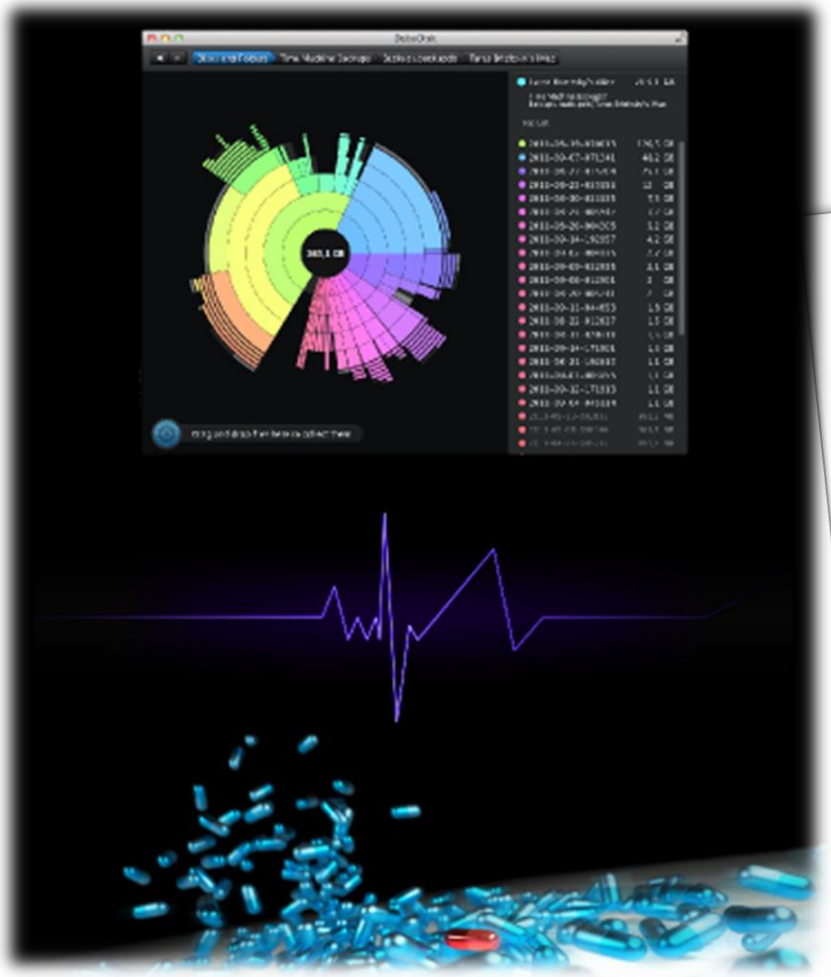
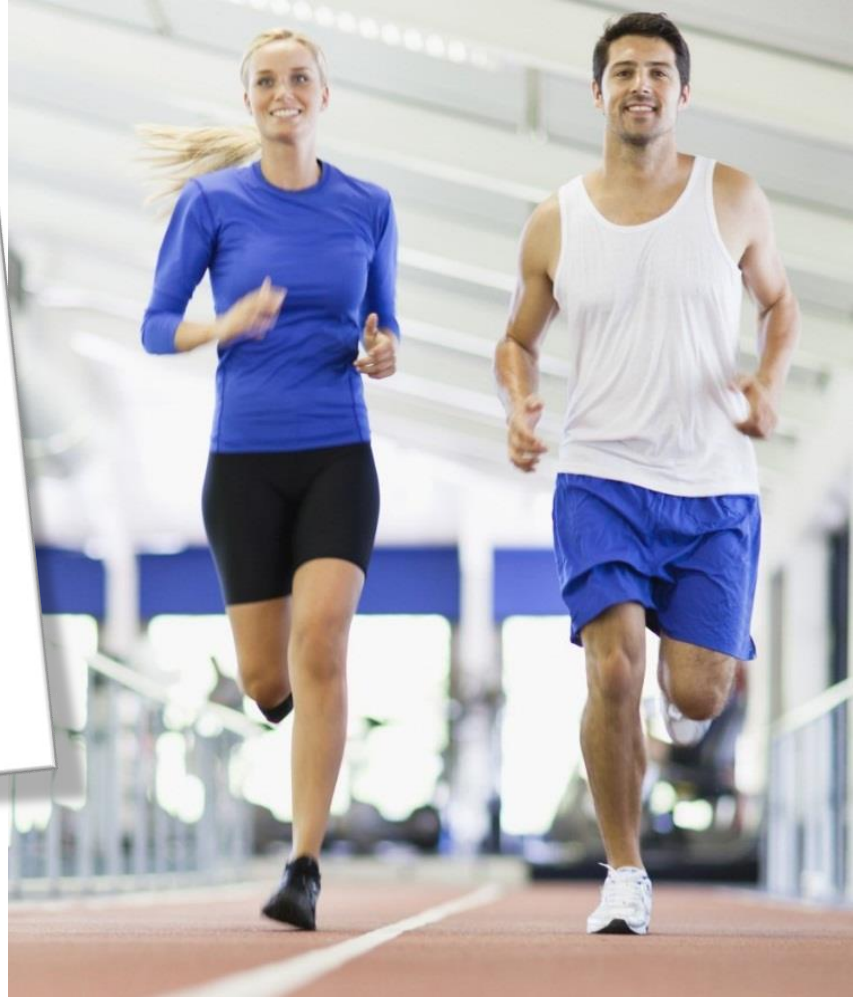




SOLUTIONS FOR HEALTHCARE

CENACLE RESEARCH

ABOUT US

- Cenacle Research Offers a variety of Healthcare solutions crafted to the needs of:
  - Individuals (Patients)
  - Care Providers (Hospitals)
  - Control & Monitoring Boards (Govt. and Statutory Boards)
  - Participatory Entities (Labs, Drug Stores, Insurance Providers..)
  - System Integrators

ABOUT US

- Cenacle Research Offers a variety of Healthcare solutions crafted to the needs of:
  - Individuals (Patients)
    - Personalized Healthcare
  - Care Providers (Hospitals)
    - Clinical Decision Support Systems
  - Control & Monitoring Boards (Govt. and Statutory Boards)
    - Population Health Analytics
    - Real-time Epidemic Outbreak Detection
  - Participatory Entities (Labs, Drug Stores, Insurance Providers..)
    - Order Prediction
    - Sales Analysis
  - System Integrators
    - Electronic Health Records
    - Health Information Exchange
    - Connected Experience

POPULATION HEALTH ANALYTICS

Case Studies by Cenacle Research

POPULATION HEALTH ANALYTICS

- Cenacle Research case studies:
  - Foodborne Disease Outbreak Detection
  - Disease Spread Causal Factor Analysis
  - Medicine Sales Cannibalization
  - Medicare Charge Disparity Analysis
  - Prioritization for Infectious Diseases

FOODBORNE DISEASE OUTBREAK DETECTION

CASE STUDY

FOODBORNE DISEASE OUTBREAK DETECTION

- Attribution of Food borne illnesses to Food Commodities
- *Goal*: Measuring probability and magnitude of disease outbreaks at a specific region and time based on food consumption and outbreak data
  - Government has a target for disease control – what is the probability that the targets can be met?

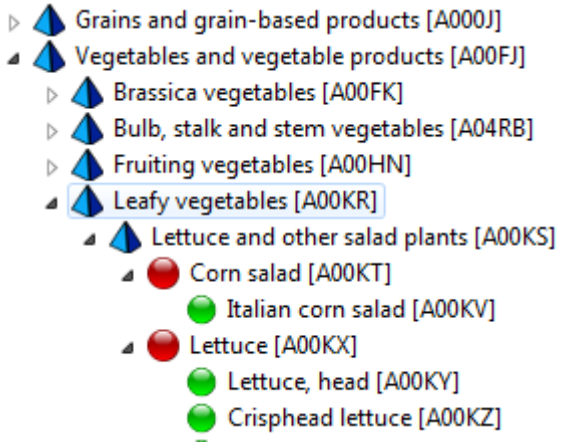
Pathogen / Syndrome	Year																	2010 National health objective[§]	2020 National health objective[¶]
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012		
Surveillance population (millions) †††	14.27	16.13	20.71	25.86	30.64	34.85	37.86	41.75	44.34	44.77	45.32	45.84	46.33	46.76	47.14	47.51	47.51		
Campylobacter	23.59	24.55	19.42	14.82	15.36	13.63	13.38	12.63	12.82	12.71	12.73	12.81	12.64	12.96	13.52	14.28	14.30	12.3	8.50
Listeria **	0.43	0.43	0.53	0.40	0.33	0.26	0.25	0.31	0.26	0.29	0.28	0.26	0.26	0.32	0.27	0.28	0.25	0.24	0.20
Salmonella	14.46	13.55	13.61	16.07	14.08	15.04	16.24	14.46	14.65	14.53	14.76	14.89	16.09	15.02	17.55	16.45	16.42	6.8	11.40

DATA

- Food borne disease historic data

Year	Month	State	Genus Species	Status	Location Of Consumption	Total Ill	Total Hospitalizations	Total Death	FoodVehicle
1998	June	Washington			Private home	2			chicken, unspecified
1998	August	Washington	Vibrio cholerae	Confirmed	Restaurant	2	0	0	oysters, unspecified
1998	September	Vermont	Salmonella enterica	Confirmed	Other	4	0	0	

- Food classification data



- Food consumption data

RESULTS

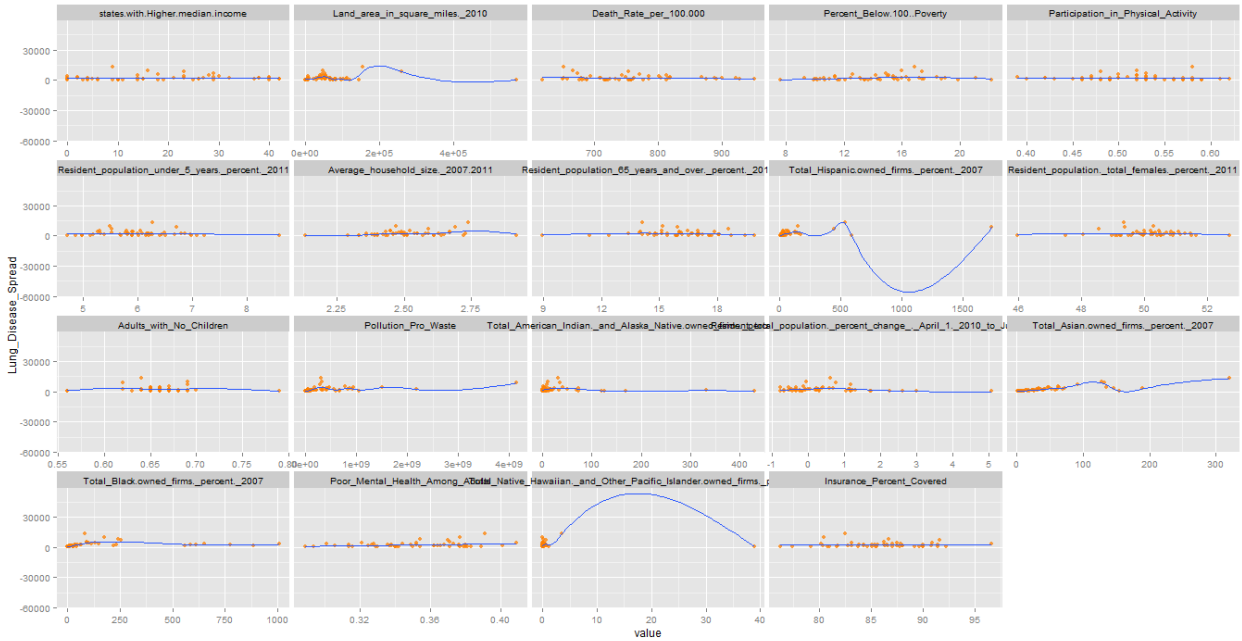
- Analytics model capable of predicting the probabilities of foodborne disease outbreaks with 86% accuracy
- Case in Point:
  - Successfully predicted the probability of 30 people getting ill due to consumption of leafy vegetables at picnic in Missisipi during September with Salmonella Entrica Infection

DISEASE SPREAD CAUSAL FACTOR ANALYSIS

CASE STUDY

DISEASE SPREAD CAUSAL FACTOR ANALYSIS

- Map disease spread to the factors affecting it
- *Goal*: Given the geographical, socio-economic factors and disease incidents, estimate the probability of a person getting affected by the disease
  - Control disease spread by controlling the causal factors affecting it



DATA

- Drug sales

Rank	Drug	Units (000)
1	budesonide Generic Drug	22,605
2	acetaminophen/hydrocodone Generic Drug	19,617
3	omeprazole Generic Drug	15,505

- Geographic data
  - Weather conditions, Seasonality, Pollution data etc.

Max 1-hour NO2	UNITS	DAILY_AQI_VALUE	DAILY_OBS_COUNT	PERCENT_COMPLETE	AQS_PARAMETER_CODE	AQS_PARAMETER_DESC	CSA_CODE
21.9	ppb	20	21	88	42602	Nitrogen dioxide (N	132
31.3	ppb	29	24	100	42602	Nitrogen dioxide (N	132
42.4	ppb	40	24	100	42602	Nitrogen dioxide (N	132
38.3	ppb	36	22	92	42602	Nitrogen dioxide (N	132

- Socio-economic data
  - Population density, Age groups, Per-capita income size etc.

Location	Children 18 and under	Adults 19-64	65+	65-74	75+
United States	78,379,000	188,005,800	41,506,800	23,383,300	18,123,400
Alabama	1,215,700	2,871,600	640,000	357,500	282,500
Alaska	201,100	432,600	58,300	34,800	23,500
Arizona	1,733,300	3,935,000	818,400	483,000	335,300
Arkansas	732,600	1,712,100	448,900	253,000	195,900
California	9,880,600	23,148,800	4,340,800	2,454,700	1,886,100
Colorado	1,315,900	3,090,100	580,300	323,000	257,300

RESULTS

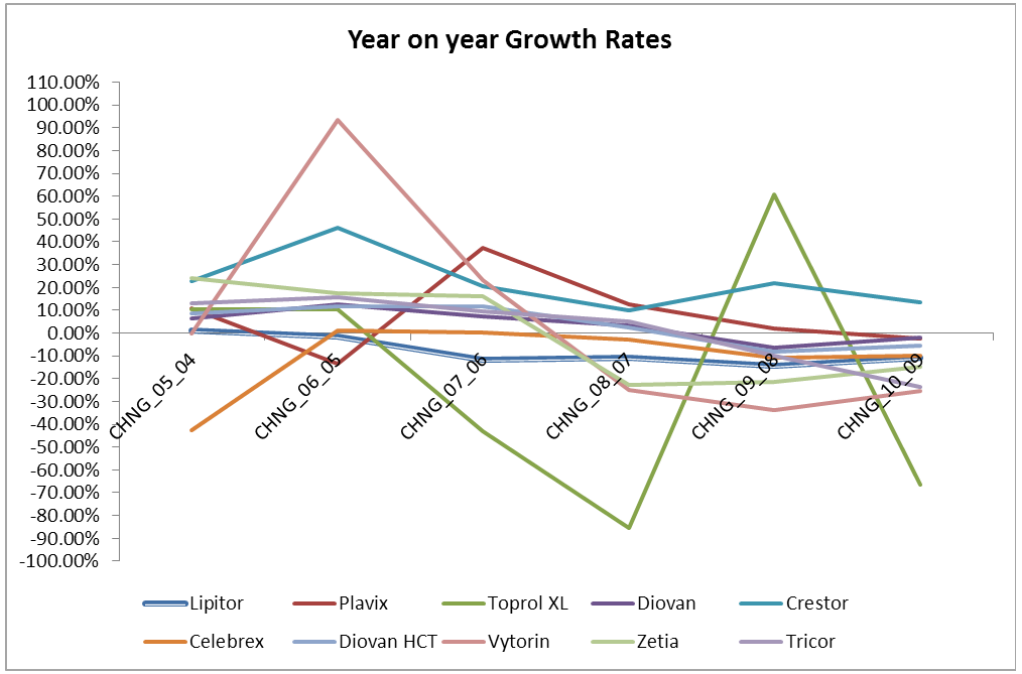
- Analytics model capable of mapping the diseases with their causal factors with 84% accuracy
- Case in Point:
  - Identifying the factors affecting the lung disease spread based on patient's dietary habits, living geographical circumstances, socio-economic factors, family conditions and past medical history.

MEDICINE SALES CANNIBALIZATION

CASE STUDY

MEDICINE SALES ANALYSIS

- Competition and Sales comparison within Medicine groups
- *Goal*: Find any cannibalization effects and demographic, age, sex associations and trends



DATA

- Time series drug sales data

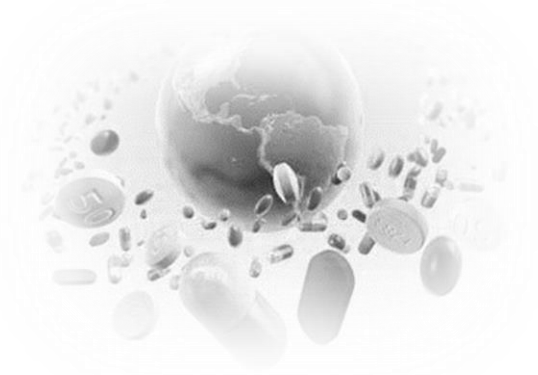
Rank	Drug	Current Manufacturer	Total Rxs (000)	% Change 2003
1	Lipitor	Pfizer Inc	62,541	6.6%
2	Synthroid	Abbott Laboratories	42,105	-7.0%
3	Norvasc	Pfizer Inc	30,929	4.3%
4	Toprol XL	AstraZeneca Pharmaceuticals	30,450	16.3%
5	Zoloft	Pfizer Inc	28,755	0.6%
6	Zocor	Merck & Co., Inc.	23,804	-1.7%

- Demographic data
- Socio-economic data

Characteristic	Total	Under $5,000	$5,000 to $9,999	$10,000 to $14,999	$15,000 to $19,999	$20,000 to $24,999	$25,000 to $29,999	$30,000 to $34,999	$35,000 to $39,999	$40,000 to $44,999	$45,000 to $49,999	$50,000 to $54,999
All Races												
All Households	121,084	4,261	4,972	7,127	6,882	7,095	6,591	6,667	6,136	5,795	4,945	5,170
TYPE OF RESIDENCE												
Inside metro statistical areas	101,526	3,565	3,961	5,658	5,469	5,665	5,263	5,463	5,032	4,800	4,173	4,289
Inside principal cities	40,616	1,991	2,135	2,751	2,536	2,546	2,192	2,415	2,109	2,061	1,641	1,638
Outside principal cities	60,910	1,574	1,825	2,907	2,933	3,119	3,070	3,048	2,923	2,739	2,532	2,651
Outside metro statistical areas (4)	19,558	697	1,012	1,468	1,413	1,430	1,329	1,205	1,104	995	772	881
REGION/DIVISIONS												
Northeast	21,774	769	892	1,290	1,115	1,164	1,070	1,073	992	1,000	775	903

RESULTS

- Analytics model capable of revealing the sales cannibalization effects among similar class of drugs
- Results played important role in building personalized health regimes for chronic disease patients
  - Trends of cannibalization over period of time in similar class of drugs establishes generic trends of reception for group of patients forming cohorts

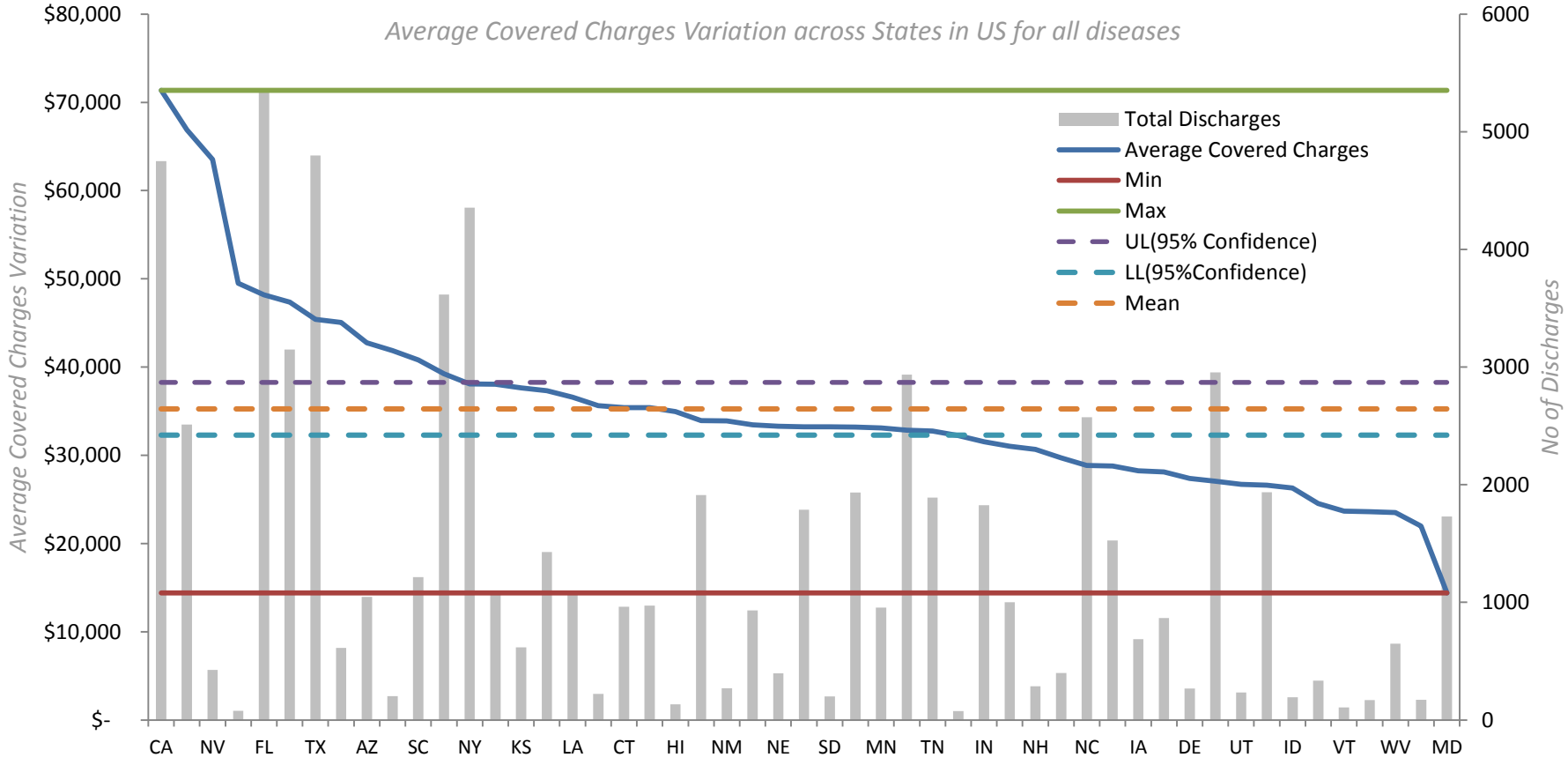


MEDICARE CHARGE DISPARITY ANALYSIS

CASE STUDY

MEDICARE CHARGE DISPARITY ANALYSIS

- *Goal*: Identify the culprit hospitals and the factors for the charge disparity



DATA

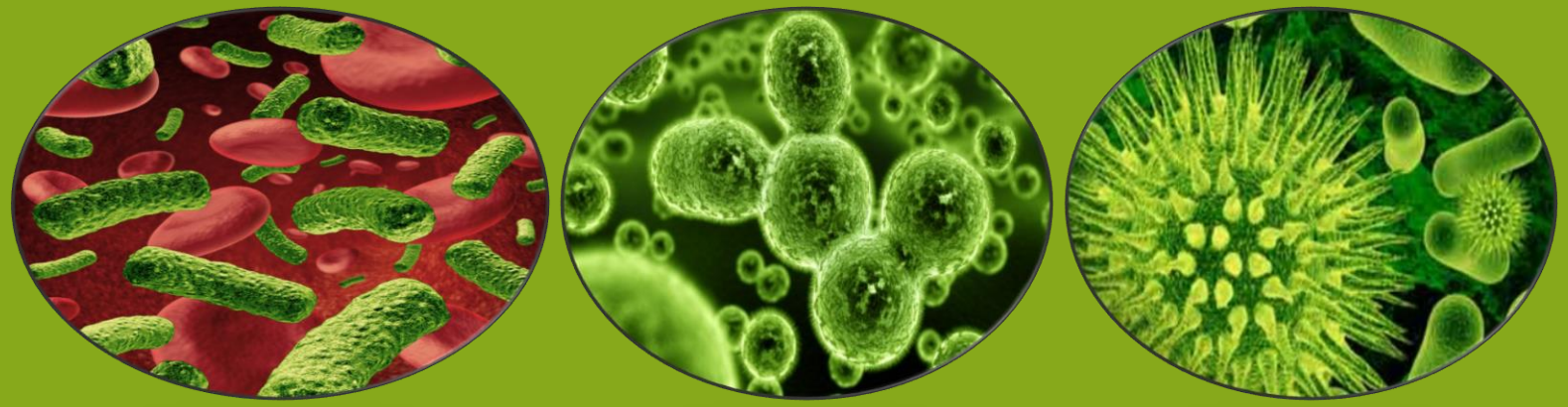
- Inpatient discharge group data for 3100+ US hospitals
- Data for top 100 disease groups with average charges within each DRG
- Hospital infrastructure data

F1 | Acute_Care_Hospital_Beds_per_1000_Residents

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	HRR	HRR_City	State	Number_	Resident_	Acute_Car	Hospital	FTE_Hospi	Total_Phys	Primary_C	Total_Spe	Medical_S	Hospital-B	Surgeons_	Resident_I	Allergists/_	Anesthesic
2	1	Birmingham	AL	8554	2216270	3.46	4.15	15.1	177.3	63	111.8	37.4	22.2	41	35.4	0.72	9.15
3	2	Dothan	AL	3482	363788	3.33	4.32	16.3	154.6	53.7	98.5	30.6	21.9	40.7	6.7	0.91	9.16
4	5	Huntsville	AL	5348	571384	2.61	4.66	14.5	178.2	67.7	108	34.6	23	39.1	13.3	0.82	9.94
5	6	Mobile	AL	4638	795089	3.08	4.39	15.4	171.2	56.9	112	38.4	22.1	41.2	27.8	0.61	8.97
6	7	Montgomery	AL	3750	450233	2.74	3.6	11.3	155.2	61	91.8	29.4	19.7	35.8	13.5	1.05	6.97
7	9	Tuscaloosa	AL	3049	245113	3.52	4.83	17.8	181.2	67.7	111.1	36.4	21	35.7	25.6	1.59	7.97
8	10	Anchorage	AK	1661	666346	2.54	4.26	15.5	244.7	100.5	140.8	43.3	28.7	53.1	13.3	0.81	15.33

RESULTS

- Analytical insights into the disease spend waste happening at population level
- Policy recommendations and infrastructural requirement guidelines for Medicare



PRIORITIZATION FOR INFECTIOUS DISEASES

CASE STUDY

PRIORITIZATION FOR INFECTIOUS DISEASES

- Classifying the most frequent pathogens in order of their significance for national surveillance and epidemiological research
- *Goal*: Create a basis for strategic and conceptual decisions in the field of infectious disease epidemiology
  - Goal is to come up with relative ranking rather than an absolute cut-off (beyond which diseases are not considered important)

Criteria	Values		
	−1	**0**	**1**
		Burden of disease	
Incidence	< 1/100,000	1–20/100,000	> 20/100,000
Severity	Hospitalization is rare, work loss is < 2 days, no persisting handicaps	Hospitalization is rare, work loss of > 5 days is rare, few persisting handicaps	Hospitalization is frequent, work loss of > 5 days is frequent, persisting handicaps occur
Mortality	< 50 deaths/year in Germany	50–500 deaths /year in Germany	> 500 deaths/year in Germany
		Epidemiological dynamic	
Outbreak potential	Outbreaks are rare	Outbreaks with five or more cases are rare	Outbreaks with five or more cases are frequent
Trend	Diminishing incidence rates	Stable incidence rates	Increasing incidence rates
Emerging potential	Disease already endemic or unlikely to be introduced to Germany	Disease has the potential to be introduced to Germany sporadically	Disease is likely to emerge in Germany in a relevant way

DATA

- Notifiable diseases and pathogens data for Germany region.
  - Disease, Case category, compliance with the case definition
  - Reporting week, month, quarter, and year
  - Age group , Sex, Pathogen (e.g., serovar, phage type, etc.)

Meldekategorie	klin.-epidemiologisch	klin.-labordiagnostisch	klinisch	labordiagn. bei nicht erfüllter Klin.	labordiagn. bei unbek. Klin.
Adenovirus	197	1356	0	0	0
Botulismus	0	5	0	0	0
Brucellose	0	15	0	0	0
Campylobacter	243	40408	0	0	0
Cholera	0	1	0	0	0
CJK	0	24	39	5	0
Denguefieber	0	574	0	0	0

RESULTS

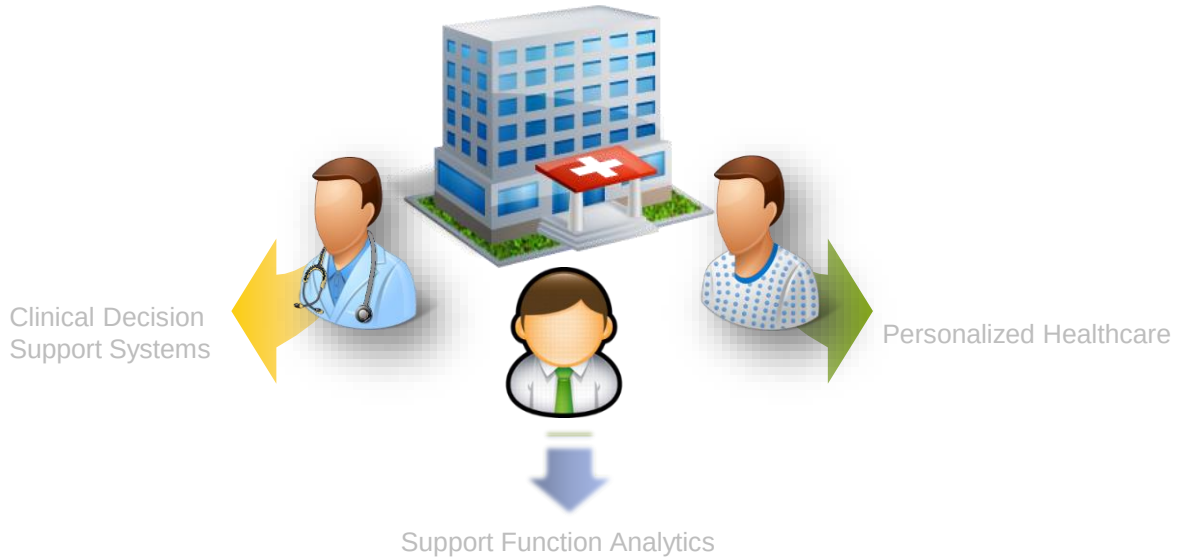
- Classification model prioritizing the pathogens in the order of their significance
- The relative ranking model provides the basis for formulating nation wide strategy for combating infectious disease monitoring, control and eradication

SOLUTION LANDSCAPE

Cenacle Research

SOLUTIONS LANDSCAPE

- For Doctors
  - Clinical Decision Support System
    - Diagnostic Assistance
    - Treatment Guidance
    - Risk Assessment
- For Patients
  - Personalized Healthcare System
    - Disease Modelling
      - Behavioural Patterns Analysis
      - Cohort Identification & Patient profiling
    - Personalized Insurance
  - Electronic Health Records
- System-wide
  - Health Information Exchange
  - Real-time Monitoring & Population Health Indicators
    - Epidemic Outbreak Detection
    - Contagious Disease Spread Modelling
    - Farm-to-Fork Analysis
  - Connected Experience



SOLUTION LANDSCAPE: FOR DOCTORS

- Clinical Decision Support Systems (CDSS)
  - Intelligent algorithms capable of digesting the medical records and helping doctors in making right decisions

  - Diagnostic Assistance
    - Based on the symptoms indicated by patient, CDSS identifies the most probable disease and suggests the right diagnostics to the Doctors
    - Eliminates redundant tests and avoids unnecessary costs, reducing the delay in treatment

  - Treatment Guidance
    - Based on the Diagnostic results, helps Doctors identify and prescribe the right treatment personalized for each patient

  - Risk Assessment
    - Helps the Doctor assess the risk of a potential treatment to a patient through the means of simulation

SOLUTION LANDSCAPE: FOR PATIENTS

- Personalized Healthcare
  - A personalized medicine regime that is designed based on patient's living habits, socio-economic factors, living geographical conditions and past medical history
  - Every individual is Unique
    - Not all drugs are suitable for all
    - Identifying differences between patients is critical to understanding the nature of illness
  - Unity in Diversity
    - Diseases are united in their symptoms, but divided in their right cure for each patient
    - Cohort identification plays critical role in designing the right medicinal regime for each disease
  - Our exploratory analysis techniques and advanced Monte Carlo simulation methods infer the right personalized healthcare model for each individual

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Do More.