# Cost of testing stategies in LAMP, qPCR, and isolations/quarantine beds

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### Costs of testing and isolation

LAMP tests cost around $3.50 per test
qPCR tests cost around 10$pertestWeassumethathousingstudentsinquarantine/isolationcosts$50 per day, though we report raw student days as well

### Testing Scenarios

LAMP testing may be costly to implement. So, does the use of LAMP justify the cost of implementation? Cost can come from a number of mechanisms - raw dollars, student days lost in a semester, overburden of health infrastructure, etc. Here we attempt to describe four scenarios of testing: 1. No action beyond surveilance qPCR tests administered to symptomatic students 2. An attainable 2000 LAMP tests per day, confirmatory qPCR tests of positive LAMP students, and surveilance qPCR tests administered to symptomatic students 3. 2000 LAMP tests per day as diagnostic tests (pending FDA approval) and surveilance qPCR tests administered to symptomatic students 4. And 2000 LAMP tests per day with pooling factors of 1:3 and surveilance qPCR tests administered to symptomatic students

We will record the number of students isolating and quarantining per day as well as the number of days in excess of forcasted supply, the number of qPCR tests administered to symptomatic students and confirmatory qPCR tests as well as the number of days in excess of forcasted supply, and the costs

### Modeling assumptions

Please refer to prior documentation of LAMP modeling for intricate descriptions of outcomes. Here, we assume that the epidemic on campus with have some general characteristics the epidemic in the Fall semester and maintain similar epidemilogical trends. Instead of considering all parameter space available, we will consider best and worst case scenarios, described below.

Best Case Scenario - Immunity is high (0.15) - Introduced infections from students are low (0.0025) - Introduced infections from the community are high (1 every 10 days) - Student care-seeking (if symptomatic, seeking a qPCR test) is high (100%) - Student compliance (if test positive or contact, isolating) is high (100%) - R0, a measure of the epidemic's ability to grow, is low (2.5) - Students are notified of their test results in the same day - LAMP sensitivity is optimal (92.5%) - Contact tracing occurs (25 per day maximum)

Worst Case Scenario - Immunity is low (0.05) - Introduced infections from students are high (0.05) - Introduced infections from the community are high (1 every 5 days) - Student care-seeking (if symptomatic, seeking a qPCR test) is low (50%) - Student compliance (if test positive or contact, isolating) is high (75%) - R0, a measure of the epidemic's ability to grow, is high (3) - Students are notified of their test results with a delay of 2 day - LAMP sensitivity is suboptimal (80%) - Contact tracing fails (0 per day maximum)

```r
set.seed(123)
best <- uni_sims_par(tst = c(0,2000),
                      test.timeline = c("Sustained","Both"),
                      compliance = c(.8),
                      init.prev = c(0.005),
                      ppn_sympt = c(0.35),
                      care.seeking = c(.5),
                      R0.on = c(2, 3),
                      R0.off = c(2, 3),
                      test.scenario = c("1 Day"),
                      sens.pcr = 1,
                      spec.pcr = 1,
                      sens.lamp = c(0.75, 0.9250),
                      spec.lamp = 1,
                      lamp.diagnostic = c(F),
                      community.intro.daily.on = 1,
                      community.prob.daily.on = c(0.1),
                      community.intro.daily.off = 1,
                      community.prob.daily.off = c(0.1),
                      immunity = c(0.1),
                      N0 = 16750,
                      on.campus.prop = .25,
                      contact.tracing.limit = c(25),
                      pooling = c(1,2),
                      pooling.multi = c(1),
                      days = 100,
                      sims = 100,
                      ncores=4)
```

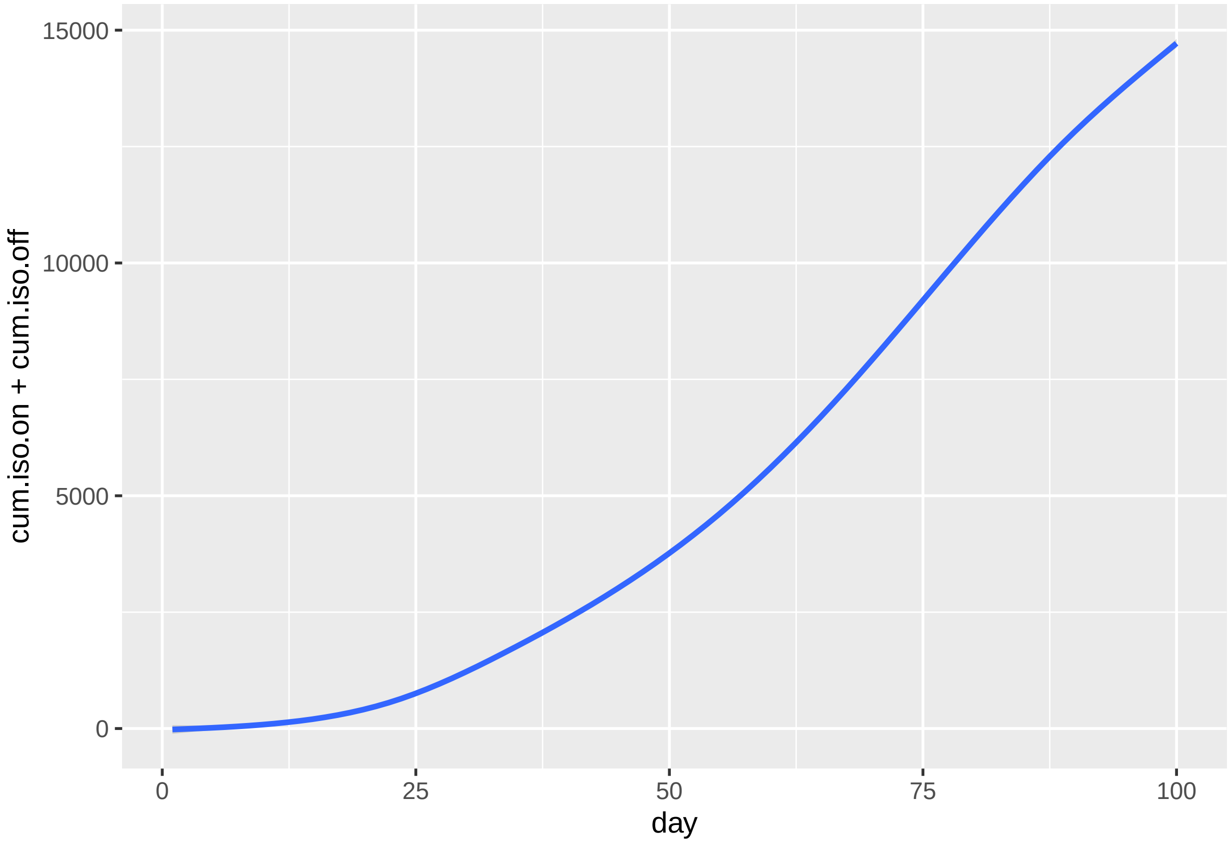
```
## Warning in rep(1:leng, each = days): first element used of 'each' argument
```

```r
best. <- best %>%
  group_by(group) %>%
  mutate(cum.cases.on = cumsum(new.cases.on),
         cum.reporting.symptoms.on = cumsum(reporting.symptoms.on),
         cum.all.symptomatics.on = cumsum(all.symptomatics.on),
         cum.all.asymptomatics.on = cumsum(positive.asympt.on),
         cum.cases.off = cumsum(new.cases.off),
         cum.reporting.symptoms.off = cumsum(reporting.symptoms.off),
         cum.all.symptomatics.off = cumsum(all.symptomatics.off),
         cum.all.asymptomatics.off = cumsum(positive.asympt.off),
         cum.sum.missed = cumsum(missed.pcr),
         cum.iso.on = cumsum(isolation.complying.on),
         cum.iso.off = cumsum(isolation.complying.off),
         cum.qua.on = cumsum(quarantine.complying.on),
         cum.qua.off = cumsum(quarantine.complying.off),
         pcr.demand.sym = cumsum(symp.pcr),
         pcr.demand.asym = cumsum(asymp.pcr)
  )
```

```r
best. %>%
  filter(R0.on == 3,
         pooling == 1,
```

```
        sens.lamp == .925) %>%
  ggplot(aes(x = day, y = cum.iso.on+cum.iso.off)) +
  geom_smooth()
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```




**Costs in best scenario**

```
best.cummulative <- best. %>%
  filter(day == max(day)) %>%
  group_by(tests, test.timeline, pooling, R0.on, sens.lamp) %>%
  summarize(mean.cases = sum(cum.cases.on+cum.cases.off),
            sd.cases = sd(cum.cases.on+cum.cases.off),
            mean.iso = sum(cum.iso.on+cum.iso.off),
            sd.iso = sd(cum.iso.on+cum.iso.off),
            mean.quarantine = sum(cum.qua.on+cum.qua.off),
            sd.quarantine = sd(cum.qua.on+cum.qua.off),
            mean.pcr.sym = mean(pcr.demand.sym),
            sd.pcr.sym = sd(pcr.demand.sym),
            mean.pcr.asym = mean(pcr.demand.asym),
            sd.pcr.asym = sd(pcr.demand.asym)
            )
```

```
## `summarise()` regrouping output by 'tests', 'test.timeline', 'pooling', 'R0.on' (override with `.grou
```

```r
df <- best.cummulative[c(1,3,17:32),]
write.csv(df, "SimulationsForPrice.csv")
df$mean.iso[which(df$tests==0)][1]+df$mean.quarantine[which(df$tests==0)][1]
```

```
## [1] 2786161
```

If we test only symptomatic students, we can expect an epidemic with a size between $2.94173 \times 10^5$ and $1.01975 \times 10^6$. As a result, we can expect between 456.14 and 1718.47 qPCR tests will be demanded by students, equating to between 4561.4 and $1.71847 \times 10^4$ dollars. The resulting epidemic will cost between $2.786161 \times 10^6$ and $4.234539 \times 10^6$ student-days lost to forced isolation and quarantine measures, with an attendant cost of potentially between $1.3930805 \times 10^8$ and $2.1172695 \times 10^8$ dollars if each isolation day costs 50 dollars to house students.

If we test 2000 random students per day with poor LAMP sensitivity (80%) and an equal distribution of tests across the semester, we can expect an epidemic with a size between NA and NA. As a result, we can expect between NA and NA qPCR tests will be demanded by students, equating to between NA and NA dollars. The resulting epidemic will cost between NA and NA student-days lost to forced isolation and quarantine measures, with an attendant cost of potentially between NA and NA dollars if each isolation day costs 50 dollars to house students.

If we test 2000 random students per day with good LAMP sensitivity (92.5%) and an equal distribution of tests across the semester, we can expect an epidemic with a size between $3.8409 \times 10^4$ and $1.77411 \times 10^5$. As a result, we can expect between 35.62 and 261.75 qPCR tests will be demanded by students, equating to between 356.2 and 2617.5 dollars. The resulting epidemic will cost between $2.546733 \times 10^6$ and $3.968873 \times 10^6$ student-days lost to forced isolation and quarantine measures, with an attendant cost of potentially between $1.2733665 \times 10^8$ and $1.9844365 \times 10^8$ dollars if each isolation day costs 50 dollars to house students.

If we test 2000 random students per day with poor LAMP sensitivity (80%) and a front-loaded distribution of tests across the semester, we can expect an epidemic with a size between NA and NA. As a result, we can expect between NA and NA qPCR tests will be demanded by students, equating to between NA and NA dollars. The resulting epidemic will cost between NA and NA student-days lost to forced isolation and quarantine measures, with an attendant cost of potentially between NA and NA dollars if each isolation day costs 50 dollars to house students.

If we test 2000 random students per day with good LAMP sensitivity (92.5%) and a front-loaded distribution of tests across the semester, we can expect an epidemic with a size between $2.3973 \times 10^4$ and $6.9927 \times 10^4$. As a result, we can expect between 23.55 and 87.88 qPCR tests will be demanded by students, equating to between 235.5 and 878.8 dollars. The resulting epidemic will cost between $1.86909 \times 10^6$ and $3.35235 \times 10^6$ student-days lost to forced isolation and quarantine measures, with an attendant cost of potentially between $9.34545 \times 10^7$ and $1.676175 \times 10^8$ dollars if each isolation day costs 50 dollars to house students.

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If we increase pooling to a factor of 2 (assuming that pooling will decrease sensitivity by a factor of 2), we can increase the distribution of tests to students.

If we test 2000 random students per day with poor LAMP sensitivity (80%), with a pool of 2, and an equal distribution of tests across the semester, we can expect an epidemic with a size between NA and NA. As a result, we can expect between NA and NA qPCR tests will be demanded by students, equating to between NA and NA dollars. The resulting epidemic will cost between NA and NA student-days lost to forced isolation and quarantine measures, with an attendant cost of potentially between NA and NA dollars if each isolation day costs 50 dollars to house students.

If we test 2000 random students per day with good LAMP sensitivity (92.5%), with a pool of 2, and an equal distribution of tests across the semester, we can expect an epidemic with a size between $1.6963 \times 10^4$ and $4.2432 \times 10^4$. As a result, we can expect between 12.89 and 42.03 qPCR tests will be demanded by students, equating to between 128.9 and 420.3 dollars. The resulting epidemic will cost between $1.816205 \times 10^6$ and $2.92223 \times 10^6$ student-days lost to forced isolation and quarantine measures, with an attendant cost of potentially between $9.081025 \times 10^7$ and $1.461115 \times 10^8$ dollars if each isolation day costs 50 dollars to house students.

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If we test 2000 random students per day with good LAMP sensitivity (92.5%), with a pool of 2, and a front-loaded distribution of tests across the semester, we can expect an epidemic with a size between $1.5498 \times 10^4$ and $2.6218 \times 10^4$. As a result, we can expect between 15.13 and 28.11 qPCR tests will be demanded by students, equating to between 151.3 and 281.1 dollars. The resulting epidemic will cost between $1.467287 \times 10^6$ and $2.125339 \times 10^6$ student-days lost to forced isolation and quarantine measures, with an attendant cost of potentially between $7.336435 \times 10^7$ and $1.0626695 \times 10^8$ dollars if each isolation day costs 50 dollars to house students.

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