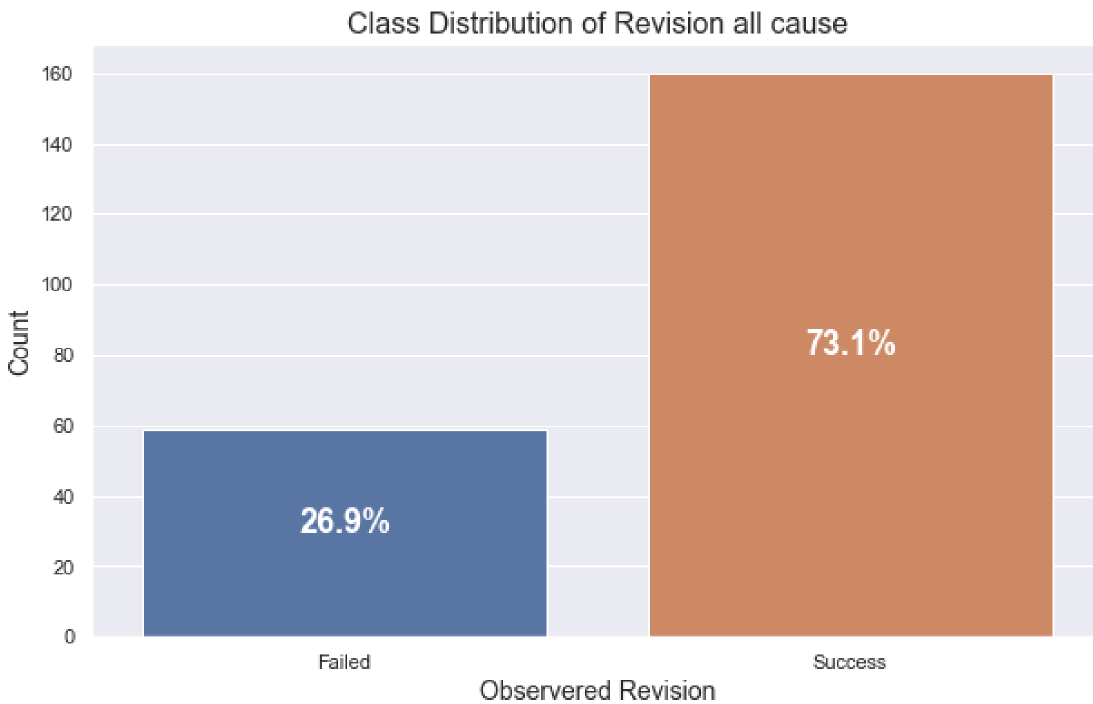
0.1 Percentage breakdown of revision and why it was performed.



0.2 Percentage breakdown of revision and why it was performed.

0.2.1 Multivariate Analysis

While our Analysis of Survivorship revolves around the entire dataset, it is important to note that our primary focus will be on the listed variable in the dataset.

In this study, typical research questions include:

(1) What is the impact of certain clinical characteristics on a patient's survival? For example, is there any difference between the group of people who has higher BMI and those who don't?

(2) What is the probability that an individual survives a specific period (years, months, days)? For example, given a set of patients, we will be able to tell that if 200(random number) days after the diagnosis has been passed, then the probability of that person being alive at that time will be 0.7 (random number).

(3) Are there differences in survival between groups of patients?

Multivariate analyses on survivorship

1. **Age**

- Separate on greater than 65 ii Separate on less than 65

1 BMI

- Separate on less than 40
- ii Separate on greater than 40

2 Gender

- Men

2.1 Women

We can answer the below questions by analyzing the **variables(Age, BMI, Gender)** listed above.

(1) We can find the number of days until patients showed symptoms of failure.

(2) We can find the age group, gender, and BMI with the highest level of failure.

(3) We can find which Reoperations has the highest survival probability.

(4) We can find whether a person's sex has a significant effect on their survival time?

We are going to perform a thorough analysis of patients.

2.1.1 Calculating Summary Statistics for Multivariate Data

It gives us some statistical information like the total number of rows, mean, standard deviation, minimum value, 25th percentile, 50th percentile, 75th percentile, and maximum value for each column in our dataset.

	Reason for Revision	Count	Percentage
0	arthritic progression	20	9.13
1	aseptic loosening	20	9.13
2	bearing dislocation	3	1.37
3	infection	1	0.46
4	instability	1	0.46
5	intractable pain	2	0.91
6	medial tibial overload	2	0.91
7	poly damage dt loose cement foreign body	1	0.46
8	tibial collapse	6	2.74
9	unknown	3	1.37

2.1.2 Calculating Correlations for Multivariate Data

It is often of interest to investigate whether any of the variables in a multivariate data set are significantly correlated.

Let's take a deeper dive into our dataset to understand some of the underlying relationships based on certain conditions

2.1.3 Kaplan-Meier Estimator with groups

Let's divide our data into 2 groups: **Gender** (Male and Female), **Age** (>65 and <65), and BMI(>40 and < 40). Our goal here is to check is there any significant difference in survival rate if we divide our data set based on sex, age, and BMI .

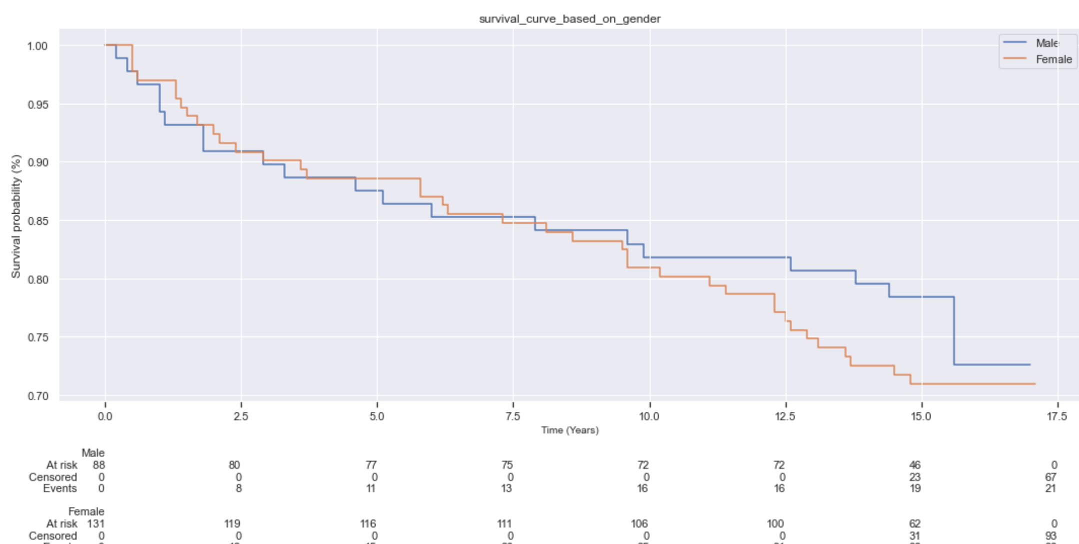
- Gender

2.2 Age Greater and less than 65

- BMI Greater and less than 40

Gender

2.2.1 The plot of Survival Probability Curve for Male and Female

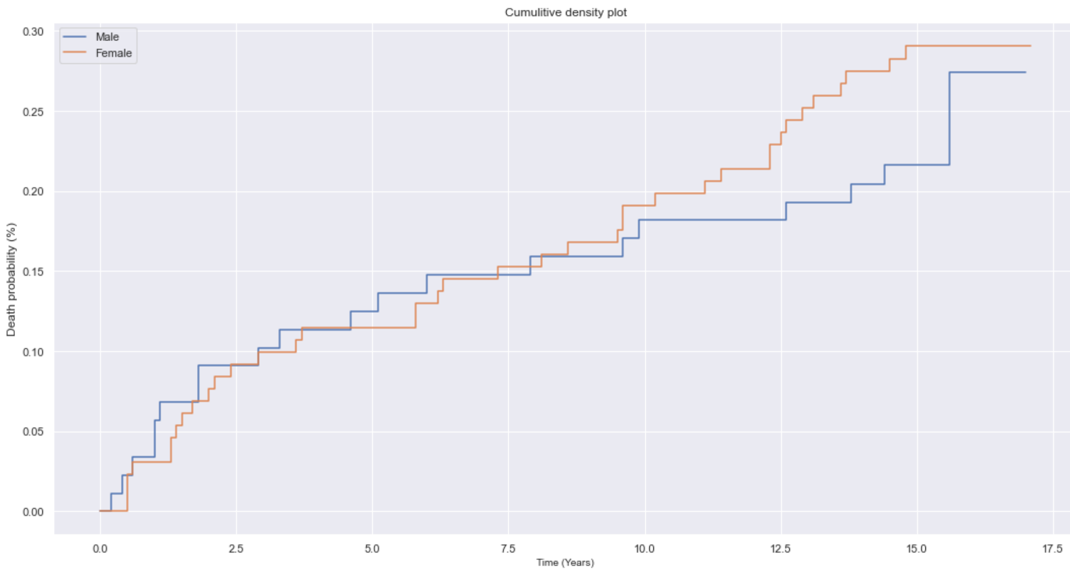


Notice that the probability of a **male** surviving is higher than the probability of a **female** from **9.6 Years(9 years and 6 months)**. So from this data, we can say that the medical researchers should focus more on the factors that lead to poor survival rates for female patients after **9.6 Years**.

Cumulitive$_{density}$

It gives us a probability of a person dying at a certain timeline.

2.2.2 The plot of Probability of a person dying at a certain timeline based on Gender



Log-Rank Test For Gender

Goal: Here, our goal is to see if there is any significant difference between the groups being compared.

Null Hypothesis: The null hypothesis states that there is no significant difference between the groups being studied. If there is a significant difference between these groups, then we have to reject our null hypothesis.

Less than (5% = 0.05) P-value means that there is a significant difference between the groups that we compared. We can partition our groups based on their sex, age, race, method of treatment, etc.

It's a test to find out the value of P.

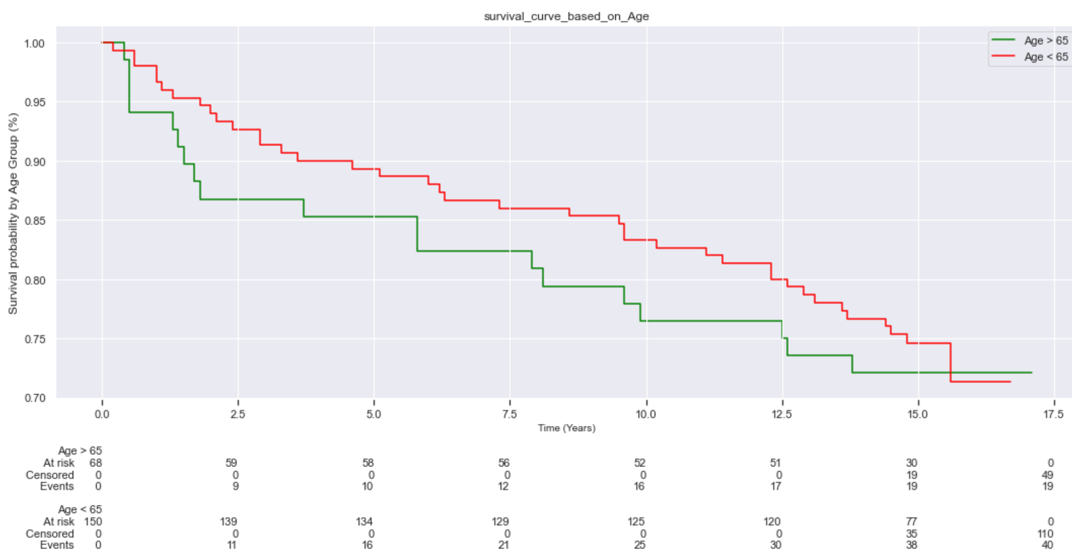
t_0	-1
null_distribution	chi squared
degrees_of_freedom	1
test_name	logrank_test

	test_statistic	p	-log2(p)
0	0.60	0.44	1.19

Here notice that for our **Gender** groups, the test_statistic equals 0.60, and the P-value indicates (<0.44), which is not statistically significant and denotes that we have to accept our null hypothesis and admit that the survival function for both Genders is not significantly different. The P-value gives us strong evidence that “sex" was not associated with survival years. In short, we can say that in our example, “sex" has no major contribution to survival years.

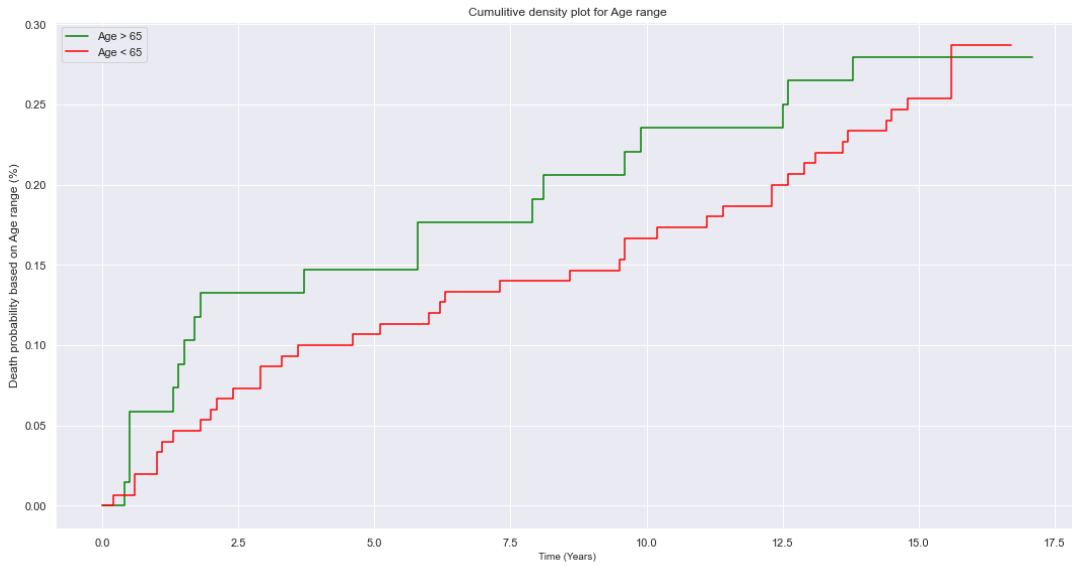
Age Greater and less than 65

2.2.3 The plot of Survival Probability Curve By Age Group



Notice that the probability of surviving for Age less than **65** is higher than the probability surviving for people with age greater than 65. So from this data, we can say that the medical researchers should focus more on the factors that lead to poor survival rates for Age greater than 65.

2.2.4 The plot of the Probability of a person dying at a certain timeline based on Age range (> 65 and < 65)



Patients with an age greater than 65 have a higher probability of dying, Another area medical researchers have to look into.

t_0	-1
null_distribution	chi squared
degrees_of_freedom	1
test_name	logrank_test

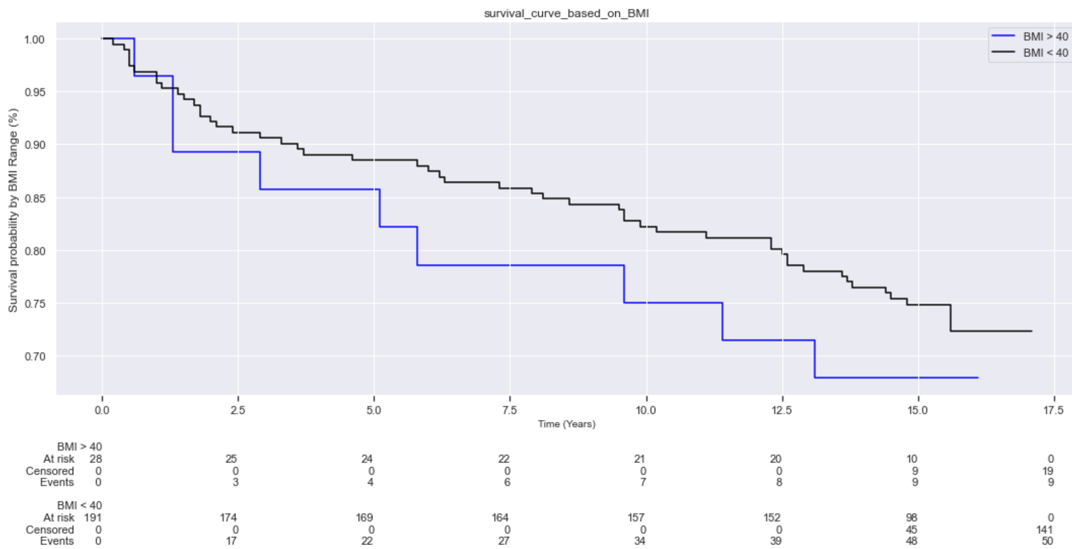
	test_statistic	p	-log2(p)
0	0.14	0.71	0.49

Log-Rank Test For Age Range ($>$ or $<$ 65 years)

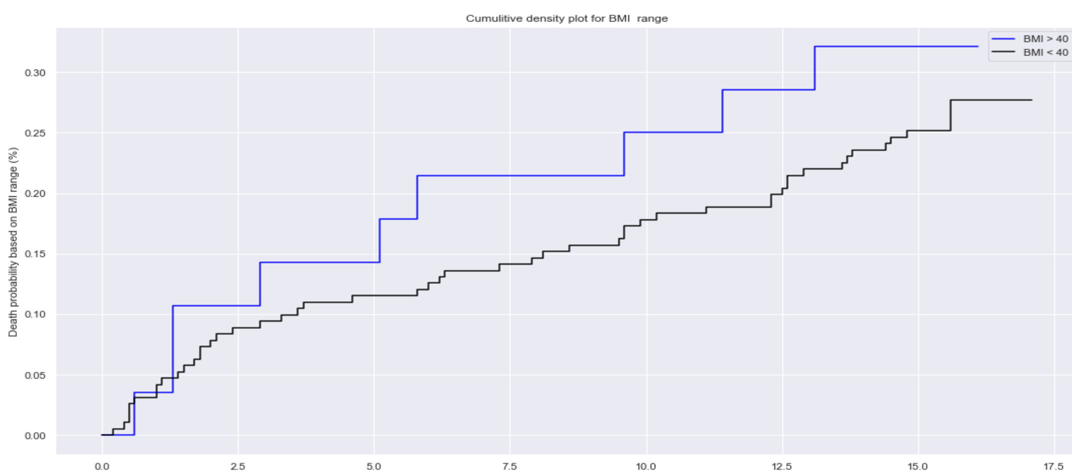
Here notice that for our Age groups, the test_statistic equals **0.14**, and the P-value indicates (<**0.71**), which is not statistically significant and denotes that we have to accept our null hypothesis and admit that the survival function for both Age Range is not significantly different. The P-value gives us strong evidence that "Age Range" was not associated with survival years. In short, we can say that in our example, "Age Range" has no major contribution to survival years.

BMI greater and less than 40

2.2.5 Plot of Survival Probability Curve By BMI Range



Notice that the probability of surviving for a BMI less than 40 is higher than the probability of surviving for people with a BMI greater than 40. So from this data, we can say that the medical researchers should focus more on the factors that lead to poor survival rates for BMI greater than 40.



Plot of Probability of a person dying at a certain timeline based on BMI range (>40 and and <40)

t_0	-1
null_distribution	chi squared
degrees_of_freedom	1
test_name	logrank_test

	test_statistic	p	-log2(p)
0	0.60	0.44	1.19

Log-Rank Test For BMI Range (> or < 40)

Here notice that for our BMI range, the test_statistic equals 0.60, and the P-value indicates (<0.44), which is not statistically significant and denotes that we have to accept our null hypothesis and admit that the survival function for both BMI range is not significantly different.

2.2.6 Cox proportional hazard model

The Cox proportional hazard model is basically a regression model generally used by medical researchers to find out the relationship between the survival time of a subject and one or more predictor variables. In short, we want to find out how different parameters like age, sex, bmi, height affects the length of survival for a subject.

model	lifelines.CoxPHFitter
duration col	'Time Years'
event col	'Revision all cause'
baseline estimation	breslow
number of observations	219
number of events observed	59
partial log-likelihood	-203.94
time fit was run	2022-04-13 05:29:45 UTC

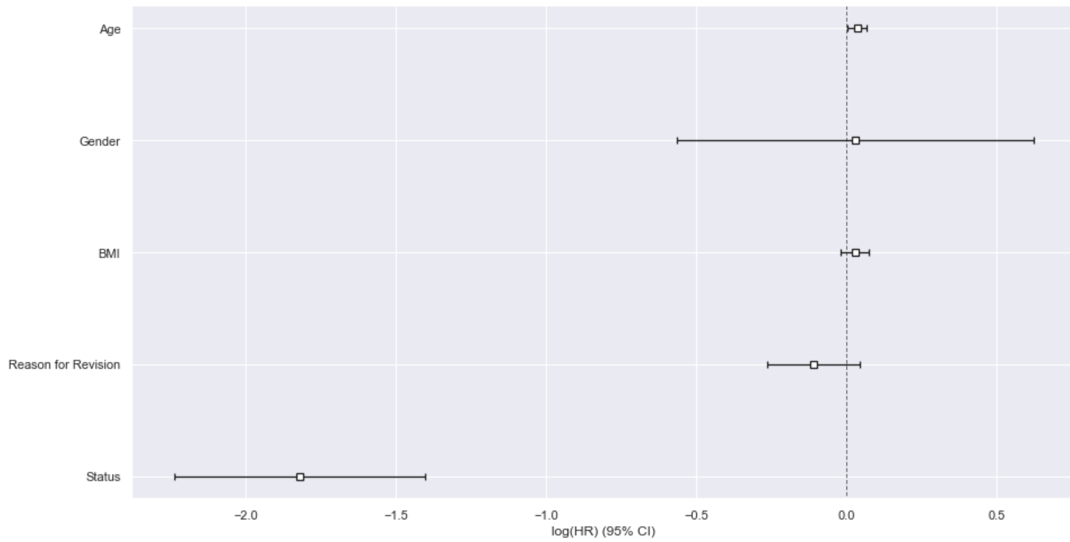
	coef	exp(coef)	se(coef)	coef lower 95%	coef upper 95%	exp(coef) lower 95%	exp(coef) upper 95%	cmp to	z	p	-log2(p)
Age	0.04	1.04	0.02	0.00	0.07	1.00	1.07	0.00	2.19	0.03	5.15
BMI	0.03	1.03	0.02	-0.02	0.07	0.98	1.08	0.00	1.23	0.22	2.20
Gender	0.03	1.03	0.30	-0.56	0.62	0.57	1.87	0.00	0.10	0.92	0.12
Reason for Revision	-0.11	0.90	0.08	-0.26	0.05	0.77	1.05	0.00	-1.36	0.17	2.53
Status	-1.82	0.16	0.21	-2.24	-1.40	0.11	0.25	0.00	-8.52	<0.005	55.81

Concordance	0.92
Partial AIC	417.88
log-likelihood ratio test	206.84 on 5 df
-log2(p) of ll-ratio test	139.55

Here notice the p-value of different parameters as we know that a p-value (<0.05) is considered significant. Here you can see that the p-value of **Age** and **Status** are <0.05.

The p-value for **Status** is <0.005 and HR (Hazard Ratio) is 0.16 indicating a strong relationship between the patients' Status and decreased risk of death.

Now notice that HR for Age is 1.04, which suggests only a 4% increase for the higher age group. So we can say that there is no significant difference between different age groups.

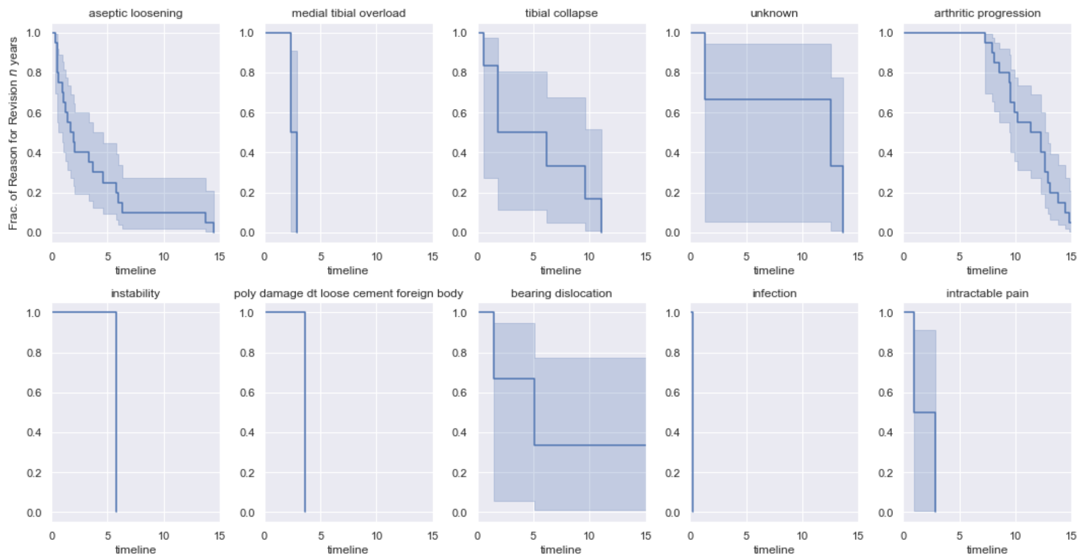


Lets Check which factor affects Revision all cause the most from the graph:

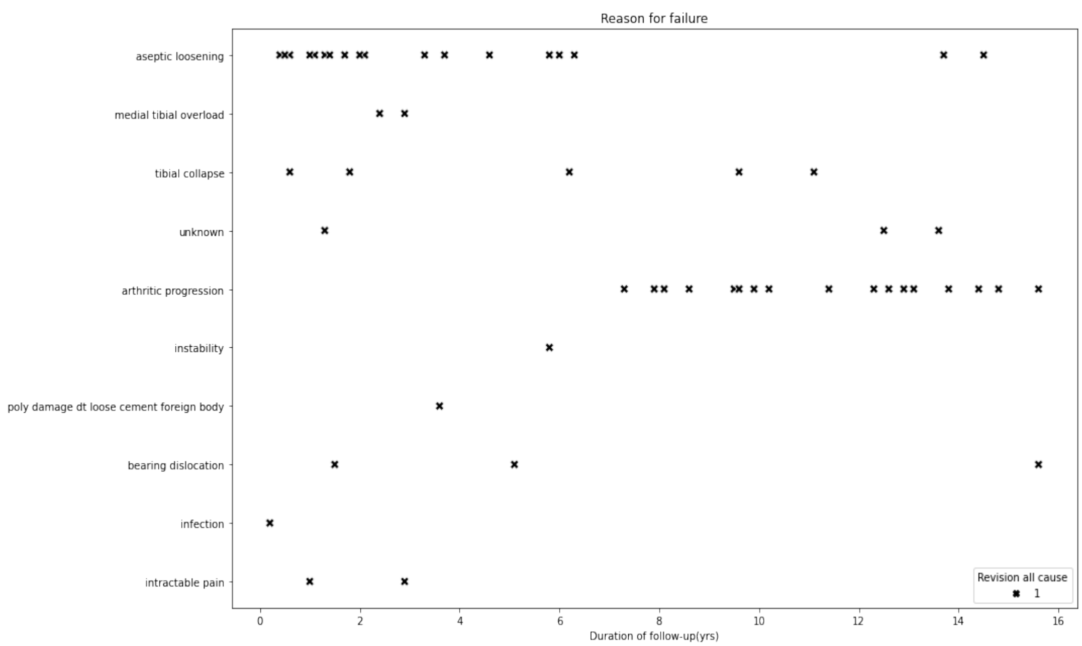
You can clearly see that **F/U Status** variable have significant differences.

Plot Survival probabilities of first 10 persons in our dataset

Lets compare the different types of Reason for Revision in the dataset:



2.3 Reason for failure



2.4 Create a patient table

	Reoperations	Reason for Revision	Time Years	Revision all cause
0	Arthroscopy 12/13/2005; revision UKA to TKA 3/...	aseptic loosening	2.00	1.00
1	Arthroscopy, removal of loose body and lateral...	aseptic loosening	6.00	1.00
2	I&D hematoma 4/20/05; radical 6/14/05; reimp 8...	infection	0.20	1.00
3	UKA to TKA done in Michigan 2019	arthritic progression	13.80	1.00
4	arthroscopy & arthrotomy w poly change dt ceme...	poly damage dt loose cement foreign body	3.60	1.00
5	arthroscopy 3/22/11 Dr. Flanigan; revision UKA...	arthritic progression	7.30	1.00
6	arthroscopy w/ synovectomy 3/13/06; revision U...	arthritic progression	9.50	1.00
7	lateral UKA added 7/25/2017 dt arthritic progr...	arthritic progression	12.30	1.00
8	lysis of adhesions / AIR (29884) and lateral m...	arthritic progression	8.60	1.00
9	major synovectomy d/t synovitis 8/8/2013; revi...	arthritic progression	8.10	1.00
10	revised 7/1/07 by Dr. Brautigan (well fixed)	intractable pain	2.90	1.00
11	revised at Cleveland Clinic	aseptic loosening	1.10	1.00
12	revision 9/11/07	aseptic loosening	1.30	1.00
13	revision UK MB to FB tibial dt loosening/colla...	aseptic loosening	1.40	1.00
14	revision UKA poly dt bearing dislocation 4/5/2011	bearing dislocation	5.10	1.00
15	revision UKA to TKA	arthritic progression	13.10	1.00
16	revision UKA to TKA	bearing dislocation	15.60	1.00
17	revision UKA to TKA 2/12/07	tibial collapse	1.80	1.00
18	revision UKA to TKA (Dr. Litchfield outside fa...	aseptic loosening	5.80	1.00
19	revision UKA to TKA 04/20/2021	arthritic progression	14.40	1.00
20	revision UKA to TKA 1/4/2015	arthritic progression	9.90	1.00
21	revision UKA to TKA 11/11/2019	arthritic progression	14.80	1.00
22	revision UKA to TKA 11/2/2015	arthritic progression	9.60	1.00
23	revision UKA to TKA 12/15/2005	aseptic loosening	0.40	1.00
24	revision UKA to TKA 12/2/2015	tibial collapse	9.60	1.00
25	revision UKA to TKA 12/29/2006 for tibial loos...	tibial collapse	0.60	1.00
26	revision UKA to TKA 12/3/2007	tibial collapse	1.80	1.00
27	revision UKA to TKA 2/27/2013	arthritic progression	7.90	1.00
28	revision UKA to TKA 4/13/2009	medial tibial overload	2.90	1.00
29	revision UKA to TKA 5/15/2007	aseptic loosening	2.10	1.00
30	revision UKA to TKA 5/16/2011	tibial collapse	6.20	1.00
31	revision UKA to TKA 7/18/2006	aseptic loosening	0.50	1.00
32	revision UKA to TKA 7/7/2005	aseptic loosening	0.50	1.00
33	revision UKA to TKA 8/19/2008	medial tibial overload	2.40	1.00
34	revision UKA to TKA 8/7/2007	aseptic loosening	1.00	1.00
35	revision UKA to TKA 9/12/2006	aseptic loosening	0.60	1.00
36	revision UKA to TKA 9/4/2012	aseptic loosening	6.30	1.00
37	revision UKA to TKA by Dr. Gullach	arthritic progression	12.90	1.00
38	revision UKA to TKA by Dr. Paley in Dayton 2016	arthritic progression	10.20	1.00
39	revision UKA to TKA d/t arthritis progression ...	arthritic progression	12.60	1.00
40	revision UKA to TKA d/t aseptic loosening 07/2...	aseptic loosening	14.10	1.00
41	revision UKA to TKA d/t wear and tear 2019	unknown	13.60	1.00
42	revision UKA to TKA dt tibial collapse 5/25/2017	tibial collapse	11.10	1.00
43	revision UKA to TKA in Circleville, I was unab...	unknown	12.50	1.00
44	revision UKA to TKA outside facility - Dr. Ber...	arthritic progression	9.60	1.00
45	revision elsewhere	aseptic loosening	1.70	1.00
46	revision elsewhere	intractable pain	1.00	1.00
47	revision elsewhere	unknown	1.30	1.00
48	revision lateral UKA added	arthritic progression	12.60	1.00
49	revision poly change (outside facility) 3/1/20...	bearing dislocation	1.50	1.00
50	revision poly dt instability 9/29/11	instability	5.80	1.00
51	revision uka to tka 2/4/2009	aseptic loosening	3.30	1.00
52	revision uka to tka 7/19/2010	aseptic loosening	4.60	1.00
53	revision, UKA to TKA 3/24/2010	aseptic loosening	3.70	1.00
54	revision, UKA to TKA 4/23/2007	aseptic loosening	0.50	1.00