ATROPOSHEALTH

From Data to Savings: Leveraging Real-World Evidence to Reduce Healthcare Costs

June 2023

Evidence-Mediated Reduction in Healthcare Costs

Healthcare organizations are under increasing pressure to provide high-quality care while managing costs. The key to aligning these aims already lies within their walls – the vast real-world data (RWD) repository within their electronic health record (EHR) systems. Converting RWD into real-world evidence (RWE) produces insights, deeper and more contextualized than with traditional data warehouses, which healthcare organizations can use to reduce costs without compromising care. This white paper examines how the Atropos Evidence Platform automates and streamlines the process of converting RWD into actionable, cost-cutting RWE. By eliminating the longstanding barriers of time and effort to learn from clinical data, the platform enables healthcare organizations to uncover optimal care pathways per patient group, medication cost vs. effectiveness, and new scientific discoveries. The potential cost savings are already evident in areas such as medications, care variation, and research. Further utilization of the platform will determine how these cost savings extend to other focus areas, such as readmission rates, length of stay, and emergency department (ED) and intensive care unit (ICU) utilization. This paper provides a comprehensive overview of the financial benefit of implementing RWE from EHR RWD across healthcare organizations.

From Data to Savings: Leveraging Real-World Evidence to Reduce Healthcare Costs

By Valerie Garrett, MD; Elizabeth Krusch; and Saurabh Gombar MD, PhD

June 2023

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01. Executive Summary

Overview

Atropos Health is the first provider of on-demand real-world evidence (RWE) at the point of care. The Atropos Evidence™ Platform enables the Green Button Informatics Consult Service (Green Button), that clinicians use to request evidence for specific patient cases. After the request is submitted, the Green Button generates observational research based on hundreds of millions of deidentified patient records. Within 48 hours, findings are delivered as an e-consult. The user experience is similar to peer-to-peer interactions, but is supported by publication-grade evidence suitable for informing care and policy decisions.

Approach for User Experience and ROI Study

This white paper discusses the findings of a 12-month retrospective analysis of platform use at a large academic medical center (AMC). Clinical reviewers from Atropos and the AMC reviewed hundreds of Green Button consult requests from practicing clinicians, researchers, and policy leaders during a one-year period. Subsequently they analyzed the user experience, patterns of adoption, and calculated the fiscal return on investment (ROI) for the AMC's clinical, business, and research enterprises.

Key Findings

The study found significant ROI for the AMC, including a potential annualized cost savings over over $3M. This includes hard-dollar savings realized during the study period, savings expected to result directly from platform use, and savings projected from targeted action per the evidence. Key areas contributing to this value were medication cost savings, research acceleration, and patient throughput and care management. Even a singular Green Button consult request could provide actionable evidence for patient care, be transformed into a publication, or support department and institution-wide policy changes pertaining to clinical quality, population health, pharmacy administration, and beyond. During the year studied, high-quality user experience led to utilization patterns that exceeded expectations - as demonstrated by the dozens of peer-reviewed publications generated during that time. A selection of these platform outputs can be accessed here.

Implications

The concept of a Learning Health System is not not a new one, but the ability to provide personalized evidence at the point of care is. Atropos Health enables a rapid generation of insights from healthcare data, leading to rapid value for healthcare and research organizations. Personalized, local evidence is crucial to improve outcomes and costs in healthcare. It's now possible with Atropos. Learn more here or visit www.atroposhealth.com.

Academic Medical Centers Can Unlock $3M in Savings from 1 Year with Atropos Evidence Platform

Real World Evidence

From institutional EHR data in 48 hours.
Generated on-demand after a user submits a simple question or hypothesis.

$576,723 in Medication Cost Savings

Enabled by formulary optimization and treatment decisions based in comparative effectiveness research on RWD.

$1,196,000 in Research Savings

Possible from a faster, easier research process. Yielded dozens of publications, 24 weeks faster than with standard methods.

$1,617,000 from Patient Throughput & Care Management

Evidence identified opportunities for targeted action to reduce LOS. Findings spanned studies on BMT, septic shock, and resident training.

02. Introduction

Overview

Atropos Health is a groundbreaking healthcare technology company dedicated to helping healthcare and research organizations unlock the power of electronic health record (EHR) data to optimize healthcare delivery. Through its innovative Atropos Evidence™ Platform, it empowers organizations to generate actionable insights from their EHR or other real-world data at scale, fostering significant enhancements in operational efficiency, clinical outcomes, and cost-effectiveness. This white paper provides an in-depth review of the transformative impact Atropos Health has had during one year of implementation at a leading academic medical center. It delves into the unique features and capabilities of the platform, examines its clinical use and influence across different departments, evaluates its ROI, and describes future opportunities. By shedding light on the emerging opportunity for routine evidence-based practice and its benefits, this paper aims to provide a valuable resource for healthcare leaders seeking to maximize the value of clinical data assets.

The Beginnings of Atropos Health

At Stanford Health Care in 2011, clinician scientists had an idea: what if actionable insights from the EHR could be extracted at the touch of a button? This spurred the "Green Button" research project in the lab of Dr. Nigam Shah, MBBS, PhD. Highlights from the 5-year research project include the development of a proprietary Advanced Cohort Engine (ACE) and temporal query language (TQL). With ACE, the data of a single patient are stored together and indexed by features and time. The team also designed an automated analytics pipeline with templatized observational study designs and machine learning (ML) for advanced statistical methods like high-dimensional propensity score matching (HDPSM), to simplify generation of user-ready study reports (Exhibit 2).[1]

Exhibit 2

Technologies Preceding Atropos Health

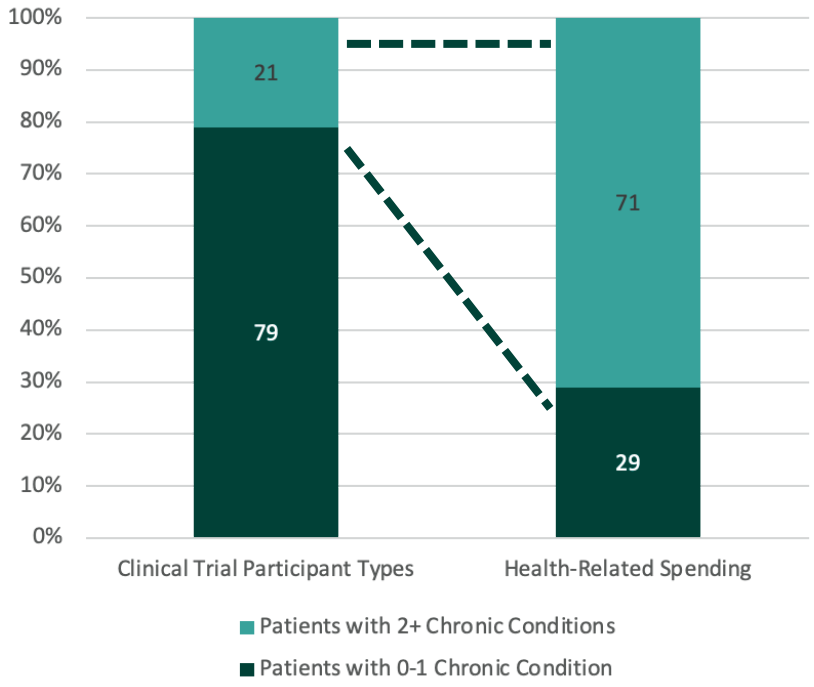
Common Data Model | ACE + TQL | Analytics Pipeline

On a Mission to Close the Evidence Gap

To understand the importance in healthcare of access to timely and relevant insights from clinical data, consider the concept of the evidence gap. A key contributor to the fiscal and operational challenges facing healthcare is the enduring lack of evidence for diverse patient care. Randomized controlled trials (RCTs) are widely regarded as the gold standard to support the use of treatments and interventions.[2] Yet these studies routinely underrepresent the demographic and clinical diversity of the population. This mismatch of available evidence to population needs significantly impacts healthcare costs and clinical outcomes. The Agency for Healthcare Research and Quality (AHRQ) Multiple Chronic Conditions Chartbook shows that patients with two or more chronic conditions accounted for 71% of healthcare-related spending but only 21% of clinical trial participants.[3] (Exhibit 3). Women comprise roughly half the population, yet a policy banning their participation in clinical trials was not legally overturned until 1993.[4] The elderly remain overlooked, despite higher disease burden and medication use.[5]

Exhibit 3

RCT Evidence vs. Population Needs



People with 2+ comorbidities comprise only 21% of clinical trial participants but account for 71% of healthcare spend.

Other patient groups underrepresented in research include people with rare diseases, who are pregnant, the elderly, women, racial minorities, rural populations, children, low socioeconomic status, transplant recipients, and transplant recipients.

These disparities result in inequitable outcomes and costs that are stratified along the lines of representation. For instance, despite increasing investment in maternal healthcare, pregnancy complications are rising and disproportionately impact women of color. This group sits at the intersection of understudied demographics—they are not well served by standards of care designed for patients dissimilar to them. This pattern has many analogues across healthcare, producing a vast economic toll at scale.[4, 6, 7, 8, 9]

03. Solution

Growing evidence suggests that personalized and data-driven patient care could change this dynamic. Anecdotal consults, second opinion services, and reviews of the existing medical literature are no longer enough. Actionable insights from EHR or other RWD, known as real-world evidence (RWE) could hold the key. Health systems have invested in curating their EHR data environments to support high-quality data acquisition. Yet obstacles to data integration, manual data manipulation, and analysis remain. The result is that while generation of actionable RWE is possible, it has never been done with the resource efficiency and speed required for integration into routine practice.[10]

To cut costs of care while maintaining high quality outcomes, healthcare organizations should prioritize generating RWE and implementing it into clinical decision-making and processes of care. This was the rationale for the work at Stanford Health Care that grew into Atropos Health, and now offers solutions for scalable RWE in healthcare.

Closing the Evidence Gap with Atropos Evidence Platform

Atropos Health's solution for rapid RWE delivery is called the Atropos Evidence Platform. It automates rapid and reliable extraction of clinical insights from EHR data. The simplest interface model, the Green Button, blends effortless search with familiar clinical consult patterns. The user experience is Q&A. Clinicians submit questions on Atropos platform and receive insights from the EHR in response within 48 hours. These insights are delivered as publication-grade observational study reports, called Prognostograms,[11] and contain extensive supporting charts and figures. At any point, the user may request a 1:1 discussion of the findings with a clinician on the Atropos team. When tied to a specific patient case, this process is reimbursable via interprofessional consult CPT codes.

Process Details: Atropos Evidence Platform (Exhibit 4)

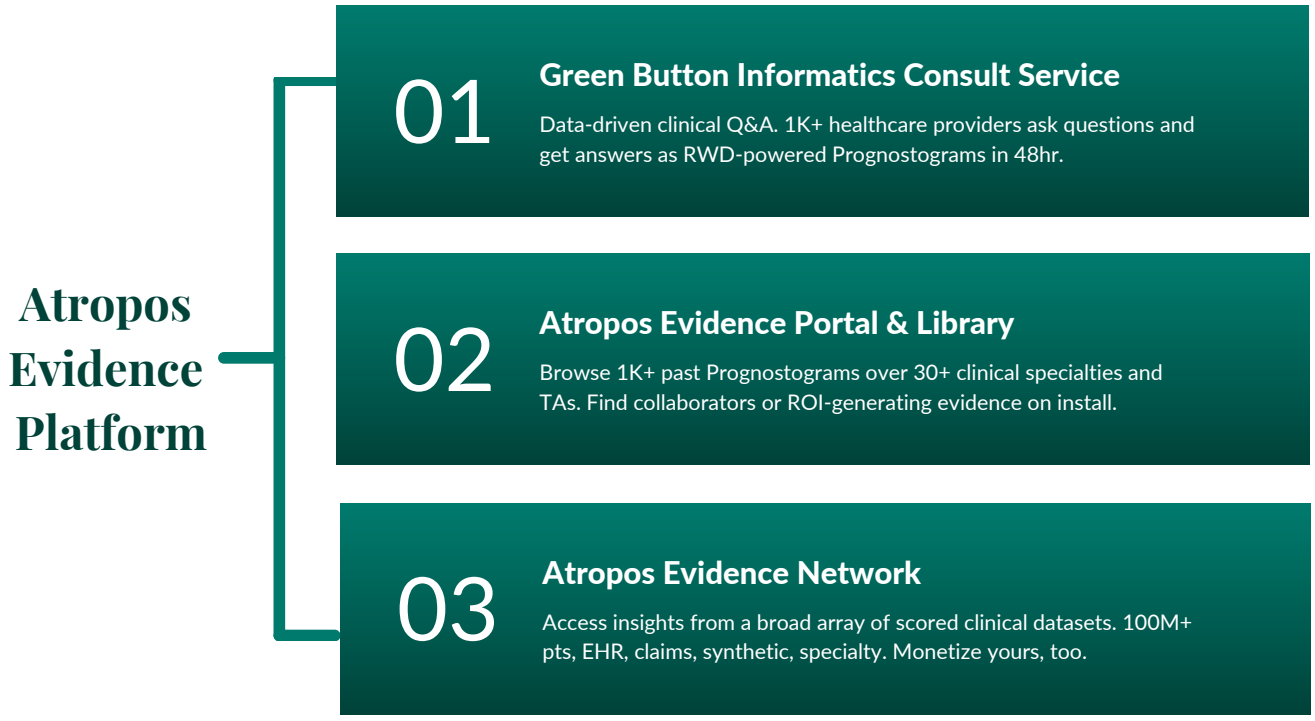
- The Green Button Informatics Consult Service (Green Button) is the simplest interface model for using Atropos Evidence Platform. Here, clinicians can access novel insights from EHR data in under 48 hours via simple Q&A.
- First, the clinician submits a question. It can be a conversational phrase (What is the difference between drug A and drug B on long-term outcomes for patients like mine? How many patients with X characteristics and Y condition are records present for over the past 10 years?) or a detailed study protocol.

- Then, Atropos Evidence Platform kicks in behind the scenes. Expanding on the underlying technologies developed throughout the Green Button Project, Atropos runs a rapid search of medical data using a proprietary search engine and temporal query language. Once the appropriate data cut or cohorts are generated, results flow through a standardized pipeline of automated observational study designs and analytic methods. A clinician on the Atropos team reviews all results and generates a simple summary and conclusion.
- The resulting Prognostogram RWE report is delivered to the requesting clinician in under 48 hours. The conversational summary and conclusion provides a quick answer which is supported by pages of corresponding statistics, tables and figures.

To date, thousands of Prognostograms have been delivered to clinicians and researchers nationwide and published (Exhibit 5). Atropos Evidence Platform has been adapted in tandem to accommodate these expanding use cases across clinical specialties and sites.

Exhibit 4

Atropos Evidence Platform Generates RWE to Optimize Care and Costs



Atropos Evidence Platform contains solutions that transform RWD into actionable insights that are surfaced where and when they are needed. Get new, publication-grade RWE on-demand with the Green Button. Novel studies as easily as asking question. Try it on more datasets, or let others try it on yours, through the Evidence Network. You join thousands of peers leveraging Atropos Evidence Platform to catalyze research, identify cost-saving opportunities, and tailor care to the patient at hand. The resulting new RWE library enables ROI on day 1 via past Prognostograms

Exhibit 5

Atropos Evidence Platform Builds on 12+ years of Research, Development, and Clinical Use

Clinician-led, peer-reviewed methodologies & outputs pave the road to real-world evidence for every clinical decision

The NEW ENGLAND JOURNAL of MEDICINE

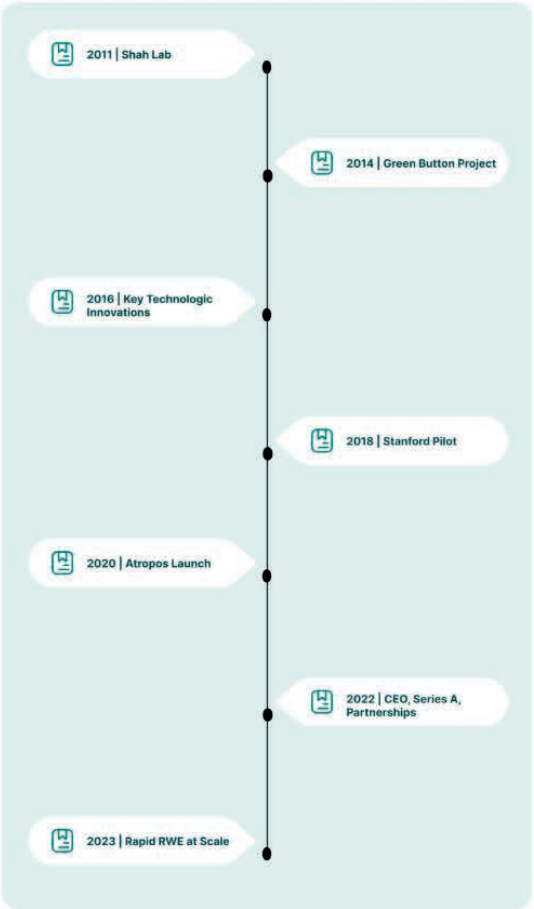
Evidence-Based Medicine in the EMR Era: Dr. Frankovich uses rapid assessment of EHR to inform a decision about anticoagulation in a patient with systemic lupus erythematosus.

JAMIA
A SCHOLARLY JOURNAL OF INFORMATICS IN HEALTH AND BIOMEDICINE

ACE: the Advanced Cohort Engine for searching longitudinal patient records: Dr. Shah's Lab + Stanford clinicians collaborate to create ACE and TQL .

ATROPOSHEALTH

Atropos Health Launches: To scale clinical informatics consults and make RWE accessible where and when it's most needed in medicine.



HealthAffairs

A 'Green Button' For Using Aggregate Patient Data At The Point Of Care: Clinicians and biomedical informaticists work to bring evidence to the bedside.

npj | digital medicine

It is time to learn from patients like mine: Stanford Physicians lead world's first informatics consult pilot at Stanford

BECKER'S HOSPITAL REVIEW

Mayo Clinic Platform partners with Atropos Health: to unlock insights that will accelerate better care, via Mayo Clinic data & Atropos' clinical informatics technology.

04. User Experience

Evaluating User Experience and ROI of the Atropos Evidence Platform: A 1 Year Retrospective Study

Overview

In this section, we move from the theoretical to the empirical, presenting concrete results derived from a comprehensive global user experience study and analysis of the one-year ROI for the Atropos Evidence Platform at a leading AMC. The assessment was meticulously designed and executed to shed light on the real-world application and tangible value of the Atropos Evidence Platform for this AMC and other health systems.

User Experience Study Results

In the first year of implementing the Green Button Informatics Consult Service at the AMC, there was extensive engagement with the platform. Over 100 individual users spanning 29 clinical departments submitted 600 queries and received Prognostogram reports in response. While the platform was initially designed with a focus on clinician use of insights for direct patient care, results of this user experience study demonstrate its adaptability to a range of emerging use cases.

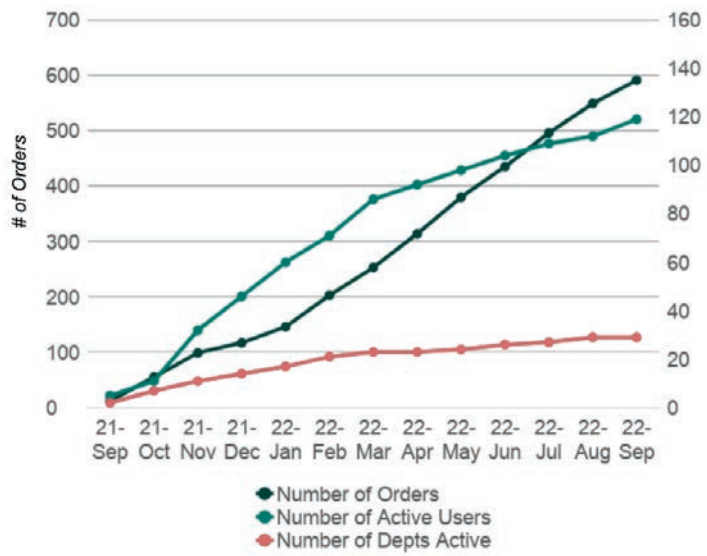
Adoption was strongest among clinical researchers who recognized its potential to expedite their productivity. These researchers were responsible for 80% of all queries submitted during the specified time period. The remaining 20% of queries were attributed to needs for evidence to guide clinical practice, quality improvement studies, and cost-effectiveness analyses.

The following user experience Net Promoter Score (NPS) charts provide a closer look into user satisfaction and engagement patterns, demonstrating the high quality of user experience offered by the Green Button Informatics Consult Service and Atropos Evidence Platform. These charts capture an emerging narrative of effective utilization at the AMC, endorsing the value and versatility of the Atropos Evidence Platform in healthcare settings (Exhibit 6).

Exhibit 6

Trends During 1 Year of Utilization: Usage, Order Volume, and Clinical Specialty

Usage and Order Volume



Top User Departments

- Gastroenterology
- Otolaryngology
- Anesthesiology
- General Surgery
- Neurology
- Heme Onc & Rad Onc

5.3 Average Prognostograms per user

Of users submitted 3+ requests **35%**

NPS: 49

9.1 High likelihood of repeat use

Would recommend to a colleague **8.4**

05. Medication Cost Savings

Platform Facilitates Cost Effectiveness Research to Deliver $576,723 in Annualized Medication Cost Savings

Overview

The first phase of the ROI study evaluated utilization of the platform by pharmacy teams to conduct comparative effectiveness research faster and more frequently. During the study period, this use case yielded local evidence that identified opportunities for formulary optimization without negative impact on patient outcomes, for a potential of $576,723 in annualized medication cost savings.

Methods

In the analytic process, Prognostograms were eligible for review if they (1) compared outcomes associated with high vs. low-cost medications; (2) exhibited no statistically significant differences in health outcomes across patient groups; and (3) if the realized or potential annualized drug cost savings of acting upon this evidence reached at least $100,000. Cost savings were calculated based upon the substitution by the lower cost drug for the higher-cost one. If the higher cost drug was removed from the AMC's pharmaceutical formulary, 100% of the cost savings were captured. If not removed, then the potential savings were estimated based on projected formulary restriction of the higher-cost drug for the lower-cost option when clinically appropriate. Three medication-cost queries were included in this analysis, including: perineural liposomal bupivacaine, rifaximin, and denosumab.

03.1

Perineural liposomal bupivacaine

03.2

Hepatic encephalopathy therapy

03.3

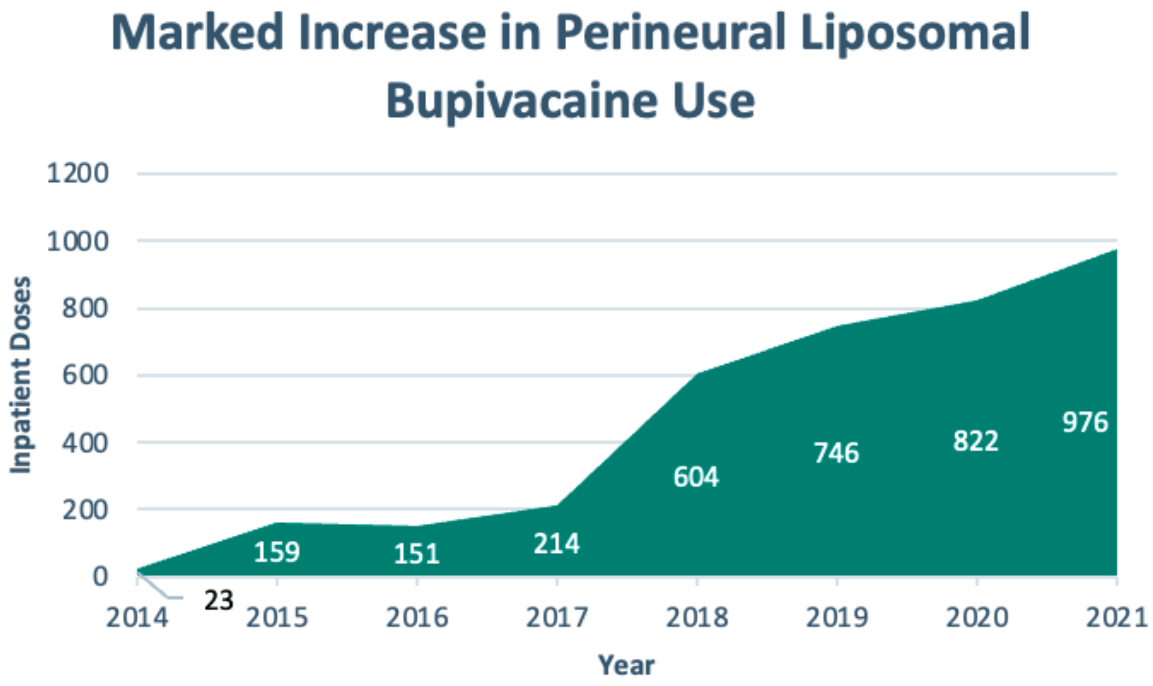
Bone modifying agents

Perineural Liposomal Bupivacaine – Local Evidence Supports Formulary Design

Perineural liposomal bupivacaine is a high-cost agent with early promise to extend peripheral nerve blocks for patients undergoing procedures resulting in decreased subsequent opiate analgesia administration and inpatient length of stay. More recent meta-analyses have shown a lack of clinical superiority with use compared with lower cost agents.[12, 13] The AMC saw a rapid increase in perineural liposomal bupivacaine use beginning in 2017. (Exhibit 7) A comparative effectiveness analysis of patient population outcomes at the request of the AMC's Pharmacy and Therapeutic (P&T) committee showed similar results to national data with no reduction in subsequent opiate use or reduced length of stay after liposomal bupivacaine (Exhibit 8). This RWE was shared by the P&T committee with clinical stakeholders and liposomal bupivacaine was subsequently removed from the AMC's formulary. At a wholesale cost of $198.94 per dose compared with $0.33 per non-liposomal bupivacaine and 976 inpatient doses of liposomal bupivacaine in 2021, the annualized cost savings from the P&T committee's use of local RWE was $193,883.[14] This case exemplifies the power of Atropos Evidence Platform in informing cost-effective formulary decisions while maintaining high-quality patient care.

Exhibit 7

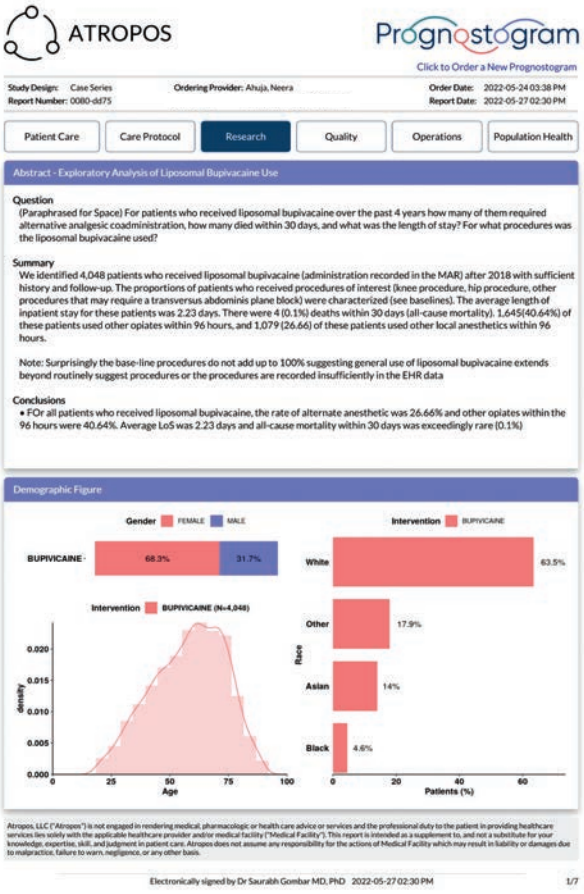
Increasing Inpatient Use of Liposomal Bupivacaine Drove Up Costs



Rise in use of perineural liposomal bupivacaine at Stanford Healthcare from 2014 to 2021. This preparation of the medication is significantly more expensive than non-liposomal bupivacaine, driving drug costs skyward along with its use. (Liposomal bupivacaine: $198.94/dose, wholesale, Non-liposomal bupivacaine: $0.33/dose, wholesale)

Evidence-Based Formulary Design Saves Medication Costs without Impacting Outcomes

Question from a clinician at an AMC: For patients who received liposomal bupivacaine over the past 4 years how many of them required alternative analgesic co-administration, how many died within 30 days, and what was the length of stay? For what procedures was the liposomal bupivacaine used?



ATROPOS

Prognostogram

Click to Order a New Prognostogram

Study Design: Case Series
Report Number: 0080-dd75
Ordering Provider: Ahuja, Neera
Order Date: 2022-05-24 03:38 PM
Report Date: 2022-05-27 02:30 PM

Patient Care | Care Protocol | Research | Quality | Operations | Population Health

Abstract - Exploratory Analysis of Liposomal Bupivacaine Use

Question

(Paraphrased for Space) For patients who received liposomal bupivacaine over the past 4 years how many of them required alternative analgesic coadministration, how many died within 30 days, and what was the length of stay? For what procedures was the liposomal bupivacaine used?

Summary

We identified 4,048 patients who received liposomal bupivacaine (administration recorded in the MAR) after 2018 with sufficient history and follow-up. The proportions of patients who received procedures of interest (knee procedure, hip procedure, other procedures that may require a transversus abdominis plane block) were characterized (see baselines). The average length of inpatient stay for these patients was 2.23 days. There were 4 (0.1%) deaths within 30 days (all-cause mortality). 1,645(40.64%) of these patients used other opiates within 96 hours, and 1,079 (26.66) of these patients used other local anesthetics within 96 hours.

Note: Surprisingly the base-line procedures do not add up to 100% suggesting general use of liposomal bupivacaine extends beyond routinely suggest procedures or the procedures are recorded insufficiently in the EHR data

Conclusions

- FOr all patients who received liposomal bupivacaine, the rate of alternate anesthetic was 26.66% and other opiates within the 96 hours were 40.64%. Average LoS was 2.23 days and all-cause mortality within 30 days was exceedingly rare (0.1%)

Demographic Figure

Atropos, LLC ("Atropos") is not engaged in rendering medical, pharmacologic or health care advice or services and the professional duty to the patient in providing healthcare services lies solely with the applicable healthcare provider and/or medical facility ("Medical Facility"). This report is intended as a supplement to, and not a substitute for your knowledge, expertise, skill, and judgment in patient care. Atropos does not assume any responsibility for the actions of Medical Facility which may result in liability or damages due to malpractice, failure to warn, negligence, or any other basis.

Electronically signed by Dr Saurabh Gombar MD, PhD 2022-05-27 02:30 PM 1/7

	BUPIVICAINE
Mastectomy	376 (9.29%)
Nephrectomy	1 (0.02%)
Nerve Block	467 (11.54%)
Shoulder Procedure	186 (4.59%)
Spine Procedure	206 (5.09%)
Tap Block	37 (0.91%)
Umbilical Hernia Repair	20 (0.49%)
Wrist Procedure	9 (0.22%)
Comorbidity score (sd)	**3.7 (3.3)**
Malignancy	1141 (28.19%)
Metastatic Solid Tumor	344 (8.5%)
Diabetes	668 (16.5%)
Diabetes with Complications	236 (5.83%)
Congestive Heart Failure	237 (5.85%)
Myocardial Infarction	125 (3.09%)
Peripheral Vascular Disease	191 (4.72%)
Chronic Pulmonary Disease	929 (22.95%)
Cerebrovascular Disease	214 (5.29%)
Dementia	43 (1.06%)
Hemiparaplegia	34 (0.84%)
Mild Liver Disease	523 (12.92%)
Severe Liver Disease	29 (0.72%)
Renal Disease	387 (9.56%)
Peptic Ulcer Disease	94 (2.32%)
Rheumatic Disease	130 (3.21%)
Hiv	11 (0.27%)
Outcomes (sd or %)	
Death in 30 Days	4 (0.1%)
Length of Inpatient Stay	2.23 (1.19)
Local Anesthetics in 96 Hours	1079 (26.66%)
Opiates in 96 Hours	1645 (40.64%)

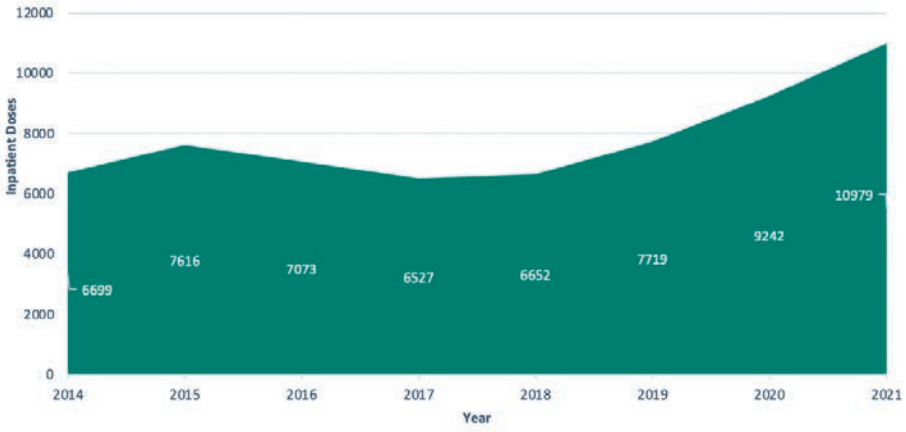
Request a Prognostogram

Hepatic Encephalopathy Therapy – Reduced Rifaximin Use Lowers Costs

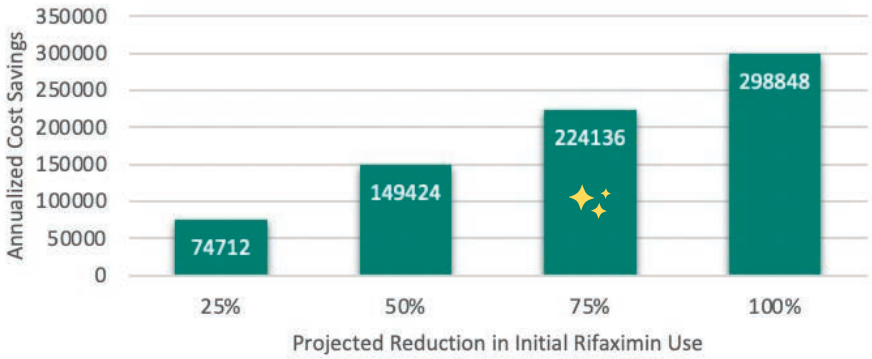
Patients with new or chronic liver impairment may suffer an alteration in mental status from elevated bloodstream ammonia which the liver fails to metabolize. High-cost rifaximin, a non-absorbable antibiotic, alters gut flora leading to lower ammonia production. Low-cost lactulose, a non absorbable synthetic disaccharide, changes gut pH to reduce ammonia absorption into the bloodstream. Due to the general tolerance and effectiveness of lactulose, current recommendations are for patients hospitalized for hepatic encephalopathy treatment be provided lactulose as first line therapy unless tolerating lactulose poorly or prescribed rifaximin chronically.[15] Rifaximin use has increased by 40% at the AMC since 2017. At the request of the Hospital Medicine department, an analysis comparing lactulose and lactulose plus rifaximin during admission for the first episode of hepatic encephalopathy showed no difference in mortality or LOS. Given these findings, there is ongoing review of potential restrictions on use of rifaximin in lactulose-refractory patients. Considering a wholesale cost of $27.22/rifaximin dose and a 75% projected reduction in its co-administration with lactulose, this measure could yield potential annualized cost savings of $224,136 (Exhibit 9).[14] This analysis provides further support for the value of Atropos Evidence Platform in lowering medication cost burden without compromising the quality of patient care.

Exhibit 9

Targeting Rifaximin Use Generates Cost Savings



40% Increase over 4 Years in Rifaximin First-Line Use for First Episode Hepatic Encephalopathy



75% Reduction in Initial Rifaximin Therapy

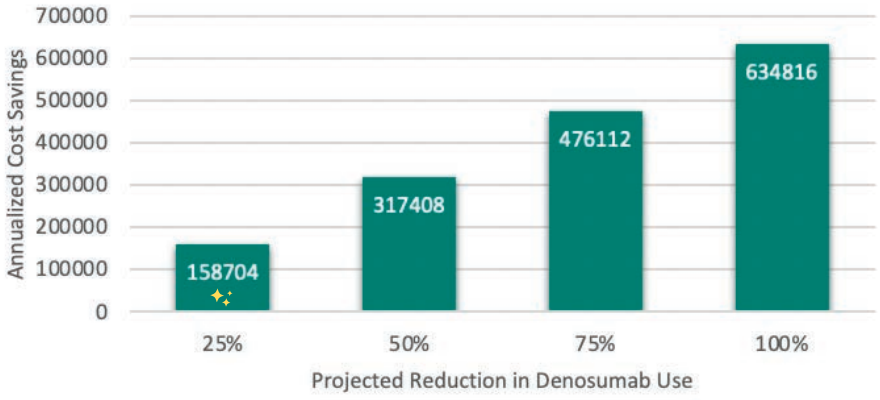
Bone Modifying Agents – Insights to Guide Shared-Decision Making

In patients with bone metastases from solid tumors, skeletal related events (SREs) such as pathologic fractures are unfortunately common and painful. The FDA has approved several agents for SRE prevention. In the absence of marked outcome differences, guidelines recommend shared decision-making with patients for drug choice. High cost denosumab, a monoclonal antibody preventing bone resorption, has modest advantages to reduce risk of SRE and time to first SRE but requires subcutaneous injections every four weeks. Low cost zoledronic acid, administered intravenously, can be dosed every 12 weeks in selected patients, reducing burden of treatment. Osteoclast inhibitor choice is influenced by tumor type and patient preference including treatment burden and price.[16] Outpatient denosumab use has steadily increased in recent years. At the Oncology department's request, zoledronic acid was compared to denosumab, showing no difference in SRE rates between the two drugs. As the burden of outpatient drug costs shouldered by patients and payors, the P&T committee is now determining how to best support shared decision-making by patients and oncologists. At a wholesale cost of $942 per denosumab dose compared with $70 per zoledronic acid dose, the projected annualized cost savings by reducing denosumab use by only 25% through supported shared decision-making would be $158,704[14] (Exhibit 10).

Exhibit 10

Savings Associated with Modulating Use of Denosumab

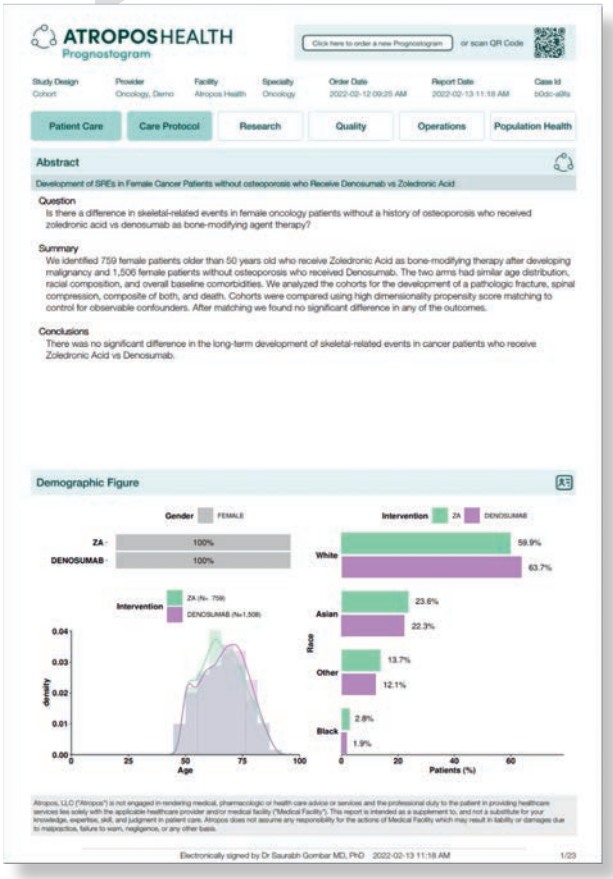
Outpatient Denosumab Use

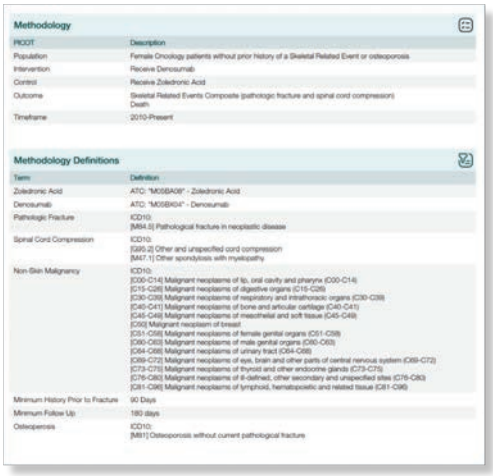


Projected Annualized Cost Savings from 25% Reduction in Denosumab Use

See the Prognostogram - An Observational Study in 48 Hours After Sending a Question

Question from a clinician at an AMC: Is there a difference in skeletal-related events in female oncology patients without a history of osteoporosis who received zoledronic acid vs denosumab as bone-modifying agent therapy?





Review the full Prognostogram

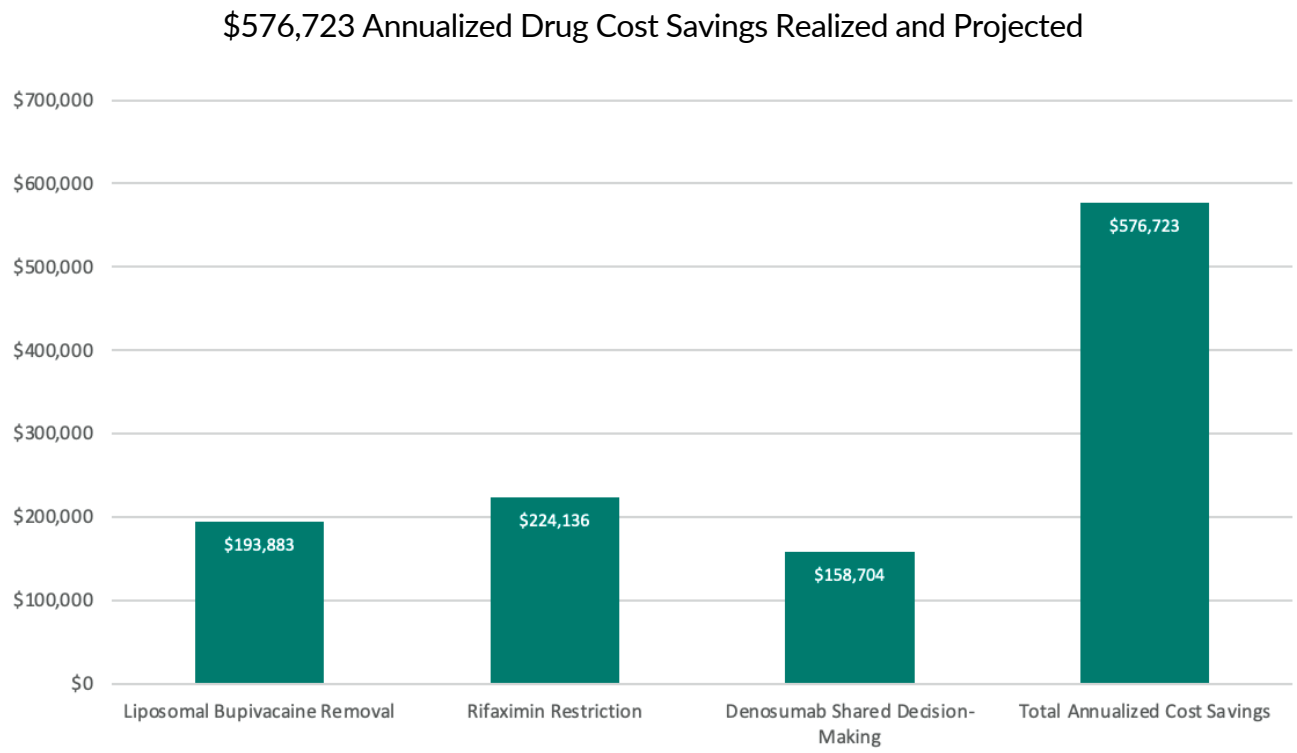
Request your own

Aggregate Medication Cost Savings

In conclusion, clinician use of Atropos Evidence Platform at this AMC to evaluate comparative effectiveness of liposomal bupivacaine, rifaximin, and denosumab with their respective lower-cost alternatives unlocks significant medication cost savings. In the first year of platform implementation pertaining to these three examples alone, the AMC realized annualized drug cost savings of $193,883. This was driven by direct Q&A, where clinicians received Prognostogram reports in 48 hours with the requisite local evidence to supplement decision-making. Further potential for cost savings lies in clinically reasonable formulary restrictions. If these were to be taken, the AMC's projected annualized medication cost savings from these examples would be $434,284 saved providing inpatient drug therapy and patient/payor savings of $158,704 for outpatient drug treatment (Exhibit 12). In aggregate, these underscore a clear return on investment for use of Atropos Evidence Platform to support medication choice and formulary design at AMCs. And beyond this favorable economic impact, it also reinforces the prioritization of patient-centric care through evidence-based approaches and shared decision-making when planning a treatment course.

Exhibit 12

Annualized Drug Cost Savings from Evidence-Based Medication Choice



From just a few Prognostogram on-demand RWE reports, hundreds of thousands in medication cost savings were enabled. Atropos Evidence Platform automated analytics to produce critical insights for formulary optimization and cost-considerate medication choice at scale.

06. Research Acceleration

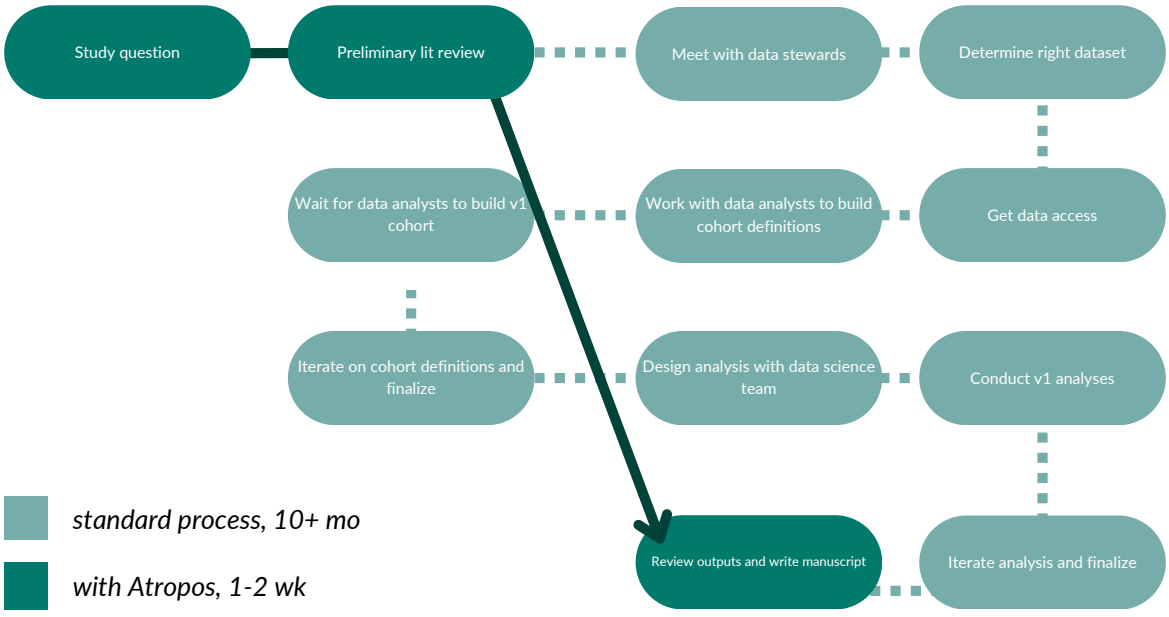
Overview

In the text to follow, we review the impact of Atropos Evidence Platform in accelerating observational research during one year at the AMC. This was a core use case of the platform, likely due to the relative simplicity of conducting observational research with Atropos as compared to standard processes.

Typically conducting observational research on health system EHR data is quite manual for investigators, who must: secure IRB approval for research projects, obtain data access, conduct chart review, clean and prepare the data, conduct analyses, and go through rounds of review and refinement before getting to a result. Many AMCs have data analysts and statisticians on staff to support research initiatives, but these teams are often heavily backlogged with requests and may lack sufficient clinical expertise and context. The result is that it takes a great deal of time, effort, and resources to conduct research. At this AMC, it can take between two and ten months to get from hypothesis to usable result for conference abstract/poster or journal submission, respectively. These hurdles position impactful research at odds with other clinical and administrative priorities, creating a bottleneck on the progress of scientific discovery (Exhibit 13).

Exhibit 13

Research Process Efficiencies with Atropos Evidence Platform



Atropos Evidence Platform simplifies the process for clinicians and researchers to conduct observational research on their health system's EHR data. Via the Green Button Informatics Consult Service, clinicians and researchers simply submit their question or hypothesis and receive a publication-grade observational study report on their AMC's EHR data in 48 hours. Atropos clinicians and scientists are available to support preparation of conference submissions and publication manuscripts, facilitate research collaboratives, or collaborate on the research iteration process. The burgeoning utility of this service was evaluated during the one year of use at the AMC in question, yielding impressive findings regarding the Green Button's ability to streamline the research process and drive productivity.

Methods

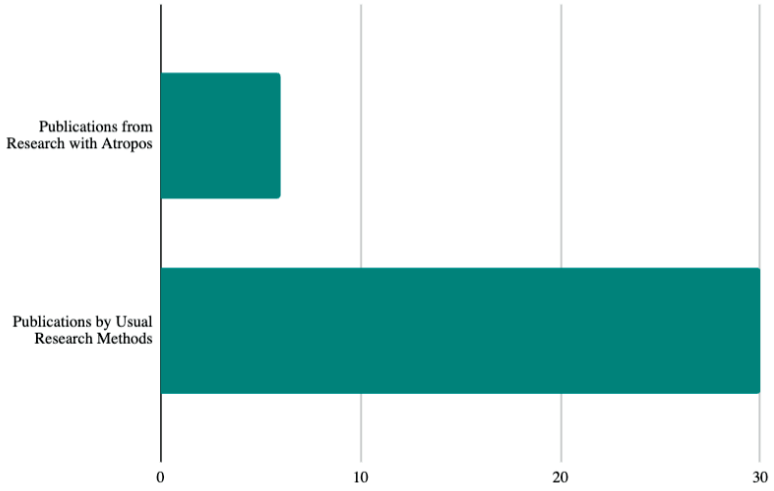
For this study, observational research impact of Atropos Evidence Platform was evaluated during a one-year period following confirmation by the AMC's Internal Review Board (IRB) that the de-identification and aggregation of data met its blanket waiver for IRB exemption. Research queries which resulted in submission for 4 common publication types (manuscript, clinical score, poster or talk abstract) were included for analysis. Research time reduction was defined as the difference in weeks from research start to artifact submission using Atropos, compared to usual observational research methods. Cost savings associated with accelerated research production have been estimated as an average of $52,000 per research study, largely due to reduction in hours from dedicated analysts, statisticians, and diminished infrastructure requirements as compared to a traditional informatics research core setup.[17]

Results

During this period a total of 23 research artifacts were successfully executed using the platform end-to-end from concept to submission of the publication. This includes 12 manuscripts, 5 posters, 5 talks, and 1 clinical score. The process was significantly faster, with an average of 6 weeks from concept to submission (across all publication types) using Atropos, as compared to an average of 30 weeks using standard research methods (Exhibit 14). This substantial efficiency gain underscores the transformative potential of the platform to expedite the clinical research process and amplify the amount of research and publications possible. The AMC's total associated cost savings were $1,196,000 for clinical research resulting in publication during this period. This number is expected to double in 2023-2024.

Hear a Researcher's Perspective : *Just to reframe how helpful this service is for clinicians like me, it likely would have taken 2 people roughly 12 months to complete this analysis. Instead, I spent a total of an hour or two, including asking the question and digesting the results. I now have a podium talk at Digestive Disease Week in May to present our findings!"*

Driving Research Process Efficiency for Less Time to Publication



Save an Average of 24 Weeks Per Pub

Journal of *Clinical Medicine*

Associations of Tinnitus Incidence with Use of Tumor Necrosis Factor-Alpha Inhibitors among Patients with Autoimmune Conditions, Natarajan et al. 2023.

HAI Stanford University Human-Centered Artificial Intelligence

How Well Do Large Language Models Support Clinician Information Needs? Dash et al. 2023

JACC JOURNALS

Cardiovascular Safety of Mexiletine as a Therapy for Myotonia in Patients with Myotonic Dystrophy, Rhee et al. 2019.

OHDSI OBSERVATIONAL HEALTH DATA SCIENCES AND INFORMATICS

Towards Similarity Search in Phenotype Libraries, Tekumalla et al. 2022

bioRxiv THE PREPRINT SERVER FOR BIOLOGY

A widely distributed gene cluster compensates for uricase loss in hominids, Liu et al. 2022.

07. Patient Throughput & Care Management

Overview

Local evidence plays a critical role in elevating patient throughput and care management. Generating evidence on local trends enables identification of opportunities for care protocol refinement and targeted interventions to reduce issues. In this portion of the study, Atropos Evidence Platform's Green Button was used to evaluate potential contributors to inpatient and ICU length of stay (LOS), including: the association of Bone Marrow Transplant (BMT) and psychiatric disease, inpatient stay during different months of the year, and MRSA coverage for patients with cirrhosis.

Methods

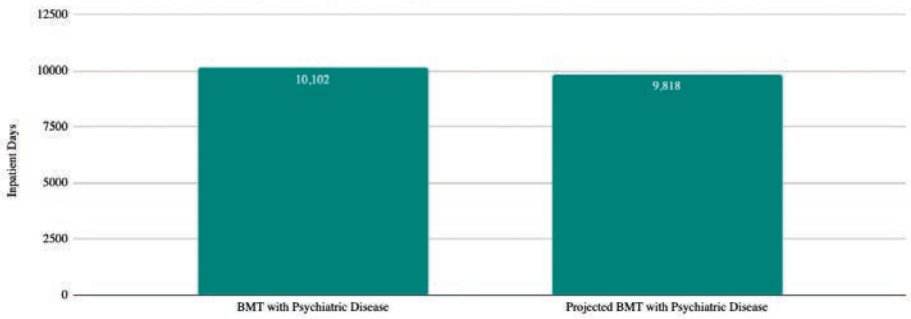
Prognostograms were eligible for inclusion in the Patient Throughput and Care Management (PTCM) analyses if the results: (1) demonstrated a meaningful and statistically reduced length of stay (LOS) or annual inpatient days as a primary outcome and 2) suggested an actionable clinical intervention to achieve a reduced LOS or annual inpatient days. In the absence of programmatic intervention, projected annualized reductions in LOS and inpatient day were calculated based on conservative estimates of interventions and care process delivery change. Hospital intensive care unit (ICU) and non-ICU cost savings were calculated using conservative figures from national estimates on hospital day expenses and a proprietary cost aversion model.[18]

Bone marrow transplantation and psychiatric disease

In one case, the AMC's psychiatry department sought to understand if there was a difference in the number of inpatient days in the first year following (BMT) for patients with or without comorbid psychiatric disease. Results from the platform showed that among 385 patients who received BMT and also had a psychiatric diagnosis (47% of the AMC's total BMT population), there were an average of 26.2 inpatient days during the timeframe in question. This is 5.1 days more than the average of 21.1 inpatient days for patients who received BMT but did not have a comorbid psychiatric disease. Further analyses would identify targeted intervention opportunities in specific subgroups. If a 10% reduction in hospital days for as few as 25% of the BMT patients with comorbid psychiatric disease were achieved, the average annual 10,102 inpatient days would decrease to 9,818 days, yielding a 284 day reduction in annualized inpatient days. Excluding any costs associated with these potential targeted interventions, this evidence-based action alone would equate to annualized cost savings of $568,000 (Exhibit 15).

BMT & Psychiatric Disease Study Enables Targeted Interventions to Reduce LOS

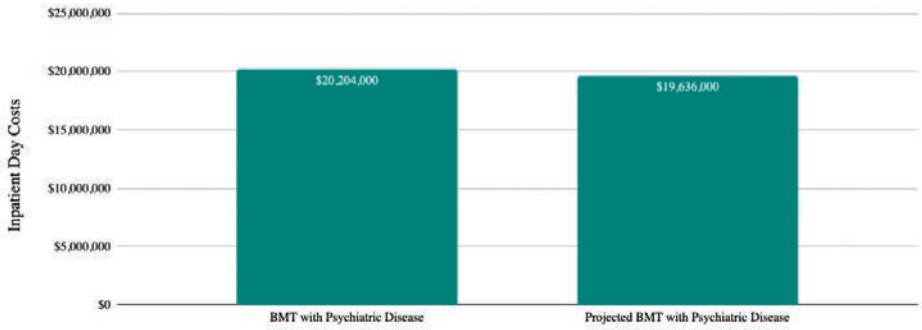
Projected 284 Day Reduction in LOS Per Year from 10% Decrease in Inpatient Days For 25% of BMT Population with Psychiatric Disease



284 Day Reduction in LOS

Projected $568,000 in Cost Savings Per Year from 10% Decrease in Inpatient Days for 25% of BMT Population with Psychiatric Disease

$568,000 in Cost Savings



Resident Training

The internal medicine department was interested in evaluating the difference in LOS during the first and last two months of each resident training year, during a 3-year lookback period at the AMC. Results from the platform showed that LOS during the first two months was 5.1 days on average–0.4 days longer than LOS during the last two months (4.7 days). This equates to 85,955 inpatient days. If targeted interventions per further study of this evidence were implemented during the first two months of residency to achieve a 0.1 day reduction in LOS in 25% of inpatients, annual inpatient days would decrease to 85,534 for 421 inpatient days saved for an annualized cost savings of $842,000 (less any costs associated with the interventions). In both this example and that concerning BMT, utilizing Atropos platform generates insights for targeted administrative action to produce significant cost savings. Furthermore, the platform could be used for complex analyses by clinical syndrome to further target the improvement programs and study their effects (Exhibit 16).

Exhibit 16

Identifying Times in Resident Training Where Modifications May Reduce LOS

Projected 421 Inpatient-Day Reduction from 0.1 Day LOS Decrease for 25% of Patients in First 2 Mo of Training Year. Conservative Estimate of Effect from Targeted Intervention per RWE.

Evidence-Based Interventions to Reduce LOS During the 1st 2 Months of the Resident Training Year are Associated with Projected Cost Savings of $842,700.

$171,910,00	$171,068,00	$842,700
No Evidence Based Intervention	0.1 Day Reduction in LOS for 25% of Inpatients from Targeted Intervention During 1st 2 Mo. of Resident Training Year	Difference in Costs from Length of Stay

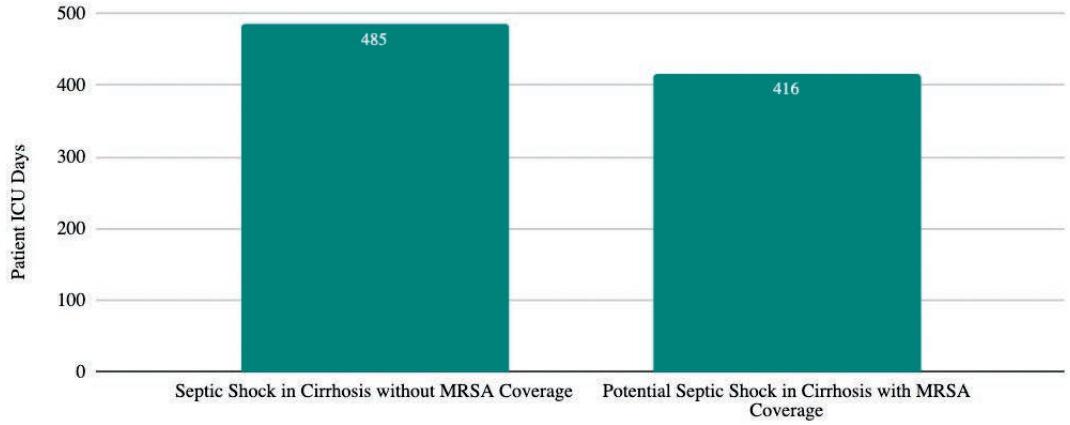
Septic Shock in Cirrhosis Patients

At the request of an intensivist, intensive care unit (ICU) LOS for patients with septic shock and underlying cirrhosis was compared based on whether empiric antibiotic coverage for methicillin resistant staph aureus (MRSA) was provided. LOS was longer (23.7 days) for patients who did not receive MRSA coverage than for patients who did (14.6 days), accounting for 485 ICU patient days. Identifying this difference in treatment pattern provides an opportunity to modify a care protocol (more routine MRSA coverage for patients who fit this profile) to reduce LOS and costs. For instance, if a 20% reduction in ICU LOS to 18.9 days was achieved for 80% of patients with this profile, assuming 20% with a known pathogen, ICU patient days would decrease to 416 for annual ICU day reduction by 69. Estimated cost savings are $207,000 (Exhibit 17).

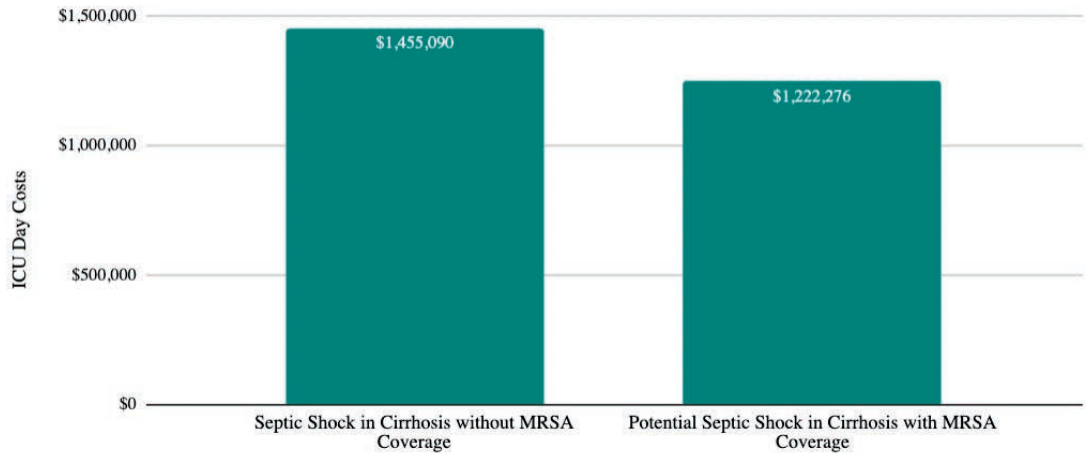
Exhibit 17

Empiric Antibiotic Coverage for MRSA in Patients with Septic Shock and Underlying Cirrhosis Associated with Reduced LOS and Expense

Projected Annual 69 ICU Day Reduction Per Year with Empiric MRSA Coverage



Projected $207,000 ICU Cost Savings Per Year

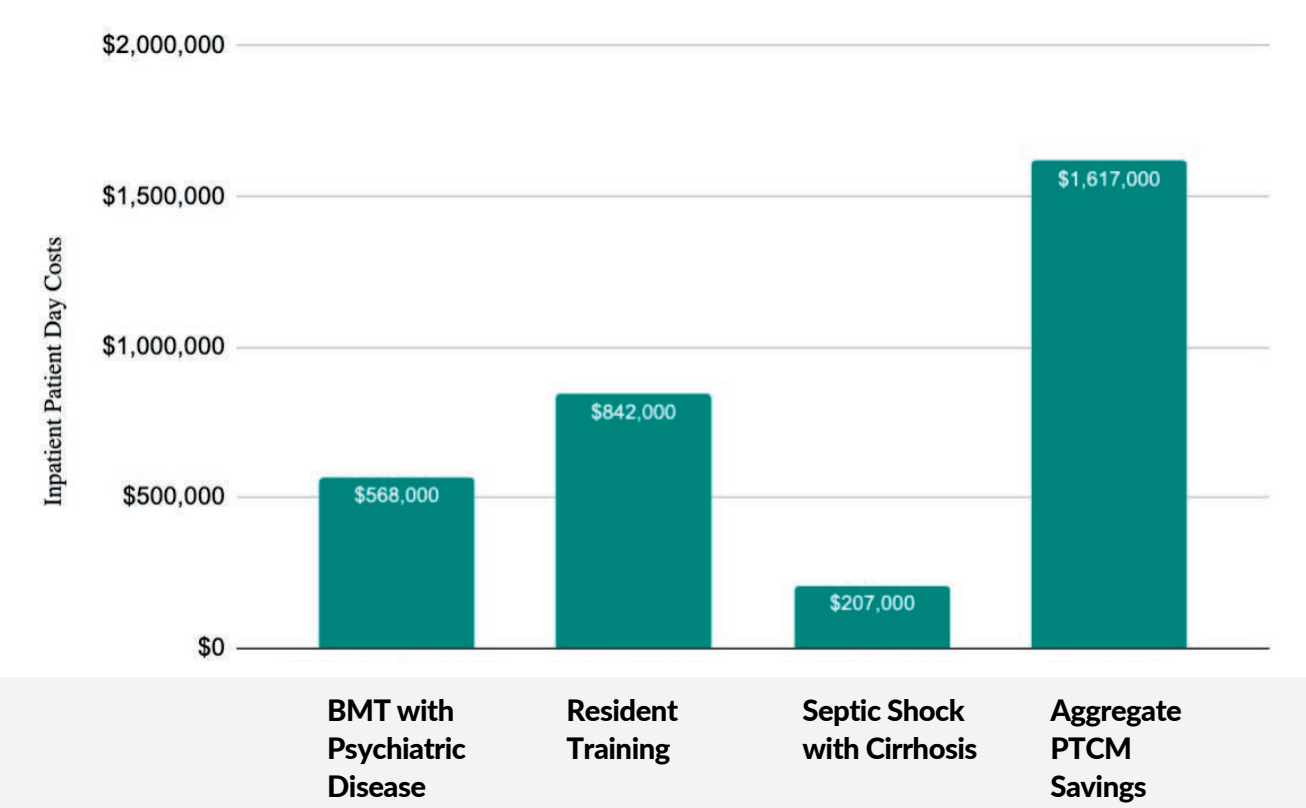


Aggregate Cost Savings Enabled by Evidence for Patient Throughput & Care Management

Based upon conservative estimates for potential interventions to reduce ICU and non-ICU LOS and patient days with further evidence generation from Atropos Evidence Platform, the projected patient-day reductions per year would be 774. This is associated with $1,617,000 in annualized cost savings (Exhibit 18).

Exhibit 18

Evidence Identifies Opportunities for Targeted Interventions to Save $1.17 M Per Year



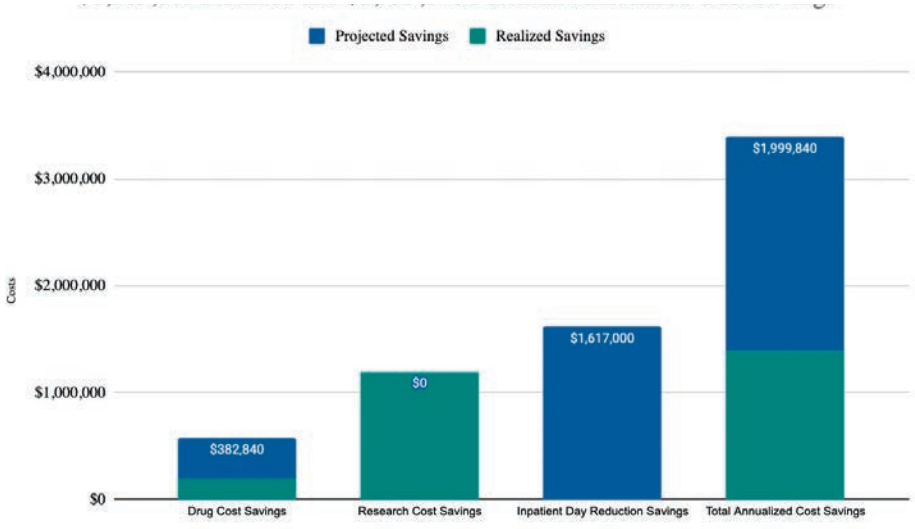
08. Summary

Summary

The potential cost savings from one year of utilization of Atropos Evidence Platform by the AMC was $3,389,723. This includes $1,389,883 in annualized cost savings realized and directly attributed to platform outputs, with another $1,999,840 in projected annualized cost savings from implementation of targeted interventions from the evidence (Exhibit 19).

Exhibit 19

One Year with Atropos Unlocks $3.39M in Potential Cost Savings for an AMC



Discussion: Value of Evidence-Based Formulary Design

The challenges optimizing formulary design is exacerbated by the steady rise in inpatient drug costs. This report demonstrates the value of Atropos Evidence Platform for generating evidence for formulary design to produce significant savings without impacting outcomes. Automation of clinically-informed analytics by Atropos enables more P&T committee reviews with the same staff, dynamic and reflexive formulary decision, and eases change management when drugs embedded into clinical practice must be restricted or removed. High formulary cost savings potential arises from the examples of liposomal bupivacaine, rifaximin, and denosumab. Such local RWE is useful not only for doctors, but also for payors and in shared decision-making with patients who shoulder financial burdens of medication choice. As the AMC continues to run more medication cost vs. effectiveness studies via Atropos, the library of replicable ROI-enabling-evidence grows.

Discussion: Value of Research Acceleration

The AMC also derived significant value from leveraging the Atropos Evidence Platform for clinical retrospective observational research. Researchers who used Atropos eliminated many of the rate-limiting steps from research, circumventing sometimes insurmountable barriers like best dataset choice, data access, or timely sourcing of analytics support. This dramatically expedited research output and multiplied the number of publications possible with the same staff. This is particularly promising for other academic medical centers, who may face constraints on their research output due to manual data extraction and cleaning or analytics support. Not only did this save approximately $1,196,000 in research costs on 23 deliverables in one year at the AMC, but the additional impact of reallocating physician and analytics staff time to other initiatives (due to diminished lift to exceed research goals) remains under evaluation. Overall, Atropos Evidence Platform has proven to be a valuable tool for accelerating, augmenting, and driving cost and time efficiencies in the observational research process.

Discussion: Value of Evidence for Patient Throughput & Care Management

By enabling clinicians across departments to glean insights from the EHR on factors contributing to ICU and other inpatient LOS, Atropos Evidence Platform unlocks opportunities for targeted intervention to reduce LOS and associated costs. This applies to the cases of the BMT patient population, first vs. last two months of resident training, and MRSA coverage for cirrhotic patients who experienced septic shock. A potential cost savings of over $1.62M is associated with conservative, targeted action per the evidence in these areas alone. We predict extending platform use to other similar evaluations will identify further areas for improvement. Atropos will continue partnering with this AMC and others to build on joint clinical and fiscal benefits of evidence-based practice over time.

Conclusions

Atropos Health originated as a "Green Button" for evidence from the EHR. Today, clinicians across all specialties and many researchers leverage Atropos Evidence Platform and its Green Button Informatics Consult Service's Prognostograms in similar ways: to support formulary design, tailor care protocols, accelerate research, reduce length of stay, and more. Atropos offers the only way to get rapid RWE from the EHR via simple, conversational Q&A. One year of optional use, evaluated for ROI in only 3 domains, yielded >3M in total in savings realized and projected as a result of platform outputs. As utilization of Atropos Evidence Platform expands, its capability to reduce costs for healthcare organizations at and beyond this scale increases. Atropos is committed to building the future of evidence-based medicine in a way that reduces financial strain on the healthcare system while elevating patient health. Further ROI study reports on the impact of Atropos Evidence Platform for quality improvement initiatives are on the horizon.

09. Future Directions

Looking Ahead

Following these early proof points of the health system value derived from the Atropos Evidence Platform, Atropos Health is poised to further augment these benefits through a suite of expanded solutions. These include multi-center research collaboratives underpinned by the platform, reflexive evidence to support existing e-consult services, and secure pathways to monetize insights from institutional data via Atropos Evidence Network. The network, which is powered by cloud-based federated architecture, enables borderless observational insights exchange without exposing the underlying RWD.

Recent Innovations – The Atropos Evidence™ Library and Network

- **Atropos Evidence Library:** Searchable content hub where thousands of Prognostograms are stored, searched, and shared. Libraries are private to each healthcare organization.
- **Atropos Evidence Network:** Scales the platform via a secure federated model for cloud-based insights generation across multiple datasets and exchange between consenting participants. The Platform is installed within network members' infrastructure to unlock evidence for them on their data. There is also the option to transact resulting insights for external users and use cases across the network – without data ever changing hands.
- **Atropos Data Scoring Solutions:** Since studies may run across multiple datasets at once through this model, Atropos developed algorithms to evaluate dataset quality and question match. The Real World Data Score™ (RWDS) is a confidential general assessment of data quality, including: size, completeness, longitudinality, and level of standardization. It is provided exclusively to the data holder. Real World Fitness Scores (RWFS™) are dynamic assessments of each dataset's utility for the use case at hand.

Furthermore, implementation of various interface models is planned across customer sites. First, use of the Green Button will be expanded across clinical departments at healthcare organizations, with a focus on turn-key solutions for targeted priority areas central to quality of care. Second, power-user tools designed specifically to enhance analytics team workflows will be made more widely available. As these solutions are increasingly adopted throughout healthcare, investigation of their immediate value and the broader impact of evidence-based practice endures. The future of Atropos Evidence Platform promises a landscape where evidence is routinely accessible and productive in reorienting resources and decisions toward cost-efficient and high quality patient-centered healthcare.

To request access to Atropos Health's solutions, contact **sales@atroposhealth.com** today.

The Impact of One Year with Atropos Health

Unlock $3M+ in Savings

Through one year of use of Atropos Evidence Platform at an academic medical center.

1K+

Prognostograms were ordered by hundreds of clinicians across various specialties and levels of tenure

Evidence-based formulary design, research acceleration, and patient throughput and care management

Were among the leading value drivers for clinician users and their institution.

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