0\_Parameters\_US.R

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# All costs in 2019 USD; model uses 2025 USD with conversion of (1+r)^t  
iter <- 50000 # define number of iterations  
discount <- 0.03 # define discount rate  
WTP <- 100000 # US WTP threshold  
  
# Number of patients in each group, registry data  
prev <- list(  
 n\_65\_HA\_cemented = 565,  
 n\_65\_HA\_cementless = 925,  
 n\_65\_THA\_cemented = 138,  
 n\_65\_THA\_cementless = 815,  
 n\_75\_HA\_cemented = 1489,  
 n\_75\_HA\_cementless = 1847,  
 n\_75\_THA\_cemented = 169,  
 n\_75\_THA\_cementless = 649,  
 n\_85\_HA\_cemented = 2279,  
 n\_85\_HA\_cementless = 2077,  
 n\_85\_THA\_cemented = 131,  
 n\_85\_THA\_cementless = 255  
)  
  
# Initial parameters  
# Cementless screws are $53ea; 55% use no screws, 24% use one, and 21% use two.  
type\_surg <- LaplacesDemon::rdirichlet(iter, c(0.55, 0.24, 0.21))  
  
# Cost per minute OT time in the USA, updated 2022 -> 2019 from https://doi.org/10.55576/job.v2i4.23  
# All procedure costs are now cost/minute \* number of minutes + add-ons (e.g. cement)  
cost\_min\_OT <- rgamma(iter, shape = 2.030, scale = 22.675) / (1 + discount)^3  
  
# Estimate of proportion of revisions due to septic vs aseptic from https://doi.org/10.1016/j.arth.2018.05.008  
aseptic\_revision <- rbeta(iter, 702, 86)  
  
generic <- list(  
  
 # Primary procedure costs = cost per minute times number of minutes. Mean duration so use rnorm  
 cost\_HA = cost\_min\_OT \* rnorm(iter, 78.400, 0.384),  
 cost\_THA = cost\_min\_OT \* rnorm(iter, 92.682, 0.887),  
  
 # Cost of revision from https://doi.org/10.1016/j.arth.2018.05.008  
 # Weighted average based on aseptic vs infected revisions  
 cost\_revision = (aseptic\_revision \* rgamma(iter, shape = 1079.724, scale = 56.392) +  
 (1 - aseptic\_revision) \* rgamma(iter, shape = 142.787, scale = 639.616)) \* (1 + discount),  
  
 # Cost of cementing  
 # Extra theatre time from original study, https://doi.org/10.1002/14651858.CD001706.pub4  
 cost\_cementing = rgamma(iter, shape = 32.478, scale = 0.223) \* # Number of minutes taken to apply cement  
 cost\_min\_OT + # Cost per minute  
 (181 \* 2 + runif(iter, min = 85, max = 115)), # 2024 cost of cementing products, 2 packs antibiotic cement plus mixing tower  
  
 cost\_cementless = (type\_surg[, 2] \* 53 + type\_surg[, 3] \* 53 \* 2) / (1 + discount)^1, # cost of cementless screws, 2024  
  
 # HA is a weighted average, 65% bipolar, 35% monopolar, based on expert advice from AJRR  
 # Assume prosthesis cost is roughly similar between cemented/cementless parts for HA  
 cost\_HA\_prosthesis = (0.65 \* rnorm(iter, mean = 2390.5, sd = 262.246) + # Bipolar  
 0.35 \* rnorm(iter, mean = 1658.5, sd = 129.085)) / (1 + discount)^1, # Monopolar  
  
 # THA assumes ceramic head, same price for cemented and cementless prostheses  
 cost\_THA\_prosthesis = list(  
 cemented = rnorm(iter, mean = 4388, sd = 164.219),  
 cementless = rgamma(iter, shape = 123.206, scale = 41.484) / (1 + discount)^3  
 ),  
  
 # Dislocation outcomes from https://doi.org/10.1016/j.arth.2018.05.015  
 # Turning costs from normal to gamma using https://doi.org/10.31219/osf.io/zf62e  
 # Study data is from 2018 so bring it up to $2019  
 cost\_dislocation\_1year = rgamma(iter, shape = 9.553, scale = 1819.097) \* (1 + discount),  
  
 # Dislocation rates from:   
 # 10.3389/fmed.2023.1085485 (HA)  
 # 10.1016/j.arth.2021.06.029 (THA)  
 dislocation\_rate = list(  
 HA\_cemented = rbeta(iter, 252, 23270),  
 HA\_cementless = rbeta(iter, 117, 8342),  
 THA\_cemented = rbeta(iter, 33, 4035),  
 THA\_cementless = rbeta(iter, 102, 11680)  
 ),  
 dislocation\_utility = rbeta(iter, 9.77, 15.95),  
 revision\_utility = rbeta(iter, 36.94, 68.59),  
 stable\_HA\_cemented\_utility\_followup = rbeta(iter, 97.973, 50.471),  
 stable\_HA\_cementless\_utility\_followup = rbeta(iter, 48.651, 35.230),  
 stable\_THA\_cemented\_utility\_followup = rbeta(iter, 5468.776, 1921.462),  
 stable\_THA\_cementless\_utility\_followup = rbeta(iter, 5526.679, 2044.114)  
)  
  
  
# Transition probabilities  
# For values at or near 0, use an approximation based on the sample size  
transitions <- list(  
  
 # Mortality rate  
 death = list(  
 age\_65 = list(  
 year1 = rbeta(iter, 402765.061, 5555716.843),  
 year2 = rbeta(iter, 446703.229, 5511780.825),  
 year3 = rbeta(iter, 283156.148, 5675327.965),  
 year4 = rbeta(iter, 46379.094, 5912113.994),  
 year5 = rbeta(iter, 12205.009, 5946280.501)  
 ),  
 age\_75 = list(  
 year1 = rbeta(iter, 1855495.430, 15375290.994),  
 year2 = rbeta(iter, 1838894.241, 15391918.387),  
 year3 = rbeta(iter, 1515113.661, 15715672.114),  
 year4 = rbeta(iter, 232456.400, 16998374.252),  
 year5 = rbeta(iter, 8301.999, 17222497.531)  
 ),  
 age\_85 = list(  
 year1 = rbeta(iter, 3881878.849, 18528870.513),  
 year2 = rbeta(iter, 3309066.057, 19101690.330),  
 year3 = rbeta(iter, 2371734.983, 20039030.295),  
 year4 = rbeta(iter, 364519.064, 22046302.395),  
 year5 = rbeta(iter, 14202.001, 22396554.447)  
 )  
 ),  
  
 # Dislocation rate increment of 0.5% per year from 10.1007/s11999-011-1987-7  
 dislocation = list(  
 HA\_cemented = list(  
 year1 = generic$dislocation\_rate$HA\_cemented,  
 year2 = generic$dislocation\_rate$HA\_cemented + 0.005,  
 year3 = generic$dislocation\_rate$HA\_cemented + 0.010,  
 year4 = generic$dislocation\_rate$HA\_cemented + 0.015,  
 year5 = generic$dislocation\_rate$HA\_cemented + 0.020  
 ),  
 HA\_cementless = list(  
 year1 = generic$dislocation\_rate$HA\_cementless,  
 year2 = generic$dislocation\_rate$HA\_cementless + 0.005,  
 year3 = generic$dislocation\_rate$HA\_cementless + 0.010,  
 year4 = generic$dislocation\_rate$HA\_cementless + 0.015,  
 year5 = generic$dislocation\_rate$HA\_cementless + 0.020  
 ),  
 THA\_cemented = list(  
 year1 = generic$dislocation\_rate$THA\_cemented,  
 year2 = generic$dislocation\_rate$THA\_cemented + 0.005,  
 year3 = generic$dislocation\_rate$THA\_cemented + 0.010,  
 year4 = generic$dislocation\_rate$THA\_cemented + 0.015,  
 year5 = generic$dislocation\_rate$THA\_cemented + 0.020  
 ),  
 THA\_cementless = list(  
 year1 = generic$dislocation\_rate$THA\_cementless,  
 year2 = generic$dislocation\_rate$THA\_cementless + 0.005,  
 year3 = generic$dislocation\_rate$THA\_cementless + 0.010,  
 year4 = generic$dislocation\_rate$THA\_cementless + 0.015,  
 year5 = generic$dislocation\_rate$THA\_cementless + 0.020  
 )  
 ),  
  
 # Revision rate from AJRR data request  
 revision = list(  
 age\_65 = list(  
 HA\_cemented = list(  
 year1 = rbeta(iter, 5075.986, 313019.131),  
 year2 = rbeta(iter, 5075.986, 313019.131),  
 year3 = (rbeta(iter, 5075.986, 313019.131) + rbeta(iter, 563.999, 317531.351))/2,  
 year4 = rbeta(iter, 563.999, 317531.351),  
 year5 = rbeta(iter, 563.999, 317531.351)  
 ),  
 HA\_cementless = list(  
 year1 = rbeta(iter, 26824.961, 828798.786),  
 year2 = rbeta(iter, 12949.986, 842674.122),  
 year3 = rbeta(iter, 4624.989, 850997.990),  
 year4 = rbeta(iter, 1849.996, 853773.155),  
 year5 = rbeta(iter, 3699.993, 851923.428)  
 ),  
 THA\_cemented = list(  
 year1 = rbeta(iter, 273.985, 18494.012),  
 year2 = rbeta(iter, 273.985, 18494.012),  
 year3 = rbeta(iter, 0.1, 10000),  
 year4 = rbeta(iter, 0.1, 10000),  
 year5 = rbeta(iter, 0.1, 10000)  
 ),  
 THA\_cementless = list(  
 year1 = rbeta(iter, 23634.966, 640589.075),  
 year2 = rbeta(iter, 5704.987, 658518.522),  
 year3 = rbeta(iter, 4074.996, 660149.290),  
 year4 = (rbeta(iter, 4074.996, 660149.290) + rbeta(iter, 815.001, 663410.394))/2,  
 year5 = rbeta(iter, 815.001, 663410.394)  
 )  
 ),  
 age\_75 = list(  
 HA\_cemented = list(  
 year1 = rbeta(iter, 32736.016, 2181409.054),  
 year2 = rbeta(iter, 11904.015, 2202242.765),  
 year3 = rbeta(iter, 5952.012, 2208196.343),  
 year4 = rbeta(iter, 4463.994, 2209677.158),  
 year5 = rbeta(iter, 1488.008, 2212667.252)  
 ),  
 HA\_cementless = list(  
 year1 = rbeta(iter, 88512.044, 3311825.646),  
 year2 = rbeta(iter, 40568.048, 3359771.930),  
 year3 = rbeta(iter, 31347.977, 3368985.589),  
 year4 = rbeta(iter, 5532.023, 3394818.027),  
 year5 = rbeta(iter, 1843.992, 3398477.039)  
 ),  
 THA\_cemented = list(  
 year1 = rbeta(iter, 337.988, 28222.012),  
 year2 = rbeta(iter, 168.994, 28391.005),  
 year3 = rbeta(iter, 0.1, 10000),  
 year4 = rbeta(iter, 0.1, 10000),  
 year5 = rbeta(iter, 0.1, 10000)  
 ),  
 THA\_cementless = list(  
 year1 = rbeta(iter, 12330.968, 408868.938),  
 year2 = rbeta(iter, 2595.996, 418604.316),  
 year3 = rbeta(iter, 648.999, 420551.455),  
 year4 = rbeta(iter, 0.1, 10000),  
 year5 = rbeta(iter, 0.1, 10000)  
 )  
 ),  
 age\_85 = list(  
 HA\_cemented = list(  
 year1 = rbeta(iter, 88725.094, 5086905.419),  
 year2 = rbeta(iter, 15924.979, 5159693.058),  
 year3 = rbeta(iter, 6825.013, 5168809.894),  
 year4 = rbeta(iter, 0.1, 10000),  
 year5 = rbeta(iter, 0.1, 10000)  
 ),  
 HA\_cementless = list(  
 year1 = rbeta(iter, 103550.019, 4185491.760),  
 year2 = rbeta(iter, 33135.915, 4255894.038),  
 year3 = rbeta(iter, 20709.969, 4268324.681),  
 year4 = rbeta(iter, 8284.001, 4280757.565),  
 year5 = rbeta(iter, 2070.996, 4286961.931)  
 ),  
 THA\_cemented = list(  
 year1 = rbeta(iter, 130.992, 17029.006),  
 year2 = rbeta(iter, 0.1, 10000),  
 year3 = rbeta(iter, 0.1, 10000),  
 year4 = rbeta(iter, 0.1, 10000),  
 year5 = rbeta(iter, 0.1, 10000)  
 ),  
 THA\_cementless = list(  
 year1 = rbeta(iter, 0.1, 10000),  
 year2 = rbeta(iter, 254.996, 64768.979),  
 year3 = rbeta(iter, 509.992, 64514.013),  
 year4 = rbeta(iter, 0.1, 10000),  
 year5 = rbeta(iter, 0.1, 10000)  
 )  
 )  
 )  
)  
  
# Utilities are discounted under the premise that a QALY now is better than a QALY later  
# Note QALYs not subject to inflation so no adjustment based on input year  
utilities <- list(  
  
 # Dislocation utility, same values as original paper  
 dislocation = list(  
 year1 = generic$dislocation\_utility,  
 year2 = generic$dislocation\_utility / (1 + discount),  
 year3 = generic$dislocation\_utility / (1 + discount)^2,  
 year4 = generic$dislocation\_utility / (1 + discount)^3,  
 year5 = generic$dislocation\_utility / (1 + discount)^4  
 ),  
  
 # Revision utility, same values as original paper  
 revision = list(  
 year1 = generic$revision\_utility,  
 year2 = generic$revision\_utility / 1 + discount,  
 year3 = generic$revision\_utility / (1 + discount)^2,  
 year4 = generic$revision\_utility / (1 + discount)^3,  
 year5 = generic$revision\_utility / (1 + discount)^4  
 ),  
  
 # Stable utility, same values as original paper  
 HA\_cemented = list(  
 year1 = rbeta(iter, 95.3001, 63.5334),  
 year2 = generic$stable\_HA\_cemented\_utility\_followup / (1 + discount),  
 year3 = generic$stable\_HA\_cemented\_utility\_followup / (1 + discount)^2,  
 year4 = generic$stable\_HA\_cemented\_utility\_followup / (1 + discount)^3,  
 year5 = generic$stable\_HA\_cemented\_utility\_followup / (1 + discount)^4  
 ),  
 HA\_cementless = list(  
 year1 = rbeta(iter, 8.044704, 6.852896),  
 year2 = generic$stable\_HA\_cementless\_utility\_followup / (1 + discount),  
 year3 = generic$stable\_HA\_cementless\_utility\_followup / (1 + discount)^2,  
 year4 = generic$stable\_HA\_cementless\_utility\_followup / (1 + discount)^3,  
 year5 = generic$stable\_HA\_cementless\_utility\_followup / (1 + discount)^4  
 ),  
 THA\_cemented = list(  
 year1 = rbeta(iter, 5575.439, 2168.226),  
 year2 = generic$stable\_THA\_cemented\_utility\_followup / (1 + discount),  
 year3 = generic$stable\_THA\_cemented\_utility\_followup / (1 + discount)^2,  
 year4 = generic$stable\_THA\_cemented\_utility\_followup / (1 + discount)^3,  
 year5 = generic$stable\_THA\_cemented\_utility\_followup / (1 + discount)^4  
 ),  
 THA\_cementless = list(  
 year1 = rbeta(iter, 5615.287, 2293.568),  
 year2 = generic$stable\_THA\_cementless\_utility\_followup / (1 + discount),  
 year3 = generic$stable\_THA\_cementless\_utility\_followup / (1 + discount)^2,  
 year4 = generic$stable\_THA\_cementless\_utility\_followup / (1 + discount)^3,  
 year5 = generic$stable\_THA\_cementless\_utility\_followup / (1 + discount)^4  
 )  
)  
  
costs <- list(  
  
 # Starting costs of surgery (no discounting required):  
 # cost of procedure alone +  
 # cost of additional cementing time +  
 # cost of prosthesis  
 HA\_cemented =  
 generic$cost\_HA +  
 generic$cost\_cementing +  
 generic$cost\_HA\_prosthesis,  
 HA\_cementless =  
 generic$cost\_HA +  
 generic$cost\_cementless +  
 generic$cost\_HA\_prosthesis,  
 THA\_cemented =  
 generic$cost\_THA +  
 generic$cost\_cementing +  
 generic$cost\_THA\_prosthesis$cemented,  
 THA\_cementless =  
 generic$cost\_THA +  
 generic$cost\_cementless +  
 generic$cost\_THA\_prosthesis$cementless,  
  
  
 # Dislocations  
 cost\_dislocation = list(  
 year1 = generic$cost\_dislocation\_1year,  
 year2 = generic$cost\_dislocation\_1year / (1 + discount),  
 year3 = generic$cost\_dislocation\_1year / (1 + discount)^2,  
 year4 = generic$cost\_dislocation\_1year / (1 + discount)^3,  
 year5 = generic$cost\_dislocation\_1year / (1 + discount)^4  
 ),  
  
 # Revision surgery  
 # Assume revision leads to THA  
 cost\_revision = list(  
 revision\_generic = list(  
 year1 = generic$cost\_revision,  
 year2 = generic$cost\_revision / (1 + discount),  
 year3 = generic$cost\_revision / (1 + discount)^2,  
 year4 = generic$cost\_revision / (1 + discount)^3,  
 year5 = generic$cost\_revision / (1 + discount)^4  
 ),  
 HA\_cemented = list(  
 year1 = (generic$cost\_revision\_HA +  
 generic$cost\_cementing +  
 generic$cost\_HA\_prosthesis),  
 year2 = (generic$cost\_revision\_HA +  
 generic$cost\_cementing +  
 generic$cost\_HA\_prosthesis) / (1 + discount),  
 year3 = (generic$cost\_revision\_HA +  
 generic$cost\_cementing +  
 generic$cost\_HA\_prosthesis) / (1 + discount)^2,  
 year4 = (generic$cost\_revision\_HA +  
 generic$cost\_cementing +  
 generic$cost\_HA\_prosthesis) / (1 + discount)^3,  
 year5 = (generic$cost\_revision\_HA +  
 generic$cost\_cementing +  
 generic$cost\_HA\_prosthesis) / (1 + discount)^4  
 ),  
 HA\_cementless = list(  
 year1 = (generic$cost\_revision\_HA +  
 generic$cost\_cementless +  
 generic$cost\_HA\_prosthesis),  
 year2 = (generic$cost\_revision\_HA +  
 generic$cost\_cementless +  
 generic$cost\_HA\_prosthesis) / (1 + discount),  
 year3 = (generic$cost\_revision\_HA +  
 generic$cost\_cementless +  
 generic$cost\_HA\_prosthesis) / (1 + discount)^2,  
 year4 = (generic$cost\_revision\_HA +  
 generic$cost\_cementless +  
 generic$cost\_HA\_prosthesis) / (1 + discount)^3,  
 year5 = (generic$cost\_revision\_HA +  
 generic$cost\_cementless +  
 generic$cost\_HA\_prosthesis) / (1 + discount)^4  
 ),  
 THA\_cemented = list(  
 year1 = (generic$cost\_revision\_THA +  
 generic$cost\_cementing +  
 generic$cost\_THA\_prosthesis$cemented),  
 year2 = (generic$cost\_revision\_THA +  
 generic$cost\_cementing +  
 generic$cost\_THA\_prosthesis$cemented) / (1 + discount),  
 year3 = (generic$cost\_revision\_THA +  
 generic$cost\_cementing +  
 generic$cost\_THA\_prosthesis$cemented) / (1 + discount)^2,  
 year4 = (generic$cost\_revision\_THA +  
 generic$cost\_cementing +  
 generic$cost\_THA\_prosthesis$cemented) / (1 + discount)^3,  
 year5 = (generic$cost\_revision\_THA +  
 generic$cost\_cementing +  
 generic$cost\_THA\_prosthesis$cemented) / (1 + discount)^4  
 ),  
 THA\_cementless = list(  
 year1 = (generic$cost\_revision\_THA +  
 generic$cost\_cementless +  
 generic$cost\_THA\_prosthesis$cementless),  
 year2 = (generic$cost\_revision\_THA +  
 generic$cost\_cementless +  
 generic$cost\_THA\_prosthesis$cementless) / (1 + discount),  
 year3 = (generic$cost\_revision\_THA +  
 generic$cost\_cementless +  
 generic$cost\_THA\_prosthesis$cementless) / (1 + discount)^2,  
 year4 = (generic$cost\_revision\_THA +  
 generic$cost\_cementless +  
 generic$cost\_THA\_prosthesis$cementless) / (1 + discount)^3,  
 year5 = (generic$cost\_revision\_THA +  
 generic$cost\_cementless +  
 generic$cost\_THA\_prosthesis$cementless) / (1 + discount)^4  
 )  
 )  
)