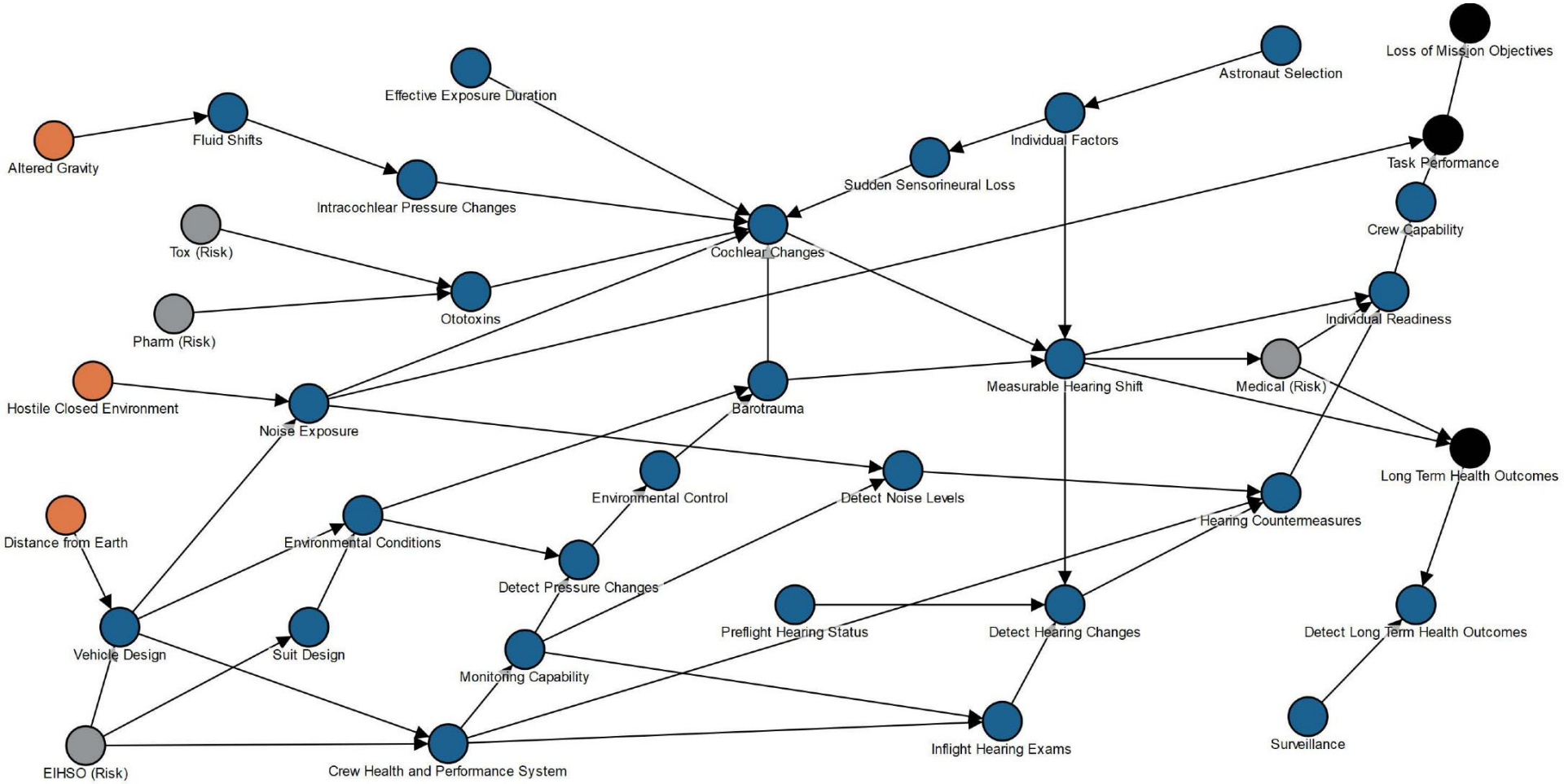
Directed Acyclic Graph (DAG) (Narrative)

- From a health perspective this DAG centers around Cochlear Changes which are changes inside the inner ear that can lead to issues with hearing. These culminate in effects on Individual Readiness and Crew Capability. This can be influenced by changes in:
  - Noise Exposure which includes Noise Intensity Level, Noise Exposure Duration, and Noise Spectrum which can also disrupt sleep and lead to degraded performance.
  - Monitoring crew health: Eustachian Tube Dysfunction (ETD) (specifically dilatory and baro-challenge-induced ETD), and ability of CM to manually pressurize middle ear (Valsalva) prior to an EVA or altered pressure event.
  - Ototoxins in the environment or in medications
  - Sudden Sensorineural Hearing Loss which is dependent on Individual Factors and has been recorded in some astronauts.
  - Intracochlear Pressure caused by Fluid Shifts in Altered Gravity environments. In this case the Effective Exposure Duration accounts for the cumulative effect that the exposure will have for different Design Reference Missions.
  - Barotrauma that can result from changes in pressure represented here by Environmental Conditions. This can result in Inner Ear Barotrauma that affects Cochlear Changes or Middle Ear Barotrauma that affects Measurable Hearing
  - Shifts without affecting the cochlea. This is affected by Suit Design.
- From a performance perspective, Noise Exposure leads directly to Task Performance showing that the noise environment can affect performance by impacting effective communications without degrading astronaut health.
- Vehicle Design and the Crew Health and Performance System enable Noise Monitoring and In-Flight Hearing Exams if these are designed into the system. When designed into the system, they enable Detect Noise Levels and Detect Hearing Changes. Inflight Hearing Exams must be coupled with Pre-Flight Hearing Status to enable detection of changes. Detection of either inappropriate Noise Levels or actual hearing changes can prompt crews to use Hearing Countermeasures such as hearing protection, which must also be designed into the Crew Health and Performance System to enable risk mitigation.
- From the Barotrauma perspective, Environmental Monitoring Capability enables us to Detect Pressure
  Changes. Standards require that crew have Environmental Control over the rate of depressurization that can minimize the likelihood of experiencing Barotrauma. A method to help reduce the risk of barotrauma includes the assessment of Eustachian tube function (tympanometry) and appropriate medications. Reduced barotrauma risk can help prevent a measurable hearing shift. EVA risk has direct link to barotrauma.
- Measurable Hearing Shifts and Hearing Countermeasures both affect Individual Readiness and Crew Capability. In some cases, Measurable Hearing Shifts can lead to medical problems like Hearing Loss both In-Mission as well as Long Term Health Conditions.


Loss of Mission Objectives
Astronaut Selection
Effective Exposure Duration
Fluid Shifts
Altered Gravity
Individual Factors
Task Performance
Sudden Sensorineural Loss
Intracochlear Pressure Changes
Crew Capability
Tox (Risk)
Cochlear Changes
Ototoxins
Individual Readiness
Pharm (Risk)
Hostile Closed Environment
Noise Exposure
Barotrauma
Measurable Hearing Shift
Medical (Risk)
Long Term Health Outcomes
Environmental Control
Detect Noise Levels
Distance from Earth
Environmental Conditions
Hearing Countermeasures
Detect Pressure Changes
Preflight Hearing Status
Detect Hearing Changes
Detect Long Term Health Outcomes
Vehicle Design
Suit Design
Monitoring Capability
Surveillance
Inflight Hearing Exams
EIHSO (Risk)
Crew Health and Performance System