50+ Years of NASA Astronaut Data - Architecting the Data and Analytics System

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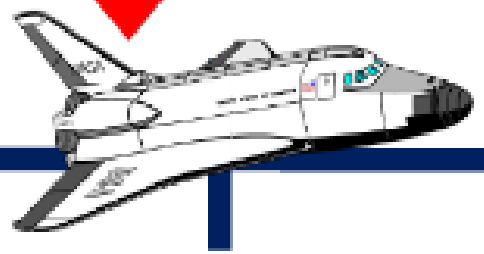
Slido.com
Event code #3852

Spaceflight Timeline

The Belmont Report

The Common Rule

Electronic Medical Record



1980 1990 2000 2010 2020

1981-2011
Shuttle Program

2000- Present
International Space Station

Medical Records

- In the late 90's NASA transitioned from traditional paper charts to an Electronic Medical Record system which improved the overall quality of care for astronauts in-flight and on the ground

Chart for 1 astronaut

Going Digital Takes Time

Flight Medicine Clinic EMR Established — Summer 1999

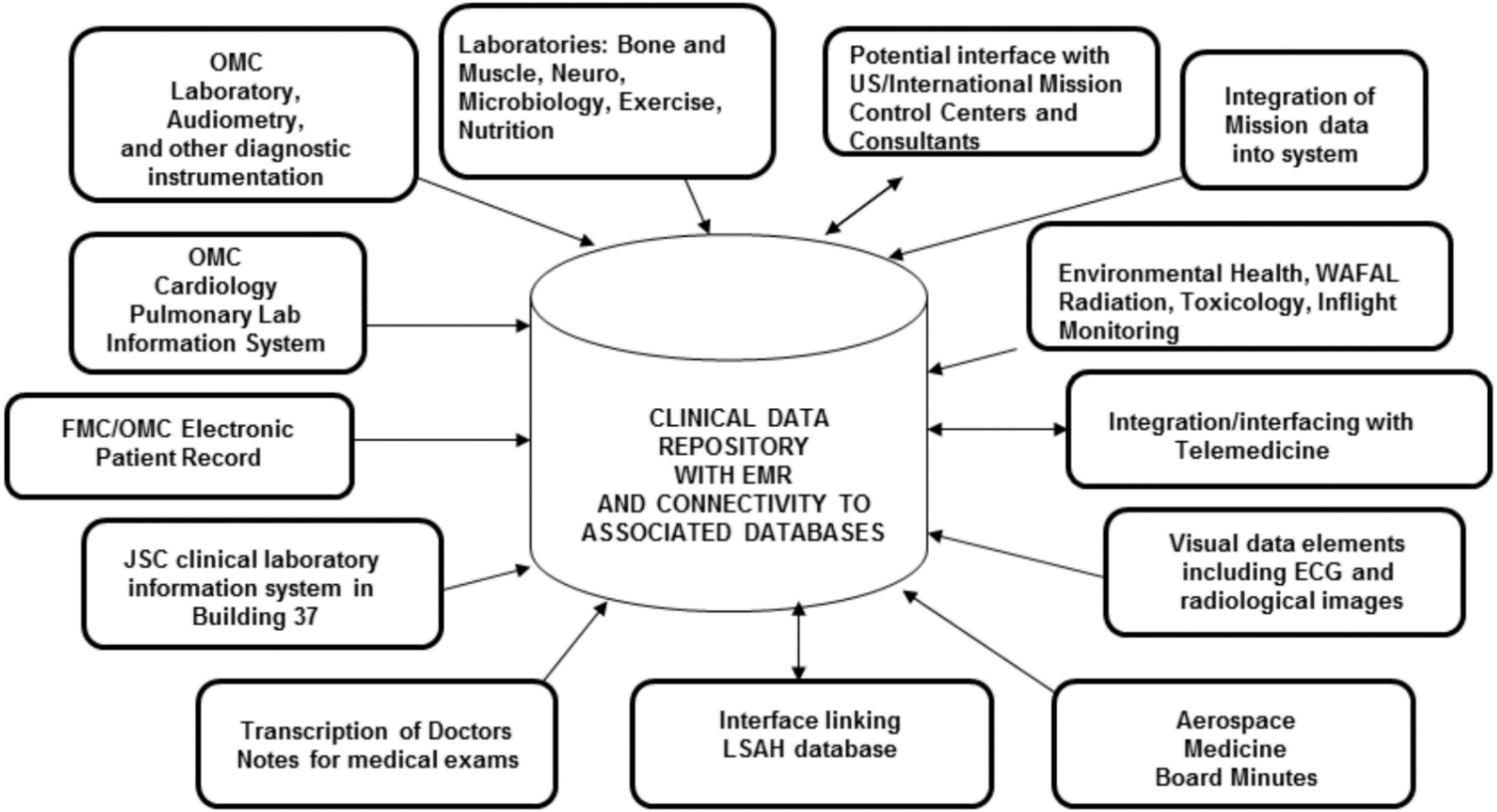
Clinical Lab Results — Spring 2000

Annual and Mission Physical Examinations — Fall 2000

Consultant Reports — Fall 2004

Ongoing Development of Data Collection — Fall 2004 - Present

Many Data Sources



Pre/In/Post-Flight MED B Requirements

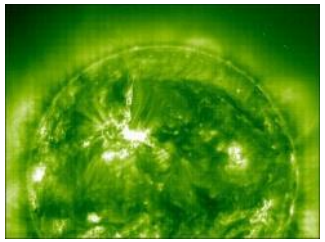
MED B #	MAT Title	Crew/Clinical Health	Occupational Monitoring	Re-certification	Preflight Time Points & Durations (minutes)																					In-flight	Postflight Time Points & Durations (minutes)																									
					L - 27 mo.	L - 24 mo.	L - 18 mo.	L - 365	L - 365/270	L - 365/240	L - 365/180	L - 330	L - 270	L - 270/180	L - 240	L - 240/180	L - 210	L - 180/90	L - 150	L - 90	L - 60	L - 20/10	L - 10/7	L - 2/1		R+ 0	R+ 0/1	R+ 0/3	R+ 3	R+ 3/7	R+ 4	R+ 5	R+ 5/7	R+ 5/30	R+ 7/10	R+ 7/14	R+ 10	R+ 14	R+ 14/30	R+ 20/30	R+ 29	R+ 30	R+ 60
	AME					180		180																																										
1.1	CS Clinical Assessment	X		X											60						60	60		30	X	60			60									60				0
1.2	CMO Health Status	X																							X																		
1.3	Private Medical Conference	X																							X																		
1.4	Neurological Assessment	X													0						0					0			0														
1.5	Neurovestibular Platform Test	X	X					45													30													30									
1.6	Resting ECG	X		X				15																			15																
1.7	24 hour ambulatory ECG	X		X					30																																			
1.8	Hearing Assessment	X	X	X	30	45		0												30					X			20								ACI						ACI
1.9	Dental	X		X											60						60																					
1.1	Ophthalmology Examination	X		X				60											120						X		5		120													
1.1	Ophthalmology Orbital MRI	X		X							60																		60													
1.1	Ophthalmology Ocular Ultrasound	X		X					90									90							X				30													
1.11	Bone Densitometry	X	X	X										60																			60									
1.12	Ultrasound Imaging	X		X		90								90																												
1.13	Body Mass Measurement	X	X																						X																	
1.14	Photodocumentation of Skin																										10															
1.15	BraimMRI / MRA	X		X							90																															
2.1	Laboratory Testing	X		X											0				0			10					0			ACI									ACI			
2.2	H. Pylori	X						0																																		
2.3	TB Testing	X						0																																		
2.4	MRSA	X						0													0					5																
3.1	Personal dosimetry	X	X																						X																	
3.2	Biodosemitry		X																		0													0							
4.1	Aerobic fitness/cycle ergometer	X	X							60											60				X					60								60			
4.2	Orthostatic tolerance	X																								ACI															
5.1	Functional Fitness Assessment	X	X										60							60											60								60	
5.2	On-orbit Strength & Conditioning Monitoring	X	X																						X															60	
5.3	Isokinetic Assessment	X													75						60									60								60	
5.4	Calf Volume measurement	X																							X																
6.1	Pre/post EVA CMO med Exam	X																							X																
6.2	Monitoring during EVA	X																							X																
6.3	Arm ergometry (Orlan)	X																							X																
7.1	Preflight Behavioral Health Status Check	X						60																																		
7.2	Preflight Psych Evaluations	X		X												60					60																					
7.3	Private Psych Conferences	X																							X																
7.4	Mood Assessment	X													0						0				X																0	
7.5	Postflight Psych Evals	X																										60							60	60				60	
7.6	Neurocognitive Assessment (WinSCAT)		X									30	30				30		30	30					X																30	
7.7	Behavioral Observation of Training																																								
8.1	Nutritional Assessments		X								45					45					45				X	20														20			
	Postflight Reconditioning				2 hours daily R+0 thru R+45																																							

- Sparse Data Points
- Spread out over time

Transition to Occupational Health Surveillance

- Visual Impairment Intracranial Pressure (VIIP) Risk Assessment
  - In 2013 NASA reported that fifteen long-duration male astronauts (45–55 years of age) had experienced confirmed visual and anatomical changes during or after long-duration flights
  - Optic disc edema, globe flattening, choroidal folds, hyperopic shifts and an increased intracranial pressure were documented in these astronauts
- Initial VIIP Surveillance Data Set (20,000+ data points)
- Imaging/Consultant Reports: 284 reports (MRI, OCT, Optical Biometry)
- Vision Data: 66,000+ data points Reviewed; 500+ Updated/Corrected

50+ Years of Data = Evidence



Solar Flare (radiation)

Isolation

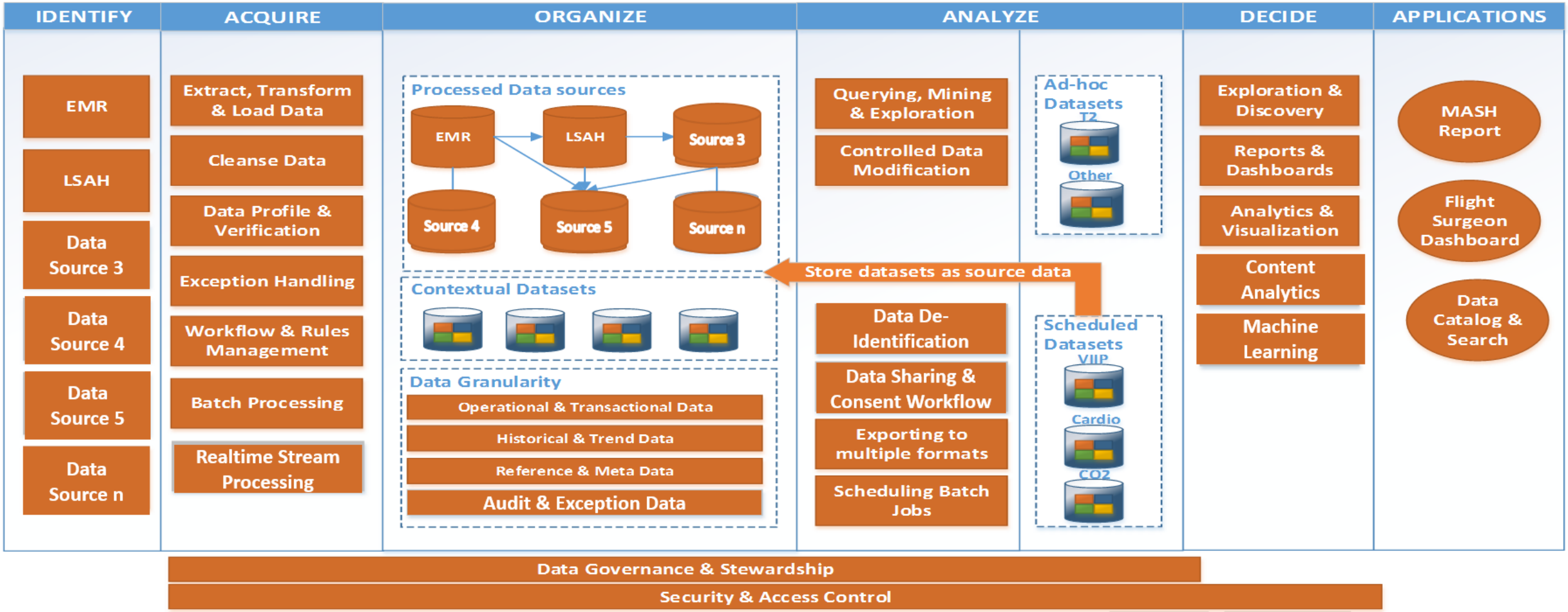
Confinement (small space)

Sensory Differences

Key Questions

- Data Acquisition: What is the right balance between structured and free text when primary goals include both completeness and retrievability?
  - EMR contains a mix. For VIIP, a person had to read free text looking for indicators
- Data Extraction: How to pull data completely and repeatably given the mix of data in the systems?
  - Data continues to flow into the systems.
- Analytics: How to trend & monitor the data in the systems for occupational health surveillance? For known risks? For identifying potential risks?
  - What tools could help us monitor VIIP? Could tools have helped us find VIIP before the sentinel event?
- Meta data: Lab tests have changed over the years. Data was collected under many different conditions. How to best structure, capture and use this associated metadata?
- Change: How to structure an architecture that is adaptable to changing needs, changing technology?
  - For VIIP new tests were added, the frequency of tests changed.

Analytics Platform



Questions?