

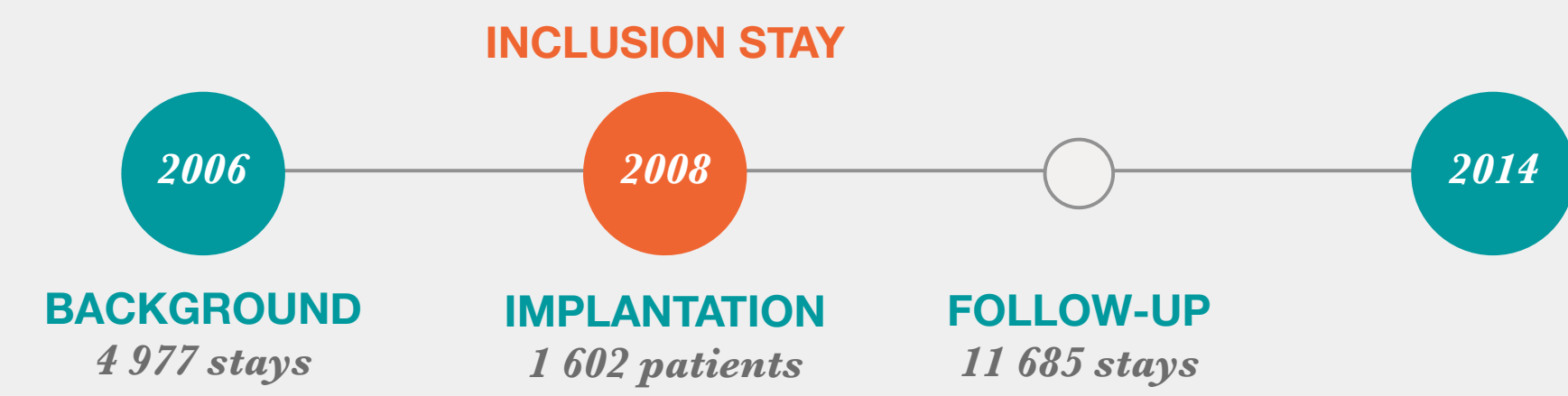
The implementation of **clinical pathways** is used to ensure a well-coordinated care offer. It allows for a standardization of practices.

The objective of the study is to reveal the potential of the **French national hospital PMSI database** to describe clinical pathways. It will bring **new knowledge** about care management and it will find underlying correlations between patients' profiles and their pathways.

The illustrative case study is the 8-year follow-up of patients implanted with a cardiac defibrillator.

METHOD FOR DATA MANAGEMENT

DATA EXTRACTION



We extracted all 2008 hospital stays with the implantation of a CRT-D (defibrillator allowing resynchronization). The source databases are the PMSI (French Medical Information System) and FICHCOMP (medical devices register). Using the anonymous ID of the 1 602 obtained patients, we then extracted their stays for 2 years ahead (2006-2008) and 5 years afterwards (2008-2013), being a total of 18 264 stays.

MORE DETAILS ABOUT DATA EXTRACTION

The extraction of the hospital stays from 2006 to 2013 was initially including all kinds of stays, being 22 829. Then, to label each stay with the main medical diagnosis, 649 different diagnosis were used. A filter was applied to remove "noisy" stays and to keep only the most relevant: a 79 mere diagnosis represent 80% of stays (being 18 264). This filter reduces data complexity and allows to focus on the main pathways.

SCIENTIFIC BACKGROUND

PROCESS MINING FOR PATHWAYS ANALYSIS

Clinical pathway model was discovered from data using a **Process Mining** approach and an **Integer Linear Programming** model. It searches for similarities in the sequence of stays of all the patients, each stay being labeled by the medical diagnosis.

SPECIFICATIONS OF THE MATHEMATICAL MODEL

Process Mining is a scientific field which is focused on studying end-to-end processes through databases. Time is key feature of the approach: clinical pathways can be analyzed over several year, and not only locally.

We developed our own **optimization algorithm** to detect similarities in the patients' sequences. It is based on both frequencies of stays and of transitions. The mathematical model is an **Integer Linear Programming**. To solve this combinatorial problem, we used **IBM Cplex solver**.

The final result is a synthetic graphical view of the most **representative pathways** of the cohort. Users can choose the level of detail to print more or less different paths.

CONCLUSION

This study shows that **clinical pathways** can be analyzed by mining the **French PMSI database**.

The pathway models are made of three components : the key hospital says, the delay of transition between two stays and the probability of following each of the paths. Such analysis can be performed for any sub-group of patients (age, gender, comorbidities).

The resulting model provide insights in the care management disease and help identifying improvement drivers.

Finally, the strength of this methodology and of the underlying algorithm is to be **generic**. It can be readily applied on other diseases.

AN OPTIMIZATION APPROACH FOR CLINICAL PATHWAY MODELING: CASE STUDY ON THE NATIONAL HOSPITAL DATABASE IN FRANCE

FIG.1 - INTEGER LINEAR PROGRAMMING MODEL

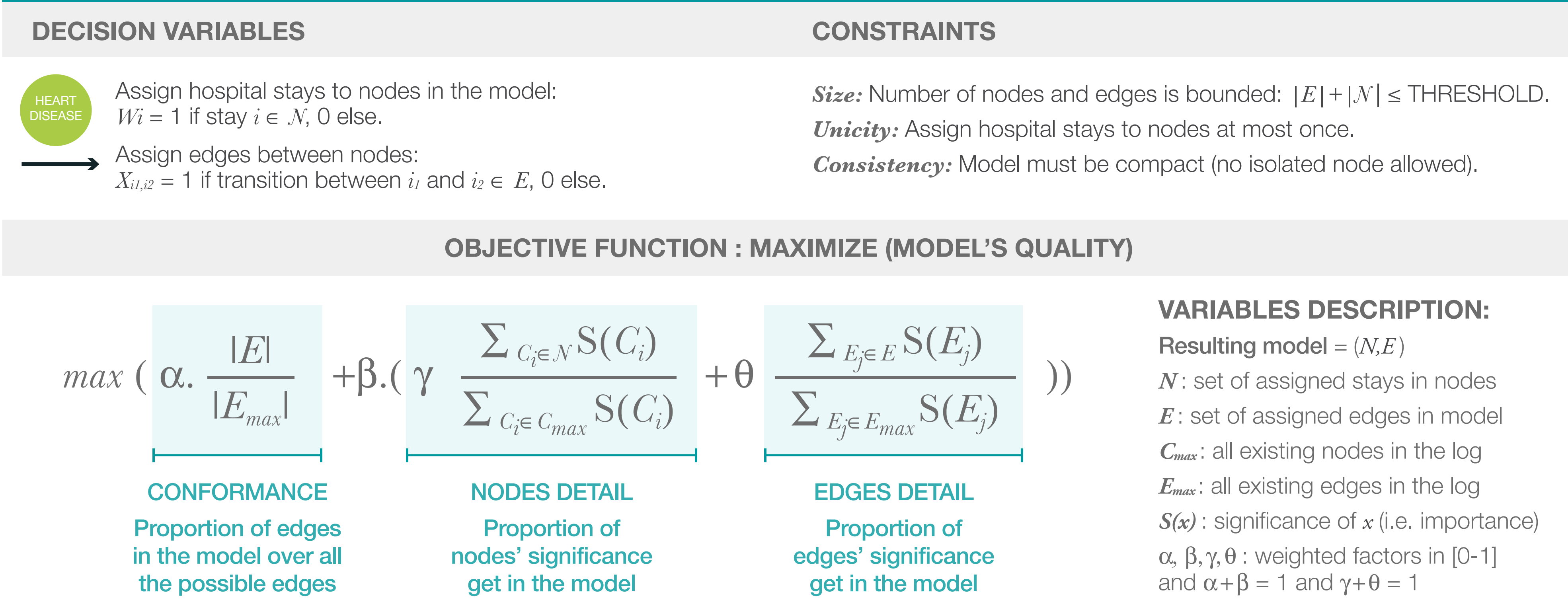


FIG.2 - RAW DATA USED AS INPUT OF THE ILP MODEL

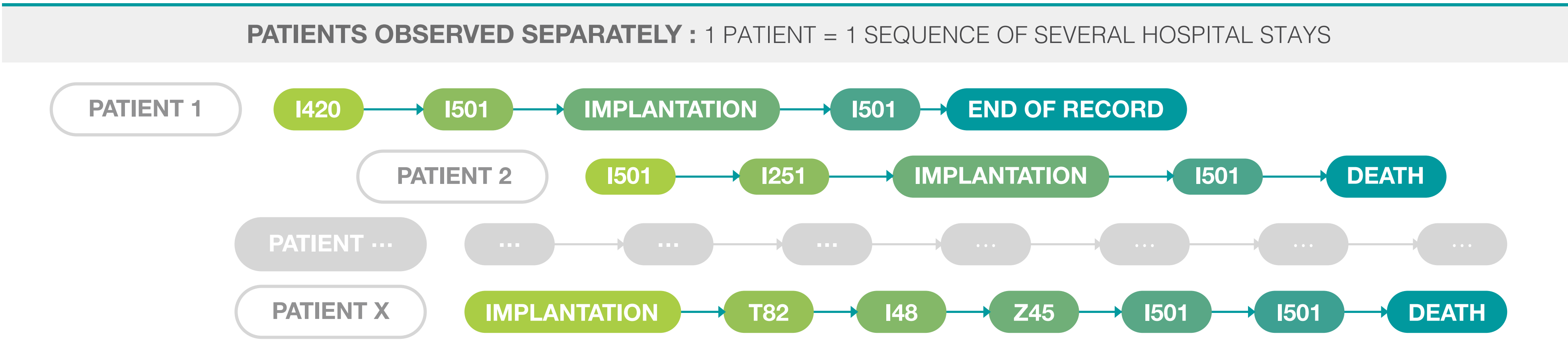
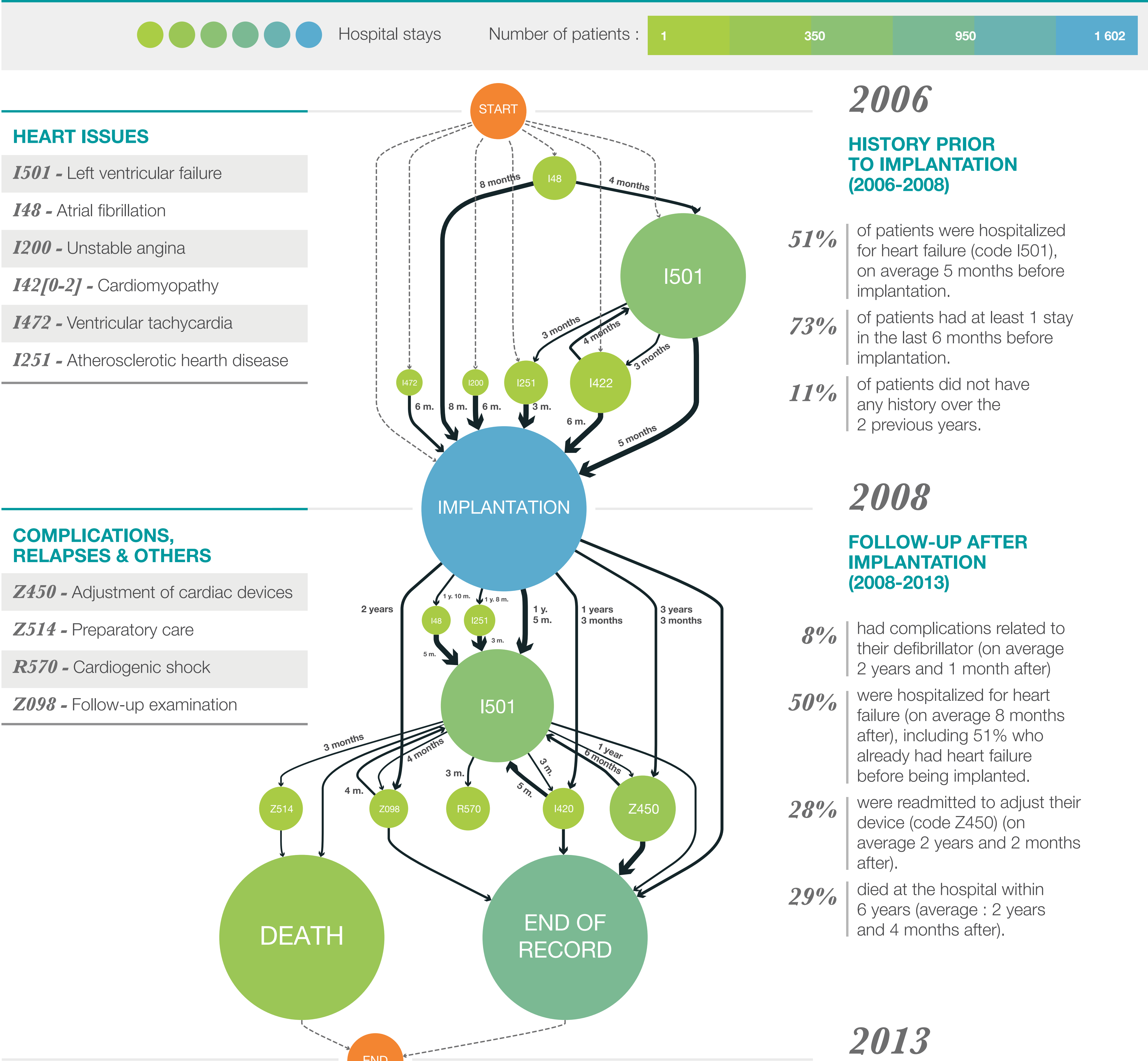


FIG.3 - SYNTHETIC PATHWAY MODEL OF IMPLANTED PATIENTS



NEXT STEP: DRIVERS TO IMPROVE THE CARE

- Anticipate failure relapse for high risk patients with more frequent follow-up.
- Early implantation of the device in the disease to reduce the risks of heart failure relapse.
- Search for deeper explanations of the early replacement of some devices (< 3 years).

8-YEAR FOLLOW-UP (FROM 2006 TO 2013)

~ 4-6 years	11	79
LIFETIME OF A DEFIBRILLATOR	STAYS ON AVERAGE PER PATIENT	DIFFERENT TYPES OF STAYS

