."* Wasted staff resources and time delays, in getting from discovery to IND submission, can be costly to an industry already struggling with getting acceptable return on investment (ROI) from R&D expenditures.

New cloud solutions are emerging that address some of the challenges of managing data, workflows, research animals, and samples. These solutions are bringing order to the chaos. However, most are point solutions that solve specific problems, and do not address the fractured data silo problem.

Climb™ from RockStep Solutions, is an enterprise solution that covers the entire spectrum of challenges in one integrated package. Because Climb is modular, configurable, and can integrate with other technology tools, organizations can choose to adopt specific functional modules to fill in the gaps, or they can choose to adopt the whole solution and solve all their operations and data management challenges at one time with one seamless software application.

Climb is a subscription enterprise informatics platform for managing biomedical research operations and data. Architected for the secure Microsoft Azure Cloud and delivered as software as a service (SaaS), Climb can be used by small labs or enterprises.

This white paper presents some of the areas in biomedical research where Climb is used to address research challenges. This paper highlights some of the Climb use-cases. For more information about Climb, please visit <https://www.rockstepsolutions.com/> or email us at info@rockstepsolutions.com.



Eliminating Data Chaos

As reported widely in the news, the ROI for R&D in the biomedical industry is tumbling rapidly. Data scientists are known to spend as much as 80% of their time wrangling data rather than doing analysis that brings value to research. As efforts to develop new drugs and therapies rely more and more on large quantities of study data, the data corral is getting crowded. It is not unusual to find a single share folder with thousands of spreadsheets of study data. Highly skilled and expensive data wranglers are now needed to locate, QC, merge, aggregate, and harmonize data for analysis. These manual processes are not only costly, but they are error prone and can lead to missed discovery opportunities or false starts at a time when efficiency and quality improvements are needed most.



Challenges of a data and analytical platform with spreadsheets and folders

- Locating data
- Conducting data QC
- Harmonizing data
- Searching and combining data across time and studies
- Developing a 360° data view of experiments and research subjects
- Managing secure data access and delivery to research collaborators
- Preventing data loss or destruction

Climb helped solve the challenge for an aging research study

In a recent Climb deployment in Dr. Gary Churchill's laboratory, at The Jackson Laboratory, RockStep loaded 1300 legacy spreadsheets and media files with over 93,000 data points into Climb, as part of an industry collaborative aging study. As part of this deployment, RockStep created data import templates so new spreadsheets coming off instruments could be easily imported into Climb via a drag and drop interface. For this research program, Climb enabled multisource data to be queried and output in standard formats. Data wranglers no longer have to spend hours and days cutting and pasting data for quality control (QC) checks and organizing data for analysis.

Dr. Churchill's Lab, The Jackson Laboratory

"... the time we'll save retrieving, quality checking, and analyzing data will significantly increase as the studies progress and we accumulate data,"

- Gary Churchill, Ph.D., Professor Karl Gunnar Johansson Chair, The Jackson Laboratory

In Vivo Workflows for Drug Discovery

High-throughput in vivo drug discovery workflows place intense demands on lab technicians and the animal care takers who have to move quickly through their tasks of locating animals, taking measurements, injecting compounds, or conducting physical exams of research subjects. In addition to challenges in the animal rooms, lab managers must be able to schedule tasks, manage resources, and have full situational awareness of progress and all lab activities. Finally, scientists need to aggregate data and potentially get 360° views into individual research subjects. Data need to be pulled together from multiple sources, across study types, and across departments in order to draw conclusions.

Challenges for in vivo drug discovery workflows

- Managing and scheduling resources
- Locating the correct animals for testing
- Logging activities and recording data
- Tracking lot numbers
- Communicating with vet staff, lab managers or scientists when questions arise
- Quality checking data
- Aggregating data for analysis
- Maintaining audit trails and chain of custody



Climb is a best in class for in vivo drug discovery workflows

Climb helps manage in vivo studies from start of study design through planning, execution, and data aggregation. Climb's task management tools allow scientists to choose from existing workflows or create new task templates as needed. Tasks can be configured to provide appropriate levels of detail to ensure consistent execution by different technicians potentially working at different sites. Climb's workflow engine is configurable to optimize work across therapeutic areas.

Lab managers use Climb's scheduling calendar tool to assign detailed tasks to technicians and balance workloads across study teams. Technicians work with mobile devices and scanners to locate animals, conduct tests, and capture data. Scientists use Climb to retrieve study data for input into their analytical tools for data analysis.



All lab activities and research communications are logged in real time and auditable with complete chain of custody tracking for all research objects.

Informatics in the Animal Room

Animal rooms are controlled spaces that require special entry procedures. Animal caretakers usually need to “gown up”, and in some cases may even have to shower, to get into high health status rooms (barrier rooms). Care takers often wear face masks and gloves while handling animals and cages. In all cases, making their work plans clear, and their data entry easy, improves the quality of work and ultimately improves the efficiency of the operation.



Processes performed in the animal room

- Managing complex breeding strategies
- Weaning and separating animals
- Collecting samples for genotyping
- Locating mice for tests and breeding
- Changing cages, checking food and water
- Conducting strain census
- Conducting animal welfare checks
- Writing and reading cage cards

Climb helps streamline work in the vivarium

With Climb, lab managers create task lists that specify the level of detail needed for each task to be successfully accomplished. Tasks can contain instructions for any work activities, including breeding, handling, moving, or genotyping animals. Each animal record includes location information to instruct the technician as to where the animal is located. Technicians using Climb can move quickly and efficiently delivering high quality work. Technicians can use computer tablets, bar code scanners, label printers, printed cage cards, and RFID tags with readers to help automate their activities. When a technician observes an animal in distress, a video or photo may be taken, if allowed, and a quick message can be sent to veterinary staff, allowing immediate decision making and initiation of treatment plans. See section on Lab Animal Health for more information.

Dr. Siegenthaler Lab, University of Colorado, Denver

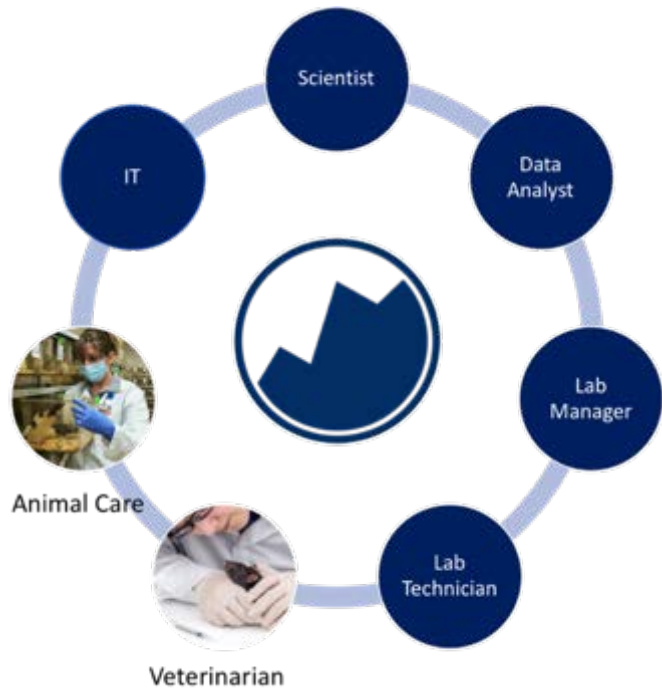
“A big positive for us is that Climb is web based... Previous databases kept all our information on one computer, and with Climb, we don’t worry about our colony data getting lost if something happens to the computer. It’s always available. Climb is user friendly, and it doesn’t take very long to learn how to use it and there is a lot of support from the company to help with training. Along those lines, the customer support is awesome! Anytime we’ve had an issue, the support team is very accommodating and always handles our concerns in a timely manner. For example, we wanted customized cage cards and they were great about the design and making the cards available for us to access relatively quickly. We would highly recommend Climb for animal colony management and research laboratories.” – Julie Siegenthaler, Assistant Professor, Dept of Pediatrics, University of Colorado, Denver.

Laboratory Animal Health

Animal health staff need to be alerted as soon as possible when an animal is observed to be suffering. Getting in and out of animal rooms is expensive in terms of staff time, materials, and added animal risk, and the process interrupts the regular flow of work. After diagnosis, a veterinarian may need to create a treatment plan for an animal. For regulatory compliance, treatment plans must be tracked and assigned to qualified technicians. Audit trails must be in place to ensure all animal treatments are conducted, and animal treatment notes are taken.

Challenges for lab animal health management

- Timely reporting of animal health concerns
- Quick response
- Locating mice for treatment
- Assigning and scheduling treatment plans
- Treatment auditing
- Treatment resolution and reporting
- Auditable communication trails



Climb is a solution for laboratory animal health management

When an animal care taker or veterinary technician observes a problem, veterinary staff can be alerted immediately with SMS, emails, or directly through the Climb message center. Messages can direct staff to animal records with video or photographs, if allowed, of the distressed animal. In all cases, the alert is tracked in the Climb audit logs. Veterinary staff can respond immediately with instructions, or they can make the decision to enter the animal room to conduct an animal examination.

Climb makes regulatory reporting simple. Veterinary staff pull detailed reports from Climb, and if an audit is conducted, Climb's audit logs can easily be viewed to track any information changes (add, edit, or delete), view the previous values, and track who made the changes.



Dr. Prusiner's Lab, University of California, San Francisco

"[Climb is] drastically improving the operations of our Animal Care and Use Program." – Julian Castaneda, DVM, Ph.D. DAFLAM, Director of Animal Facility, University of California, San Francisco

Managing Resources, Activities, and Scheduling

One of the major challenges in running a research lab is assigning people and lab resources to tasks. Lab managers and veterinary staff have limited resources that need to be optimally used to meet increasing demands to get more work done with the resources they have. In addition, task assignments cross inter-department or institution boundaries. For example, animal care technicians may be assigned to retrieve animals and put them in a secure staging area before they are moved to a phenotyping pipeline. After phenotyping, samples might be collected that need to be processed in one place and then shipped to another location for imaging. Managing resources, tracking, and scheduling can be a daunting challenge.



Challenges for managing resources, activities, and scheduling

- Determining resource availability
- Over or underutilizing resources
- Communicating tasks across distributed teams
- Capturing data from distributed resources
- Real-time visibility into progress
- Audit trails
- Traceability: who conducted a task
- Having access to task lists with detailed instructions

Climb helps labs manage resources, activities, and scheduling

Climb has powerful scheduling tools for assigning resources to tasks, with color coded scheduling and calendar views. Groups of tasks can be timebound, put into jobs and protocols, and executed on individual or cohorts of animals. Tasks can be created, assigned to technicians, and associated with animals or biological samples in the database. Task records can include detailed instructions, for example, instrument calibration procedures, to guide the technician. Task records can be used to collect data for the task (e.g. body weight). Climb supports several different task types that are configurable to cover a large scope of preclinical research work.

Dr. Korstanje's Lab, The Jackson Laboratory

"Adopting Climb has improved our lab's efficiency and makes it possible to simultaneously manage multiple experiments, coordinate resources, and conduct complex protocols. In addition to having a great product, their support team is fantastic. Climb is clearly a leader in lab animal management systems!" – Ron Korstanje, Assistant Professor, The Jackson Laboratory.

Tracking Samples

Research labs often generate large numbers of samples that need to be appropriately processed, stored, and discoverable when needed. The value of samples is limited by the quality of information associated with the sample.

Challenges for tracking samples

- Managing sample inventory
- Locating samples when needed
- Finding accurate information about a sample's status
- Tracking sample history and pedigree
- Tracking sample usage in experiments



Using Climb for sample tracking

Lab managers are often tasked with sample inventory management. They need to know exactly what samples are in storage and where to retrieve them from. They also need to know how the sample was fixed, who performed the task, and how long the sample has been in storage. Perhaps most importantly, scientists need to know the pedigree of the samples and may need to review microscopic images or other important data associated with the samples. Climb includes an integrated sample management module. Researchers can use Climb to locate samples and drill down to all the details for a 360° view of a sample's history, pedigree, and data.



Dr. Brown's Lab, University of Virginia, School of Medicine

"There are a lot of positive things about Climb and RockStep Solutions. The support and response is outstanding! The team is always open to making sure we have everything we need. This is a HUGE BENEFIT! The functionality of Climb is exactly what we needed, especially since we can tailor it to our needs." – Alyssa Gillespie, Lab Manager, Research Specialist Senior, University of Virginia.

Microinjection

Microinjection is the process of injecting microscopic materials into cells using a needle and pipet. Pronuclear injection of genetic materials is one of the most common techniques used for genetic engineering. Successful microinjection for the development of transgenic or knockout animals takes a significant amount of planning and lab work. Scientists and lab managers are required to follow detailed protocols, log their activities, and keep accurate records of DNA constructs and the results.



Challenges for information and process management for microinjection

- Tracking development of a new animal model and associated constructs
- Executing protocols, tracking progress and data
- Assigning tasks to laboratory technicians
- Tracking samples
- Tracking genotypes
- Tracking success rates

Climb helps laboratories manage their micro injection projects

Scientists and lab managers developing new animal model lines need to synthesize large amounts of data and develop detailed plans for executing their projects. As a lab informatics tool, Climb provides background information that scientists can use to plan their science and genetic engineering projects. Climb's protocol and workflow module is built to meet a lab manager's need to communicate precise instructions for execution of tasks by technicians. As protocols and tasks are executed by technicians, data related to the microinjection process is entered in Climb and made available to the lab manager or scientist. With Climb, scientists and lab managers have visibility into the process and can monitor progress in real time. Climb also has a built-in report that helps the researcher track success rates.



Managing Studies

A scientific study usually starts with a scientist designing an experiment to test a hypothesis. The experimental design may include animal cohorts, phenotyping tests, complex behavioral protocols, PK studies, efficacy testing, and any number of other appropriate experimental tasks. Scientists need to translate those designs into actionable tasks that may require sophisticated instruments with precise calibration requirements or time-sensitive activities. Lab managers need to plan activities for their lab staff and resources (rooms, animals, equipment, etc) to make sure they can execute effectively and not be assigned work that exceeds their capacity.

Information and process management challenges for managing studies

- Project management
- Aggregating, harmonizing and delivering data
- Communications across distinct activity spaces and sites
- Creating executable instructions that can be followed by technicians
- Assigning tasks to laboratory technicians
- Executing tasks, tracking progress



Climb as a central tool for managing a whole research laboratory

Executing large studies can be an enormous logistical challenge. Often the whole laboratory is involved, using many nonintegrated point-solutions and putting data in share folders. Large studies may include collaborations with other research labs or data from CROs. Climb can be the communication and data conduit that unifies the various groups working on the study. Scientists can create and set up protocols in Climb, lab managers can assign staff to tasks, and animal care takers can log biometric data. All data generated in the study can be put into Climb, searched, and extracted for analysis. Climb eliminates the need for a suite of disconnected point solutions, binders, and spreadsheets. It makes it easy to manage reporting for IACUC semi-annual inspections, AAALAC site visits, and USDA inspections.

Use case – managing studies at the UCSF IND

A 50-person research group in the Institute for Neurodegenerative Disease (IND), under the directorship of Nobel Laureate, Dr. Stanley Prusiner, partnered with RockStep to develop requirements and test Climb functionality for tracking animal breeding, genetic distributions, veterinary work, biological samples, experiments, screenings, data delivery, workflow, resource management and scheduling. When the project started, the IND was committed to streamlining their business processes. They wanted to improve

their research quality and reduce the expense of maintaining their aging technologies and homegrown systems. This collaboration with RockStep Solutions led to innovations that have helped make Climb a best-in-class solution for animal model research and drug discovery. Dr. Prusiner's lab now uses Climb as a single solution to manage their research program across a diverse group of scientists, technicians, and project managers working at different sites and with collaborators at other institutions.

Climb improved their quality, increased their efficiency, and reduced costs while enabling science that was difficult to conduct using legacy tools and email.



Digitalizing research labs improves quality and increases operational efficiencies if done correctly. Planning for the roll out and getting buy-in from stake holders is essential. Keep in mind that half of the laboratory staff will typically resist change. You need to get early champions on board and identify the laggards who will be slow to buy in. We recommend reading Diffusion of Innovations by Everett M. Rogers. Understanding how populations react to and adopt change is paramount to success.

Dr. Prusiner's Lab, University of California San Francisco

"We selected this company because many of the people in it have direct, hands-on, experience in other world-class animal programs, and we felt that they really understood our needs. They have been very responsive to our requests, and we are appreciating the fruits of our collective hard work." – Julian Castaneda, DVM, Ph.D. DACLAM, Director of Animal Facility, University of California, San Francisco

Federated Research and Contract Research Organizations

Research is often conducted by multidisciplinary teams who work toward one scientific goal, across distinct sites, conducting different tests and often operating in different time-zones and countries. Contract research work is often conducted using documents to exchange data and protocols. Email and cloud repositories, like Dropbox, act as communication pipes to deliver messages and data. These tools are not designed for team collaboration.



Challenges for managing federated research and contract research orgs

- Easy access to audit trails
- Compliant security and data access controls
- Data wrangling
- Data searching across time, studies, and sites
- Data harmonization and normalization
- Real-time visibility into progress and laboratory activities across sites and studies

Climb helps manage data and protocols for federated research and CROs

Climb solves the challenges of managing federated research by providing a secure platform for collaborative studies. Hosted in the robust Microsoft Azure cloud, Climb is a secure information bridge that spans geographical regions, time-zones, and international boundaries. Scientists at one site can create tasks, detailed protocols, and assign animal cohorts to studies. Those studies can be executed at another site. Lab managers at the site of performance can use Climb to schedule activities, and data analysts can access data in real time. All participants in the study can have controlled visibility into the study progress and data. Meanwhile, IT departments do not have to manage access to data behind their firewalls, which may create institutional security risks. At the end of a study, all data and associated metadata are safely stored in one location for easy access.

Dr. Churchill's Lab, The Jackson Laboratory

"Our lab conducts high throughput lab animal phenotyping and generates enormous amounts of complex data. We have high-profile research contracts with NIH and with leading edge companies. Reliable and accurate data capture, experimental reproducibility, and process control are crucial to our science. We tried a large on-premises LIMS, and it failed to meet our need to share data across multiple sites. RockStep Solutions stepped up to the plate with Climb, and their expert data wrangler team worked directly with our phenotyping team to help address our needs. Our lab now runs more efficiently, and we are getting more science done!" - Gary Churchill, Ph.D., Professor Karl Gunnar Johansson Chair, The Jackson Laboratory

Regulatory Reporting and IACUC Inspections

Institutional animal care and use committees require that researchers maintain detailed notes on animal breeding, use, and protocols. Researchers need to be able provide records on how each animal was used in a study, and they need to be able to produce laboratory animal health records (diagnostic and treatment). For labs using paper or spreadsheet-based informatics systems, reporting is often a time consuming and stressful process requiring the time of many staff members. Time is wasted through back-and-forth emails in an effort to gather information and clarify details.

Challenges of regulatory reporting

- Tracking down detailed information on the use of hundreds of animals
- Status of on-going studies
- Tracking down information about status of animals on the shelf waiting to go into studies
- Detailed records on which technicians conducted tests or animal surgeries
- Tracking how many animals were used
- Locating all animal health records



Climb makes regulatory reporting easy

Research labs using Climb can easily prepare for annual regulatory reporting. With a few mouse clicks, they can report on all animals used or planned for use in a study. Reports can include health status, what the animals were used for, who conducted the tests, and what the outcomes were. During regulatory inspections or AAALAC site visits, printed cage cards with bar codes make it easy for inspectors to understand the connection between the physical world in the animal room and digital data in the database. Regulatory reports and inspections do not need to be massive time-consuming operations if the database is up-to-date.

Advantages of Lab Informatics in the Cloud

Information Technology for biomedical research is undergoing a rapid transformation as applications and data are moving into the cloud. According to the IT consulting firm Gartner, over 75% of all biomedical

Dr. Mu Yang Mouse Neuro Behavior Core, Columbia University Medical Center

"I just want to share my positive experience with you about Climb. Prior to using Climb, it was difficult to keep a perfect record on animal usage. It was always a pain when it comes to dealing with IACUC reviews. Since we started using Climb a year ago, we have had no mistakes in keeping records, and data entry is a breeze. During our protocol annual review a short while ago, IACUC had zero questions on our animal usage! Thank you!" – Mu Yang, Ph.D., Director, Mouse Neuro Behavior Core, Institute for Genomic Medicine, Columbia University Medical Center

research organizations will have a cloud-first policy by 2019. R&D IT is no longer defined as a suite of on-premises applications and services that are installed behind firewalls and run on servers controlled by local IT staff and accessed via local area networks. Researchers now use applications and data that are accessed over the Internet and hosted on clouds and servers that are managed by different providers.

The movement into the cloud has accelerated as cloud infrastructure and security have matured. Whereas on-premises solutions require expensive dedicated hardware, server rooms, security staff (physical and cyber), regular maintenance, and disaster recovery plans, software as a service (SaaS) solutions are simply licensed by subscription. With SaaS solutions, all the infrastructure, maintenance, security, and disaster recovery systems are provided with the service. In addition, Cloud providers such as Azure, AWS, Google, and Salesforce, can provide SOC 1 Type 2 audit reports, required by many institutions where data security is a concern.



According to Technavio Global 2015 LIMS report, 85% of the total cost of ownership of on-premises enterprise software goes into maintenance, hardware, security, and disaster recovery systems. The cloud provides elastic resources with nearly infinite capacity for growth and access to global infrastructure and the most advanced technologies such as machine learning, artificial intelligence, mobile service, and geo-replication.

IoT Sensor Systems for Animal Labs

Researchers continue to struggle with experimental repeatability. The National Institutes of Health has expressed that experimental reproducibility is one of the two cornerstones of science (<https://www.nih.gov/research-training/rigor-reproducibility>). Studies conducted with the same research models in different labs often produce inconsistent results. Being able to factor in, and control for, environmental conditions at the same time tests are conducted will help investigators develop better protocols providing more consistent results.



Climb mobile IoT

Internet of Things (IoT) devices are now commonplace, have significant computational capacity, powerful sensors, and batteries that can last years. With IoT systems, smaller is better, and IoT devices are increasingly miniaturized. In addition, machine learning algorithms can monitor IoT data streams and detect anomalous conditions.

Climb currently supports stream data from IoT devices built by Elemental Machines Inc. EM's devices have sensors that measure temperature, humidity, noise, and light. EM devices are plug and play and can survive vaporized hydrogen peroxide sterilization for use in high health status barrier rooms.



Climb users simply register the devices and associate the data streams with the relevant database objects such as animals, rooms, or cages. Facilities managers and scientists can have access to environmental data over any time-period and receive alerts in real-time if anomalous conditions are detected. Scientists can correlate the readings from the IoT devices with experimental data to better control the experimental conditions and reduce the number of experimental unknowns.

Summary and Conclusions

Biomedical research is competitive. Drug companies are seeing their ROI for R&D drop rapidly as most of the easy drug targets have already been identified and are in late-phase clinical trials or are approved drugs. To remain competitive and profitable, organizations must become more efficient and improve quality with fewer resources. Digital transformation is one of the cornerstones for streamlining R&D processes. Modern digital systems can accelerate discovery, reduce costs, improve quality, and simplify IND submissions and regulatory reporting.

University research, while largely grant or foundation funded, is not immune to the economic pressures to improve quality and reduce costs. Grant funding is getting more competitive and difficult to depend on. Universities are relying more and more on sponsored research and/or are acting as CROs to improve their bottom line. Quality and efficiency are included in the KPIs for non-profit research, as well as for-profit drug discovery.

Climb can be deployed as the core platform for digital transformation in any biomedical research organization. Climb is for managing research operations across the spectrum of research activities from the vivarium to the scientist's analytical work bench. Climb is modular, so adopters can work with the individual modules of functionality that they need and integrate easily with other tools in their data ecosystem.

Architected in the Microsoft Azure cloud, Climb is a platform for today's lab and for the lab of the future. Climb's simple subscription SaaS license model ensures you have a quick setup, with easy on-boarding. All application support, database backups, and security is provided by RockStep Solutions. Data are geo-replicated in real time meaning you automatically have a disaster recovery plan included with your standard subscription license. Climb has global infrastructure, it is scalable and cost-effective for managing research collaborations, operations, and data.



For more information please visit <https://www.rockstepsolutions.com/> or email us at info@rockstepsolutions.com.