Methodology on Return on Investment: A Case Study

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ACKNOWLEDGEMENTS
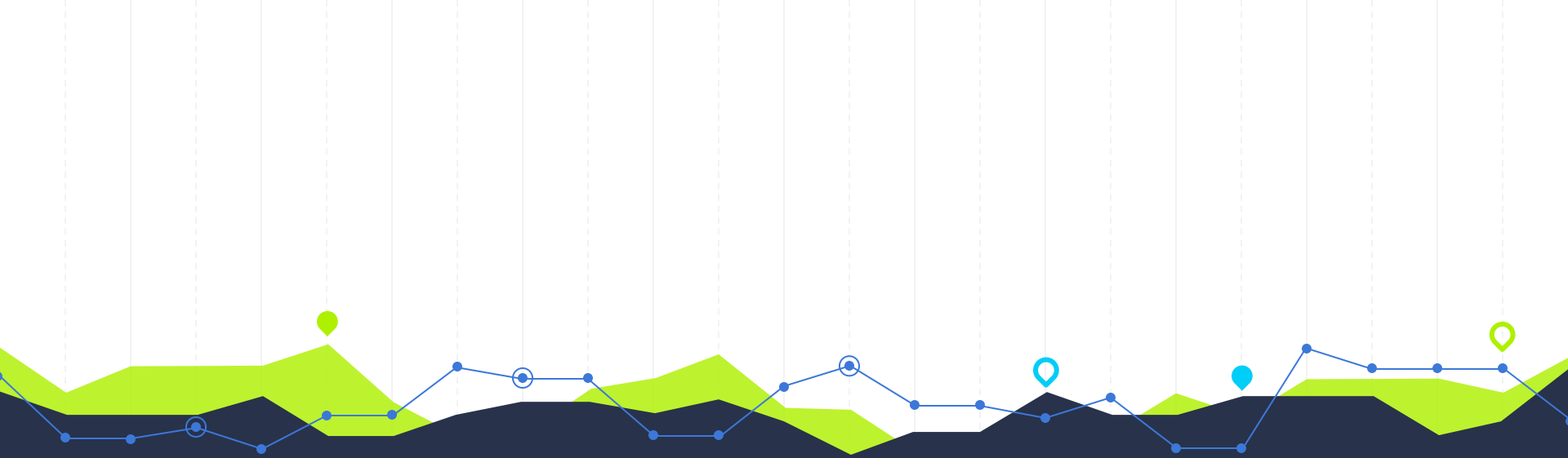
Background

1

OBJECTIVES

- Review of available literature on return on investment analyses of health interventions, including, but not limited to early warning systems
- Conduct a return on investment analysis to quantify the benefits of early warning alert and response systems, using data from one country as a case study example

LITERATURE REVIEW

◉ **Goal:** To learn about:

   (1) Return on investment (ROI) methods

   (2) Early warning alert and response systems (EWARS)

◉ Findings from the literature on ROI and EWARS

◉ Over 50 documents reviewed (journal articles, textbook chapters, WHO guidelines, epi bulletins, proposals etc.)

EARLY WARNING ALERT AND RESPONSE SYSTEMS (EWARS)

◉ Grounded in the principles of surveillance; rely on epidemic intelligence

◉ **Purpose:** collect information on epidemic prone diseases to trigger prompt public health response.

◉ Larger window of opportunity for rapid response and control measures → preventing the spread of potential cases → averting a potential outbreak

◉ Establishment and operationalization costs

ECONOMIC EVALUATION METHODS: COST BENEFIT ANALYSIS

◉ ROI analyses examine the amount of benefits produced in response to a particular investment.

◉ Used by various industries, increasingly being used by the health sector to provide evidence of benefits from investing in certain interventions

◉ Cost Benefit Analysis (CBA) allows us to make comparisons by expressing the results of an intervention in terms of a benefit-cost ratio

EXPLORING MEASURES: DALYS, INCIDENCE, MORTALITY

◉ Several indicators available to estimate disease burden
- **Incidence:** number of new cases of disease
- **Mortality:** number of deaths from a disease
- **DALYs:** (Disability Adjusted Life Years): sum of the Years of Life Lost (YLL) due to premature mortality in the population and the Years Lost due to Disability (YLD) for people living with the health condition or its consequences
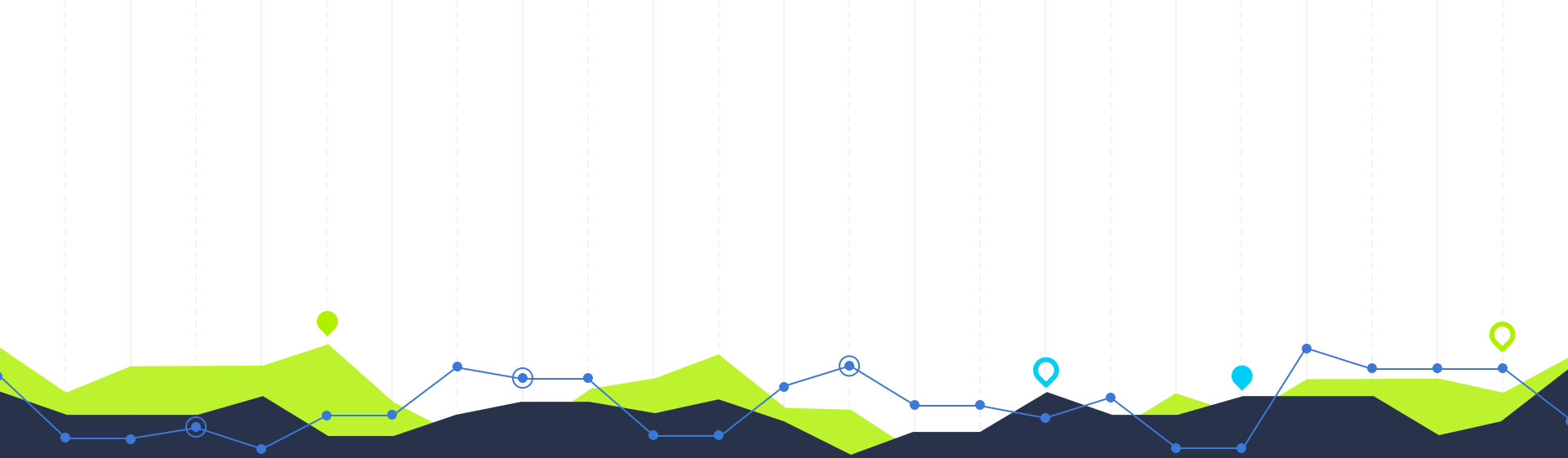
Methodology

2

AVERTED BURDEN OF DISEASE

- 6 diseases were chosen from the over 20 monitored
- Regression modelling for attributable fraction
- Median age of death estimated based on literature review to calculate years of life lost

COST ESTIMATES

- EWARS cost (establishment and investment) - from WHO Regional Office
- From the literature:
  - Country-specific average income per capita
  - Hospital and drug costs
  - Disease-specific length of hospital stay

LOGIC MODEL

EWARS

| INPUT	PROCESS	OUTPUT	OUTCOME	IMPACT
Funding, software, hardware, workspaces, staff	Training, developing guidelines, setting up sites for detection of cases and generation of alerts	Trained staff, developed guidelines, established sites	Alerts generated, cases detected, investigation & appropriate response generated	Reduced morbidity and mortality

CASE STUDY: PAKISTAN'S DISEASE EARLY WARNING SYSTEM (2006 to 2014)
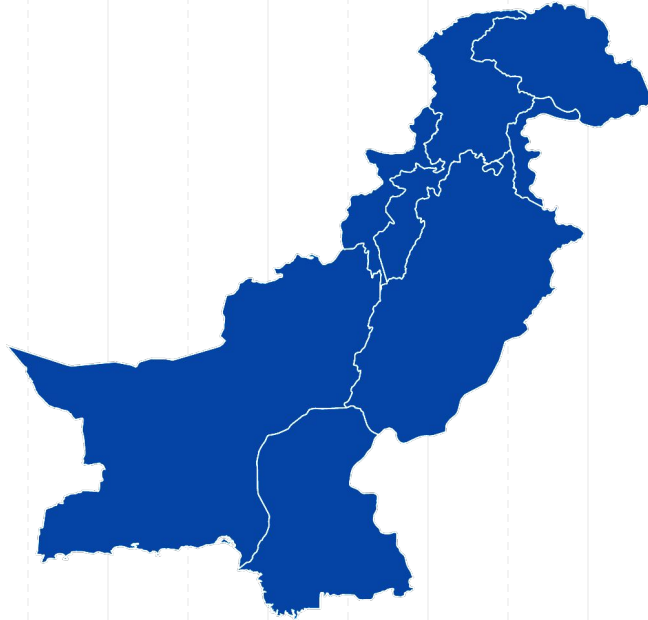
- ◉ PAKISTAN: chosen based on convenience sampling, country suggested by EMRO
- ◉ In response to Pakistan's disastrous earthquake in 2005, the WHO and the National Institute of Health in Pakistan collaborated to develop the Disease Early Warning System (DEWS), with the objective of investigating and mitigating disease outbreaks
- ◉ DEWS ran from 2006 to 2014, with data available before establishment, during and after it ended

DISEASES INCLUDED IN DEWS

Acute Diarrhoea (non-cholera)
Acute Flaccid Paralysis
Acute Jaundice Syndrome
Acute Lower Respiratory Infection
Acute Upper Respiratory Infection
Acute Viral Hepatitis
Acute Watery Diarrhoea
Bloody Diarrhoea
Cutaneous Leishmaniasis
Dengue fever

Diphtheria
Pertussis
Haemorrhagic Fever
Malaria
Measles
Meningococcal Meningitis
Neonatal Tetanus
Pneumonia
Scabies
Unexplained Fever

DISEASES INCLUDED IN OUR ANALYSIS

MEASLES

MALARIA

DIARRHEA

Acute Diarrhoea (non-cholera)
Acute Watery Diarrhoea
(Suspected Cholera)
Bloody Diarrhoea

LOWER RESPIRATORY INFECTION

MENINGITIS

Meningococcal Meningitis

HEPATITIS

DATA SOURCES

◉ Data on establishment and operational costs of EWARS
   ■ WHO Pakistan Country Office
   ■ WHO Eastern Mediterranean Regional Office
◉ Data on cases (mortality rates) and covariates
   ■ Institute of Health Metrics and Evaluation (IHME) Global Burden of Disease (GBD) database
   ■ http://ghdx.healthdata.org/gbd-results-tool

STATISTICAL ANALYSIS: ATTRIBUTABLE FRACTION

HOW MUCH OF THE DECREASE IN MORTALITY IS ASSOCIATED WITH EWARS?

Mortality is complex, with several causal factors

Conducted inferential statistical analysis (regression modelling) to determine the proportion of the decrease in mortality attributable to EWARS, controlling for other variables.

Central diagram labels: EWARS, Smoking/Pollution, MORTALITY, Access to healthcare, Income & Education

STATISTICAL ANALYSIS: IDEAL SCENARIO

◉ Panel data methods with a large dataset
◉ Region-specific mortality data for all included diseases matched with where and when EWARS was established
◉ Use variation in timing of EWARS (exogenous) to identify effects of EWARS
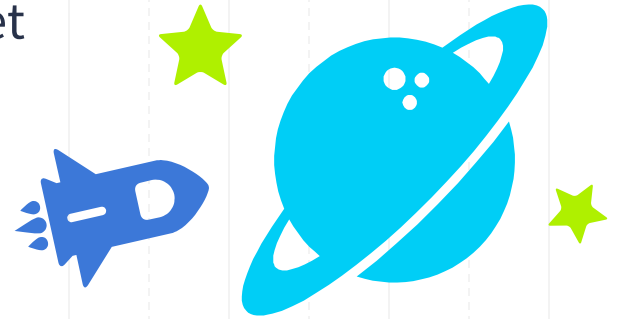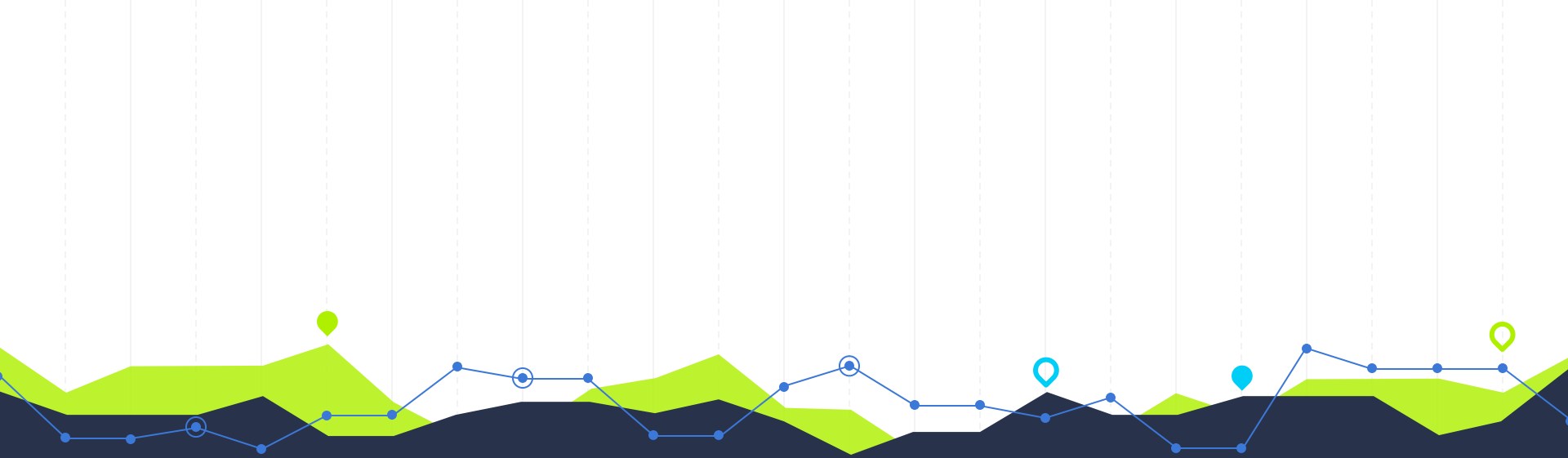
STATISTICAL ANALYSIS: REAL WORLD CONSTRAINTS

- Region-specific mortality data for all diseases not available
- Region-specific EWARS establishment timelines not available
- Not enough data for panel data or time-series regression methods

STATISTICAL ANALYSIS: ALTERNATIVE APPROACH

- Linear regression models using available aggregate data
- LIMITATIONS: Violating OLS assumptions
  - Presence of Autocorrelation
  - Non-random sample
- Generated robust variance estimates to help address these limitations
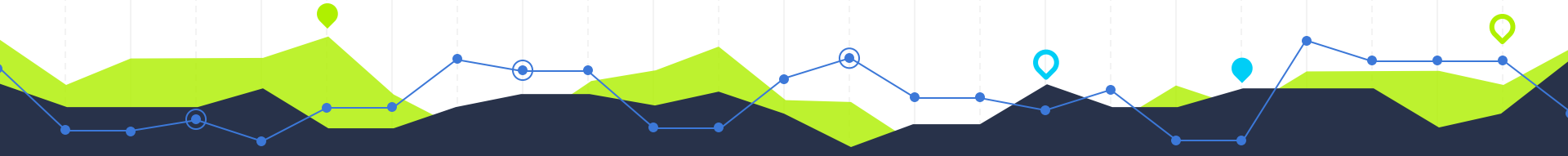
Results 1

REGRESSION RESULTS

✅ **MEASLES**

Coefficient = **-8.38**, p=0.008

95%CI (-14.25, -2.51)

❌ **MALARIA**

EWARS **NOT** ASSOCIATED WITH **STATISTICALLY SIGNIFICANT** REDUCTION IN MALARIA MORTALITY RATES

✅ **DIARRHEA**

Coefficient = **-2.85** p=0.024

95%CI (-5.27, -0.43)

✅ **LOWER RESPIRATORY INFECTION**

Coefficient = **-0.88**, p=0.003

95%CI (-1.41, -0.36)

✅ **MENINGITIS**

Coefficient = **-0.73**, p=0.008

95%CI (-1.24, -0.22)

❌ **HEPATITIS**

EWARS **NOT** ASSOCIATED WITH **STATISTICALLY SIGNIFICANT** REDUCTION IN HEPATITIS MORTALITY RATES

ANALYSES WERE CONDUCTED USING STATA/IC 15

THE AVERTED MORTALITY ASSOCIATED WITH EWARS

	EWARS MORTALITY RATE REDUCTION	DEATHS AVERTED	YEARS OF LIFE LOST AVERTED (PER DEATH)	YEARS OF LIFE LOST AVERTED
MENINGITIS	**-0.7318823**	1014	40.83	41395
MEASLES	**-8.378174**	11606	63.83	740793
DIARRHEA	**-2.846807**	3943	66.08	260586
LOWER RESPIRATORY INFECTIONS	**-0.8820816**	1222	34.83	42558

INVESTMENT COSTS OF EWARS (MILLIONS OF RUPEES) - FROM EMRO

ITEM	COST
ESTABLISHMENT	12.09
TRAINING, CAPACITY BUILDING	10.24
DEWS TOOLS, NEWSLETTERS, EDUCATIONAL MATERIAL	3.12
EQUIPMENT, FURNITURE, MAINTENANCE	2.35
LAB ITEMS AND MEDICATIONS	1.50
TRANSPORT AND MAINTENANCE	6.90

ITEM	COST
BUILDING CONSTRUCTION	9.20
PRINTING, OFFICE SUPPLIES AND PUBLICATIONS	0.30
SUPERVISION, MONITORING, FIELD VISITS, OUTBREAK INVESTIGATION	1.00
MID-TERM EVALUATION	0.20
OTHER COSTS	0.30
TOTAL COSTS	47.20

OPERATIONAL COSTS OF EWARS (MILLIONS OF RUPEES) - FROM EMRO

ITEM	COST
ESTABLISHMENT	3.10
TRAINING, CAPACITY BUILDING	1.00
DEWS TOOLS, NEWSLETTERS, EDUCATIONAL MATERIAL	0.55
POL & MAINTENANCE OF TRANSPORT	0.25
SUPERVISION, MONITORING, FIELD VISITS, OUTBREAK INVESTIGATION	0.20
UTILITIES & MAINTENANCE	0.20

ITEM	COST
PRINTING,OFFICE SUPPLIES AND PUBLICATIONS	0.15
CONTINGENT EXPENDITURE	0.05
OTHER COSTS (POSTAGE, OFFICE EXPENDITURE)	0.05
TOTAL COSTS	**5.55**

ANNUAL OPERATION COST = 5.55 MILLION
YEARS IN OPERATION = 8   i.e. 2006 to 2014
TOTAL OPERATIONAL COST = 44.4 MILLION

ADJUSTING FOR INFLATION

- Estimated cost of EWARS:

    INVESTMENT 47.20 million PKR

    OPERATION 44.44 million PKR

- Cost in USD:
    INVESTMENT 405928.6 USD

    OPERATION 381840 USD

- Inflation factor 13.7 (median, 2010), based on literature review

- Cost of EWARS, adjusted for inflation:

    461540.8 + 434152.1 **= 895,692.9 USD**

	PKR	USD	INFLATION ADJUSTED (USD)
INVESTMENT	**47201000**	**405928.6**	**461540.82**
ANNUAL OPERATION	*5550000*	*47730*	*54269.01*
ALL YEARS OPERATION	**44400000**	**381840**	**434152.08**
TOTAL INVESTMENT + OPERATION COST			**895692.90**

CALCULATING THE BENEFITS (AVERTED LOSSES, USD)

	CASE MANAGEMENT			
	WAGE LOSS AVERTED	**HOSPITAL COSTS**	**DRUG COSTS**	**TOTAL COSTS AVERTED**
MENINGITIS	62629989	383734	152074	62094181
MEASLES	1120820150	4392766	1740858	1114686526
DIARRHEA	394266402	1492611	591524	392182267
LOWER RESPIRATORY INFECTIONS	64390819	462485	183283	63745051
TOTAL	1642107360	6731595	2667739	**1,632,708,025**

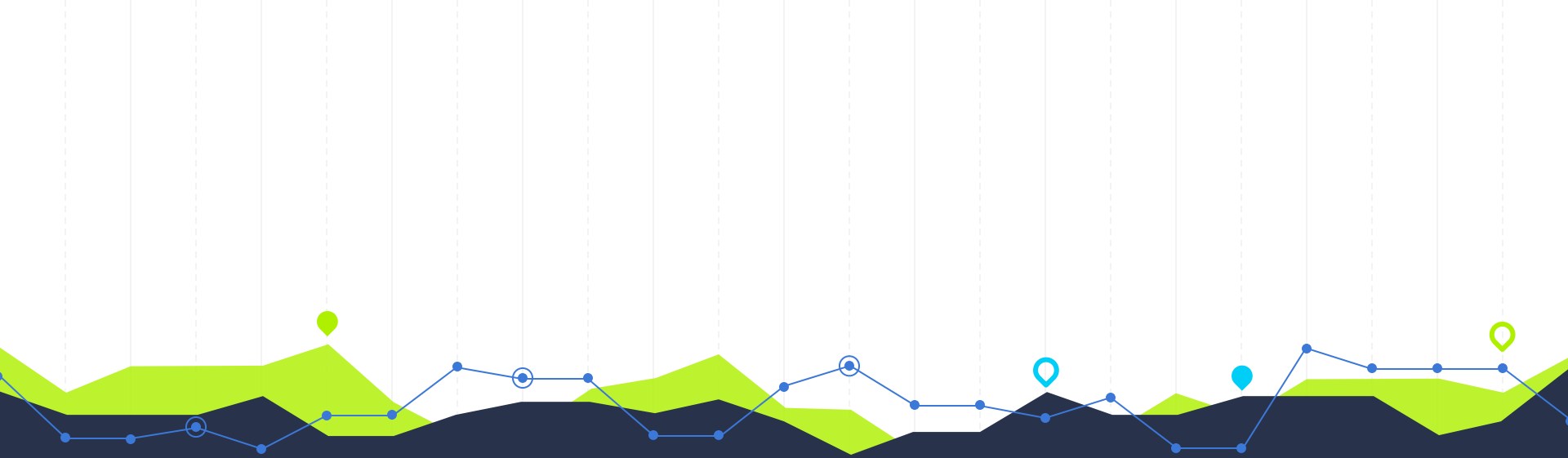# CALCULATING THE BENEFIT COST RATIO

$$BCR = \frac{Benefits}{Costs}$$

$$BCR = \frac{Wage\ Loss\ Averted - (Hospital\ Costs + Drug\ Costs)}{(Investment\ Costs + Operational\ Costs)}$$

Total Benefits = 1,632,708,025 USD

Total Costs = 895,693 USD

BCR = 1822.84

Positive return on investment!!!

Conclusion

1

Early Warning Alert and Response Systems
OFFER POSITIVE RETURNS
ON INVESTMENT

NEXT STEPS

THANK YOU!