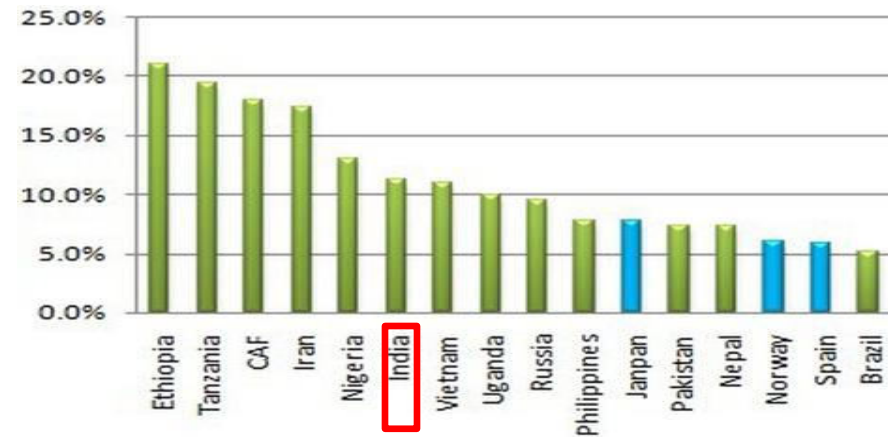# System dynamics application for surgical patient pathway mapping to model surgical site infections and optimize antimicrobial use
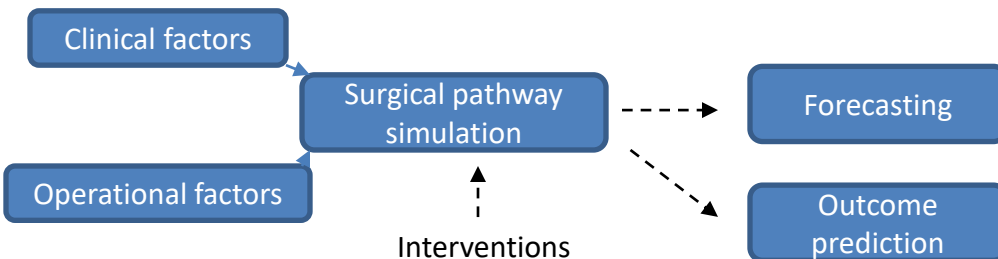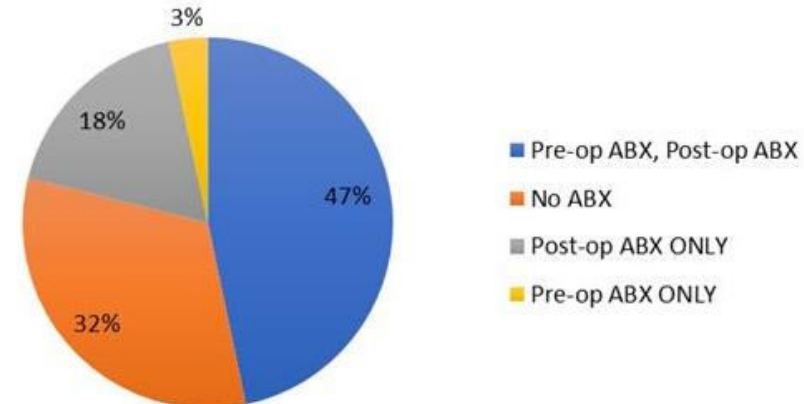
Amrita Institute of Medical Sciences

Problem statement

- Post-operative infections are major cause of morbidity.
- SSI account for 15% of nosocomial infections
- Use of antibiotics post-operatively account for 60% among surgical patients.
- Need for implementing interventions for optimization of antibiotic use and minimization of antimicrobial resistance along the surgical pathway in health care settings
- A model to simulate various proposed interventions to understand its effect on real world outcomes.

Incidence of SSI

Antibiotic Usage

- Pre-op ABX, Post-op ABX — 47%
- No ABX — 32%
- Post-op ABX ONLY — 18%
- Pre-op ABX ONLY — 3%

Clinical factors → Surgical pathway simulation

Operational factors → Surgical pathway simulation

Interventions → Surgical pathway simulation

Surgical pathway simulation ⇢ Forecasting

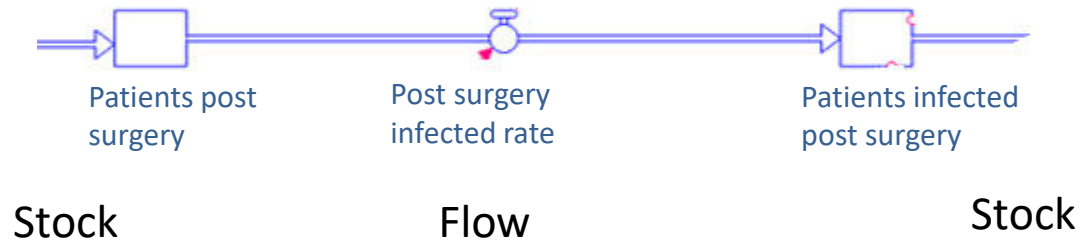Surgical pathway simulation ⇢ Outcome prediction

System Dynamic model

- Simulation method in solving real-world problems to describe relationships among variables in complex real systems.

Non-linear approach

Causal relation presumed
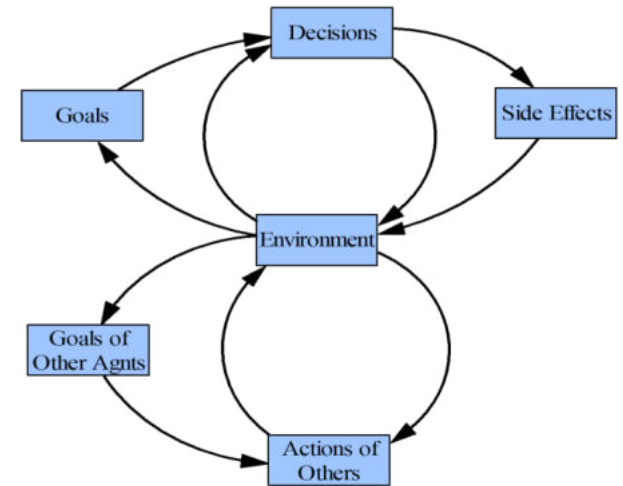
- A 'patient-centred' operational perspective/ key-entity
- Integrates the dynamic complexity of surgical pathway in the hospital : clinical and process outcomes offers a novel way to support decision making backed by analytical computer-based simulation modelling.

Patients post surgery

Post surgery infected rate

Patients infected post surgery

Stock   Flow   Stock

SD Model development

Feedback data

Data collection
- Hospital AMS and IPC data
- Admissions/Surgeries/ Finance
- Outcomes: Mortality, LOS

Informed opinion
- Surgeons/ Nurses/Admin
- Process durations

Resources tracking
- Staff productivity
- Non-human resources

Literature review
- SSI management and AMR policy documents
- Guidelines

Descriptive mapping
- Discussion with surgeons/ extended teams
- Mapping patient transitions
- Verification by surgical team/ Iterative process

Model simulation
- Variable states extraction
- Stock and flow model
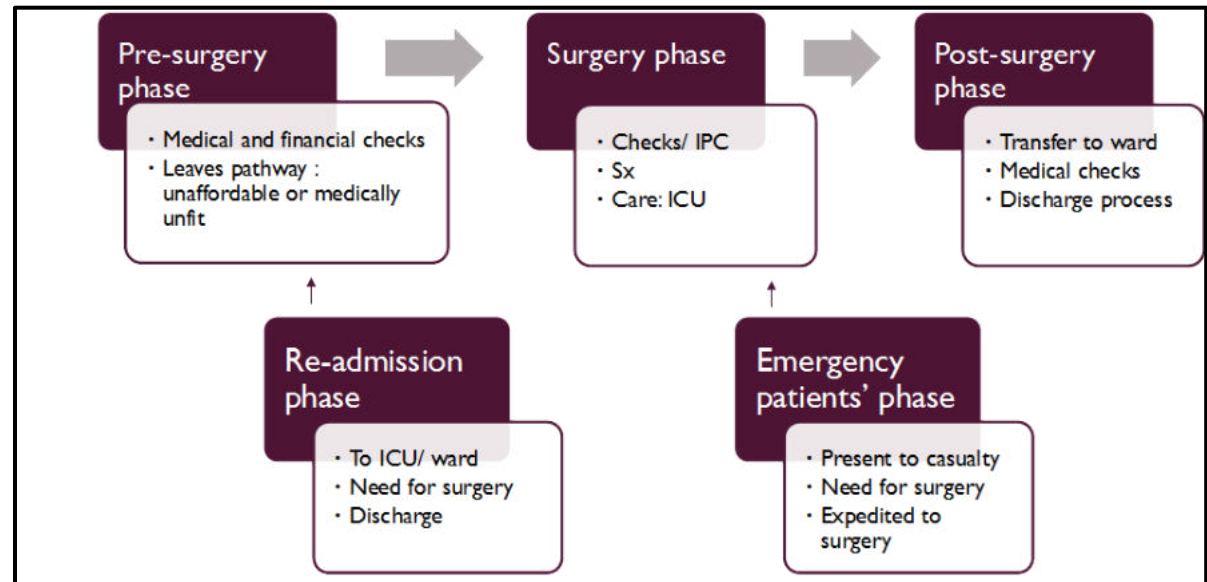- Stella Architect platform
- Equation integration

Data integration
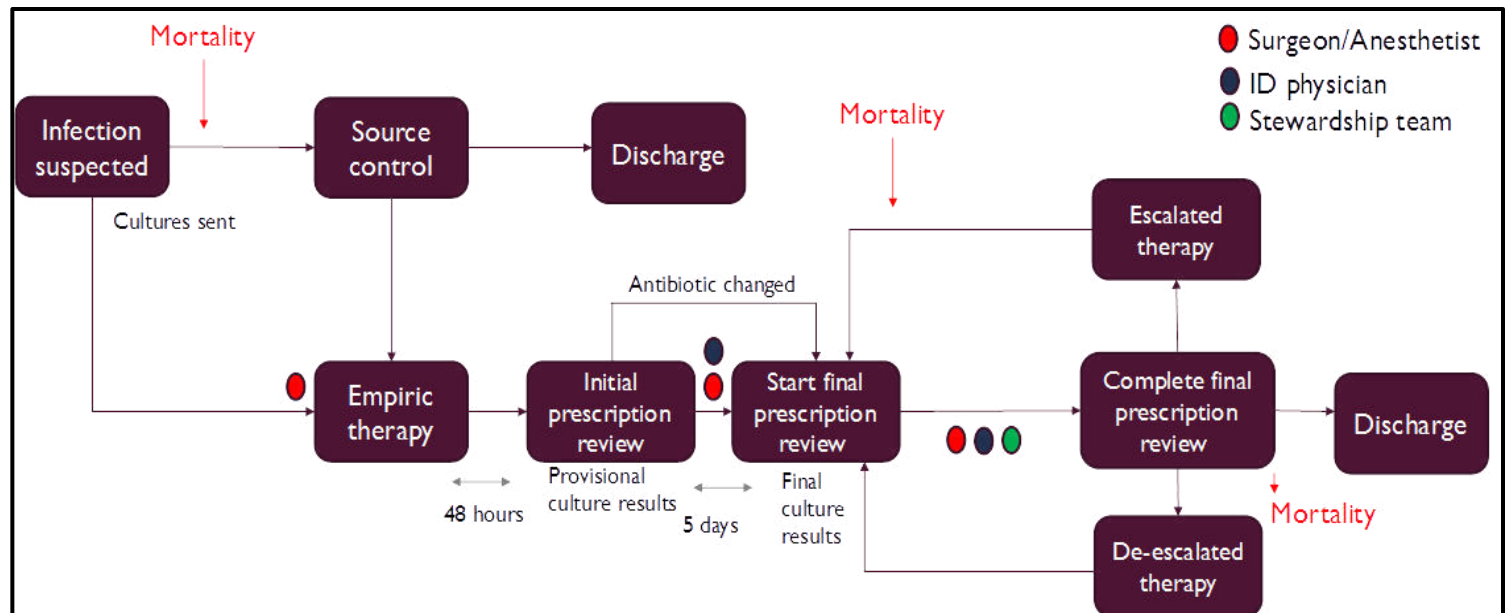- Integration of feedback data

Validation
- Pathway optimization
- Data validation
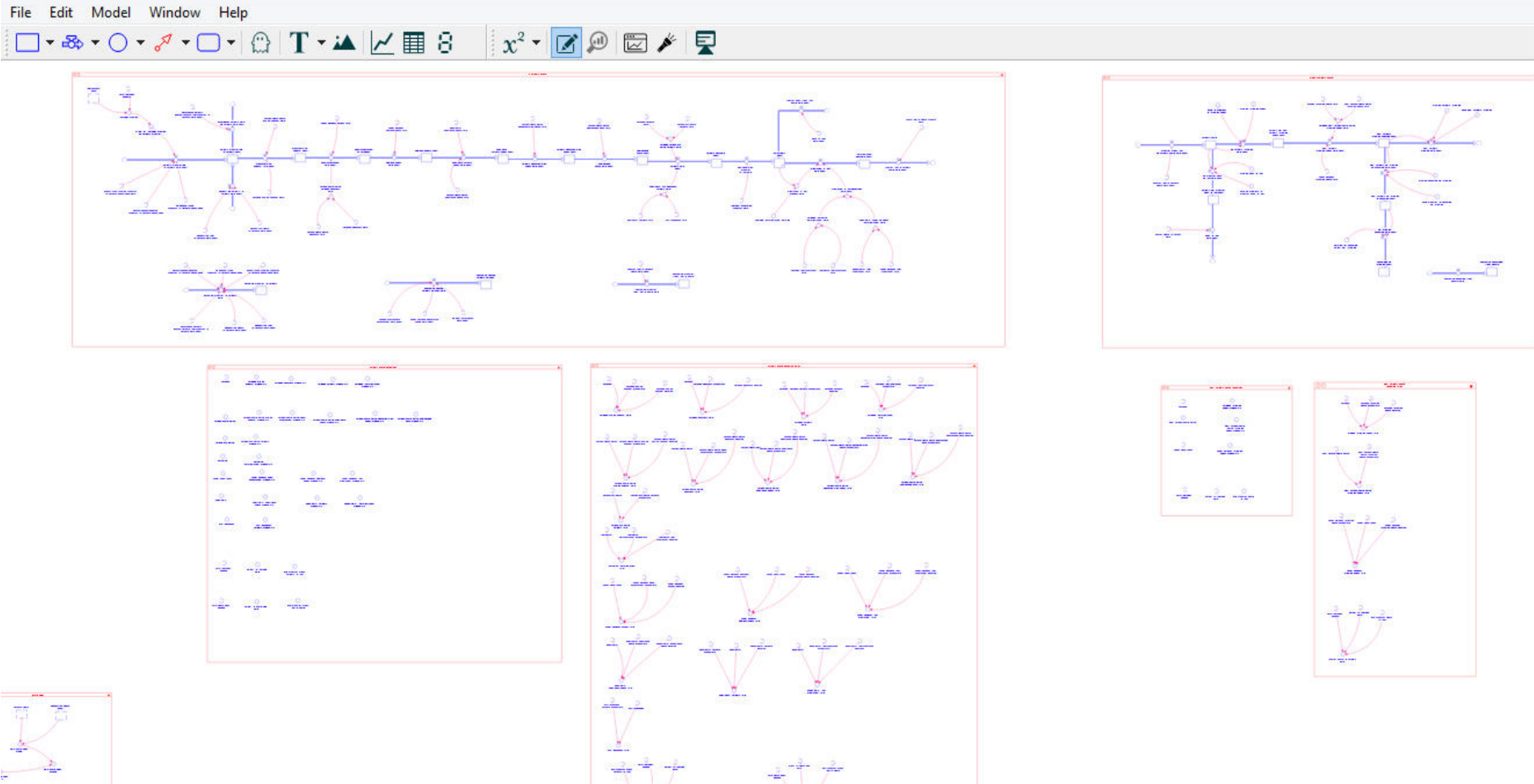
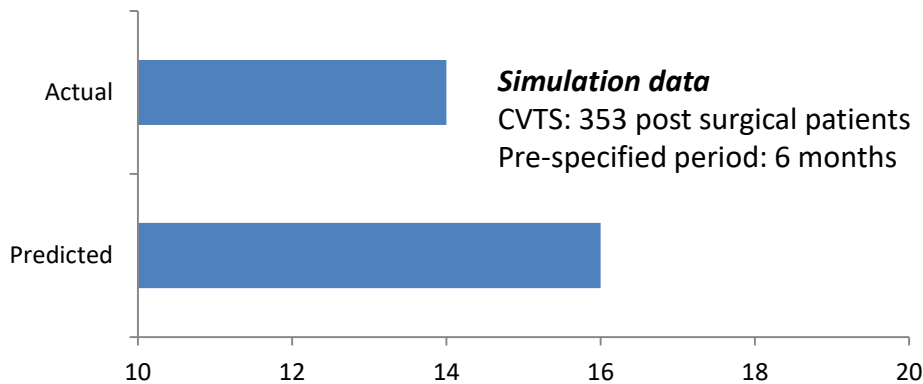**Phases/ stages of surgery modelled**

Infection pathway

Stella Architect

Outcomes

- Clinical outcome: HAIs

An approximate proportion of 4% contracting HAI was accurately reached as when the SD model predicted the actual case numbers to be 16.

Simulation data
CVTS: 353 post surgical patients
Pre-specified period: 6 months

- Operational outcome: Admissions

   Among 493 admissions into the clinical specialty, the SD model provided an approximate estimate of admissions within 10% relative precision.

Scenarios for:
-Reduction of HAIs
-Reduction of SSIs
-Reduction of antibiotic use

Proposed scenarios:
 -IPC bundle compliance
 - Peri-operative blood glucose monitoring
-Adjustment of prophylactic antibiotic for morbid obesity

Thank you