TARANAKI
District Health Board

The importance of timeliness — population level interventions and stamping out COVID-19 during Alert Level 2

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ABSTRACT

Background: The aim of this report is to predict potential outcomes of an undetected case under Alert Level 2 and the impact that timing of population level interventions has on the epidemic curve.

Method: Modelling was carried out using assumptions and methodology based on current literature, unpublished modelling reports previously completed for the Taranaki region by authors and more complex nationwide modelling reports.

Results: At day 10, 20 and 30 of Alert Level 2, the Public Health Unit (PHU) would be notified of one, two and seven confirmed COVID-19 cases respectively. The PHU is notified of approximately 47% of all new cases. Over the course of 60 days, without intervention under Alert Level 2 there are a cumulative 1414 cases, 113 hospital admissions and 14 deaths. The number of new cases, hospital admissions and deaths are reduced when Alert Level 4 is implemented early.

Conclusions: The best way to prevent widespread community transmission within Taranaki is for timely population health levels to be implemented following reintroduction of COVID-19 to Taranaki, the following recommendations are made:

1. Timely follow up of further confirmed cases of COVID-19 in Taranaki.

2. COVID-19 cases where there are incomplete chains of transmission and no obvious importation source into Taranaki should be treated as a public health emergency with rapid widespread case finding and activities in partnership with the affected population.

3. The Medical Officer of Health should advocate for the implementation of epidemic measures, including but not limited to introducing Alert Level 4, within the Taranaki region, when there have been 2 or more unrelated confirmed cases with incomplete chains of transmission, over any five day period.

4. The thresholds for public health action should be lower if there are cases which involve vulnerable populations such as Māori and Pacifika people.

5. Achieving health equity should be a key theme in all public health activities and working in partnership with iwi, and upholding Te Tiriti o Waitangi are essential requirements when working with Maori communities.

INTRODUCTION

COVID-19 was first discovered in Wuhan, China in December 2019. Since then it has resulted in a worldwide pandemic, infecting upward of 3 million people (1). New Zealand has 1,474 confirmed cases of COVID-19 as of the 29th of April (2, 3). In Taranaki there have been 16 cases since March 2020, and all linked to overseas travel or contact with a confirmed case (2).

New Zealand has adopted an "Alert Level" approach based on a risk assessment on COVID-19 transmission patterns and includes a range of public health and social restriction measures (4). On the 28th of April New Zealand moved from Level 4 of the National COVID-19 Alert System to Level 3, this allowing for loosening of restrictions on travel and work but with a greater potential for spread of COVID-19. On the 11th of May, the situation will be reviewed, and it is possible the country will move from Alert Level 3 down to Alert Level 2. With continued vigilance the chance of widespread community outbreak is expected to remain low, however there remains some uncertainty about the extent that our current measures will restrict the spread of the virus. Research from overseas shows that the extent of non-pharmaceutical interventions such as social distancing restrictions and border control measures at a population level can have a significant impact on the number of people infected by every COVID-19 case (5). A number of models have been developed to look at the spread of COVID-19 within New Zealand, including a stochastic model by Plank et al (6), which explores the possible scenarios when New Zealand moves down Alert Levels.

There remains the possibility that COVID-19 will be re-introduced into Taranaki even if the province is able to eliminate the virus. Widespread community transmission is likely if the disease spreads within populations where there are high levels of social mixing, barriers to early detection and community vulnerability. The purpose of this paper is to predict potential outcomes under Alert Level 2 from an undetected case and the impact that the timing of population level interventions has on the epidemic curve. It is hoped that the findings of the modelling will assist the Medical Officer of Health and Public Health Unit if faced with community acquired cases where there is no apparent source.

METHODS

In the modelling the R_{eff} value (effective reproductive value) is used to predict the extent of spread of COVID-19 if there is an initial undetected person with the disease in Taranaki (6, 7). A R_{eff} of 1.70 means that a single case with COVID-19 will infect on average 1.7 people. A reproductive number that is greater than one ($R_0 > 1$) will result in an exponential spread throughout the population. A reproductive number that is less than one ($R_0 < 1$) will lead to a single infection being passed onto less than one person, or in other words a progressive reduction in prevalence of the disease in the population.

The R_{eff} takes into account the effectiveness of population-wide control (ie. Alert Levels) and accounts for fast case isolation and PHU response (average of 2.18 days from onset of symptoms to isolation); thus distinguishing it from the basic reproductive number (6). The R_{eff} is higher in Alert level 2 than Alert Level 4 due to loosening of restrictions on travel, bubble size and work, allowing for a greater potential for spread of COVID-19. The R_{eff} level depends on a number of factors including but not limited to; compliance to restrictions, testing capabilities, outreach of testing and extent of asymptomatic spread. We also accounted for lockdown level fatigue in our R_{eff} value for Alert Level 4, as we predicted that people are more likely to become complacent and non-abiding to restrictions if there is a return to Alert Level 4.

A modelling scenario was created to demonstrate the potential spread of COVID-19 under Alert Level 2 and the effects of implementing Alert Level 4 public health and social restrictions at day 10, 20 and 30. We also looked at the number of cases that the PHU would be notified of, versus the number of total cases. The modelling was carried out over a 60 day period.

The modelling uses similar methodology to previous unpublished reports completed by the authors (8). Assumptions were formed from previous modelling methods, correspondence with TDHB Public Health Unit and from Plank et al, and Binny et al (6, 7) modelling papers. The assumptions are as follows.

Assumptions:

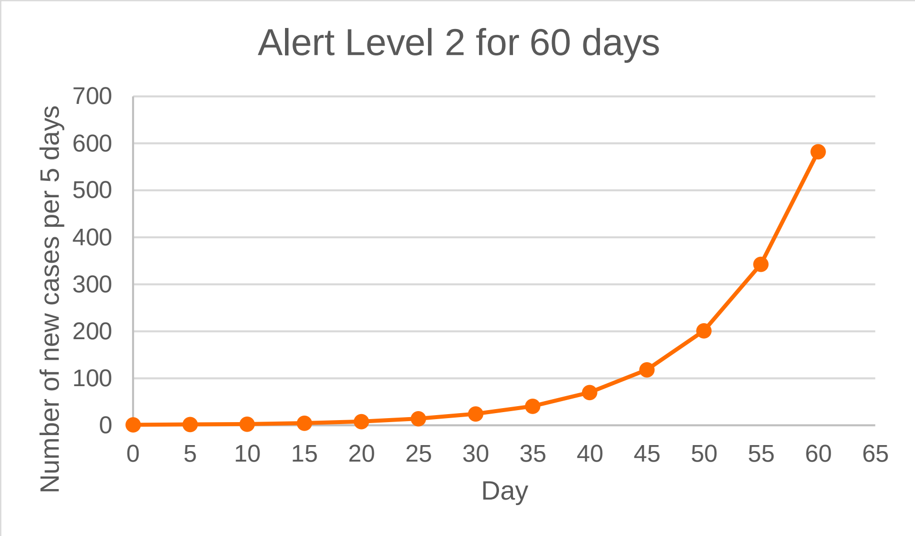
- Starting with one introduced or unknown case
- Incubation period is five days, and new infections occur immediately
- 5% of cases are hospitalised
- 1% of cases die
- 33% of people infected are subclinical/asymptomatic and thus go undetected
- 70% of symptomatic patients will get tested under level 2; this occurs on the day that they develop symptoms
- Under Alert Level 4, 90% of symptomatic cases get tested
- All tests are 100% accurate
- PHU notified of all confirmed (tested) cases within 5 days
- R_{eff} for Alert Level 2 is 1.70
- R_{eff} for Alert Level 4 is 0.75
- The Reproduction value (R_{eff}) is constant throughout the 60 day period (unless otherwise stated)
- Number of new cases is the sum of new cases over previous five days; a discrete rather than continuous measurement

For each of the scenarios, a table was formed to assess the new number of cases per five days (see appendix). This data was then extrapolated with the assumptions to determine the other fields. From the tables we created a number of graphs reflecting the key findings.

RESULTS

The number of new cases under Alert Level Two is predicted to increase exponentially with a reproductive number greater than one ($R_{eff=}$ 1.70). Without intervention there is predicted to be a cumulative 1414 cases over 60 days. With the exponential growth of cases there would be a significant increase in hospitalisations and fatalities after these 60 days unless an intervention occurs. See *Figure 1.*

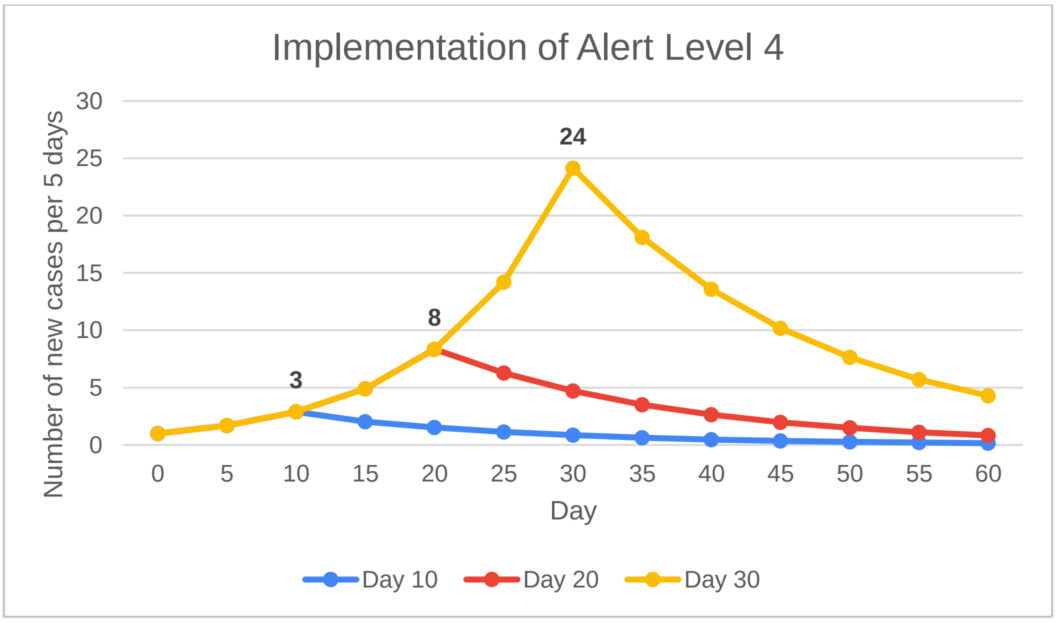
Figure 1- Number of new cases under Alert Level two with no intervention



At day 10, 20 and 30 under Alert Level 2 there would be three, eight and 24 new cases respectively. When Alert Level 4 is implemented, the number of new cases each day decreases due to the reproductive number being less than one (R_{eff} =0.75). Alert Level 4 implemented on day 10 would result in elimination of COVID-19 by day 40 within the region. Transition to Alert Level 4 at days 20 or 30, would result in one and four new cases respectively on day 60. See *Figure 2.*

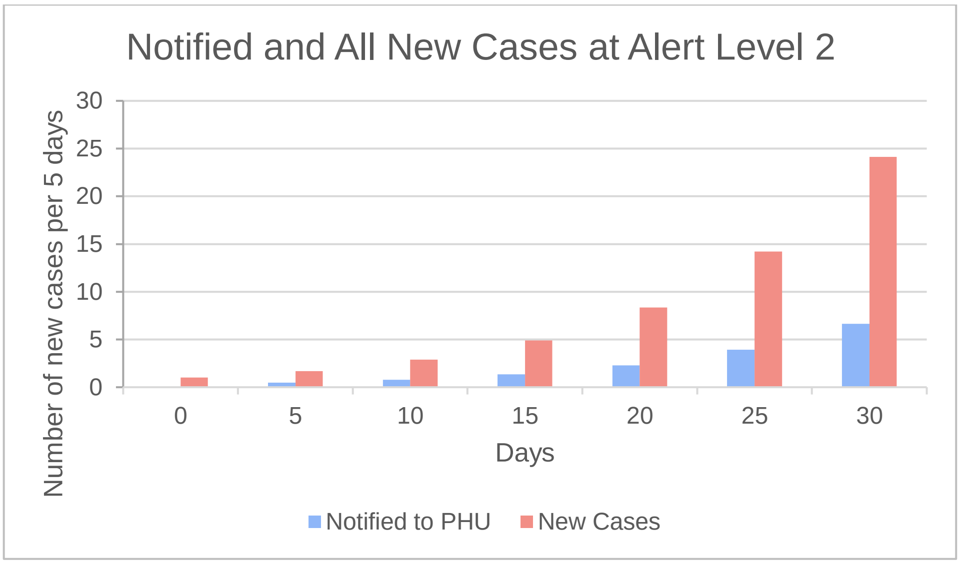
As well as reducing the number of new cases of COVID-19, our modelling predicts that reimplementing Alert Level 4 will also reduce morbidity and mortality associated with the disease. The earlier Alert Level 4 is implemented, the fewer COVID-19 related hospital admissions and deaths. Under Alert Level 2, with no interventions, there would be approximately 14 deaths and 113 hospital admissions in total over 60 days. We would expect that there would be between zero to two deaths if Alert Level 4 was implemented prior to or at 30 days. The total number of hospital admissions are predicted to be one, three, and nine when Alert Level 4 is implemented at day 10, 20 and 30 respectively.

Figure 2- Implementation of Alert Level 4 at day 10, 20 and 30



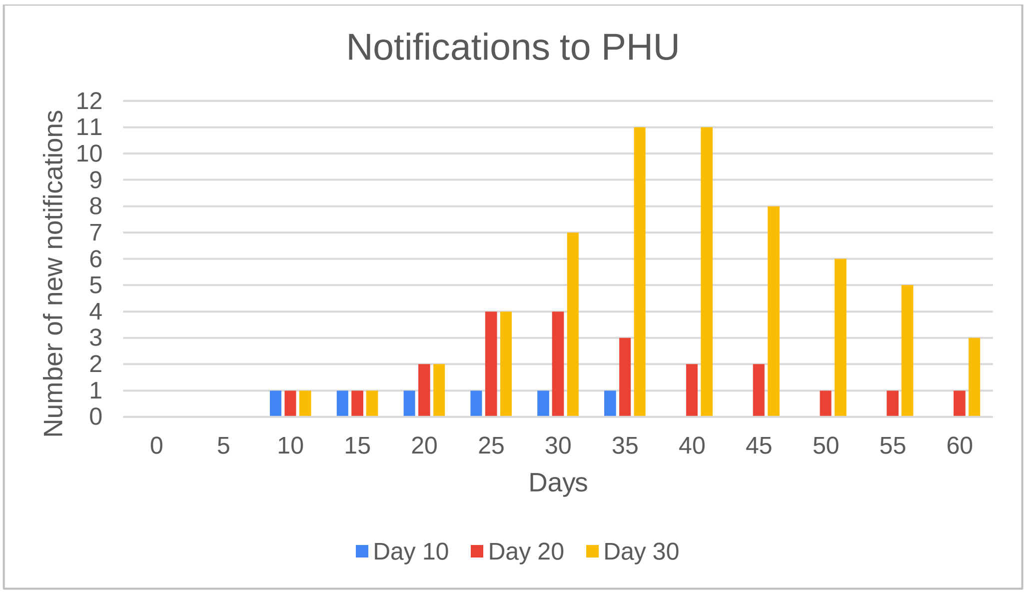
To inform public health decision-making, there needs to be rapid detection and reporting of cases to the Public Health Unit. We predicted that there were barriers to achieving this, including: 33% of cases are asymptomatic or subclinical and do not seek testing, only 70% of symptomatic cases are tested on the day they develop symptoms, and that the PHU is notified of all positive cases after five days. Because of these barriers, the PHU is only notified of approximately 47% of the new cases from five days prior. Notified cases are at a five day lag, and the notifications are an underrepresentation of the true number of new cases occurring. See *Figure 3.*

Figure 3- Cases notified to PHU vs. new number of cases in Alert Level Two



Due to the lag in notifications, and barriers to capturing the total number of cases, *Figure 4* below predicts the number of new notifications per five days that have been made to the PHU at the time of Alert Level 4 implementation. With implementation at day 10, we predict that there would have been a single notification of a confirmed COVID-19 case to the Public Health Unit. With day 20 there would have been two new notifications over the previous five days (four total notifications over the previous 15 days). With day 30, there would have been seven new notifications over the previous five days (and 15 notifications over the previous 25 days).

Figure 4- Cases notified to PHU to inform Alert Level 4 decision-making



DISCUSSION

The modelling in this report highlights the challenges of controlling large community wide outbreaks of COVID-19 under Alert Level 2 restrictions, if there was an undetected case who arrived in Taranaki. Public health interventions such as case management and quarantining of close contacts require people to have been notified to the Public Health Unit. The modelling shows that by day 15 only two confirmed cases would have been notified despite there being eleven active cases in the community with a further eight people incubating the disease.

The early implementation of Alert Level 4 restrictions at day 10 would be the most effective public health response in reducing morbidity and mortality in the Taranaki population. This scenario would 'stamp out' COVID-19 by day 40. At day 10 with the introduction of lockdown measures, there would be a total of six cases, of which only a single case would be known to the PHU. However, it is likely that the implementation of Alert Level 4 restrictions on the basis of a single notified case would be perceived as an overreach of the health sector into the region's economic and social lives, and an overreaction to the perceived threat posed.

If the Alert Level 4 restrictions were implemented at day 20, the PHU would have been notified of two new cases over the previous five days with a total of four cases notified over the previous 15 days. Implementation of Alert Level 4 at day 20 would not result in elimination of COVID-19 by day 60 and it is associated with increased risk of morbidity and mortality than an earlier implementation of Alert Level 4. Similarly to implementing Alert Level 4 at 10 days, there may be opposition to implementation of more stringent restrictions based on the small number of cases that are being reported.

Implementation of Alert Level 4 restrictions at day 30 does not reflect a timely and efficient response from a public health perspective. In this scenario, we would expect to see approximately one to two fatalities, with nine people requiring hospital admission over the 60 days modelled. At day 30 the PHU will have been notified of a total of 15 cases. Due to the high number of cases, elimination would only occur at day 100 if Alert Level 4 was to continue for the 70 days. Although there would likely be less hesitancy and opposition to implementation of Alert Level 4 at day 30, it is unlikely that there would be the willingness to remain in lockdown for 70 days to achieve elimination.

'Lockdown fatigue' refers to people's reduced compliance to restrictions under Alert Level 4. We predicted that people will become more complacent to restrictions over time, and this will lead to a higher R_{eff} value under Alert Level 4 than previous models which do not take into account the effects of lockdown fatigue (6). There should be high suspicion of community transmission before moving back to Alert Level 4, to reduce complacency and the impact of alternating between Alert Levels. High assurance of community transmission would likely cause a greater compliance to the Alert Level system.

Another consideration when interpreting this modelling is the potential for 'super spreaders' who have a reproductive number much greater than 1.70. These people have the potential to infect a large number of people within a short space of time either because they are excreting a higher number of viral particles or because they are in close contact with a large number of people. It is not certain how important super spreaders are with COVID-19 transmission but it is possible that several of the large clusters in New Zealand were caused by a super spreader (9). This emphasises the importance of a high level of community awareness, early detection and fast and effective contact tracing in order to identify the source of transmission and contain the virus in a timely manner.

In the event that COVID-19 was reintroduced into a vulnerable population within the region, we may see a greater reproductive number and increases in morbidity and mortality. Māori communities are extremely vulnerable to COVID-19 due to a number of factors, such as; reduced access to early medical attention, higher probability of hospitalisation due to comorbidities, the social determinants of health and institutional racism in the healthcare system (10). If COVID-19 was detected in a vulnerable population, such as our Māori population, a lower threshold for more stringent public health measures is recommended, and responding to this should be the priority of the PHU (8). Responses should be made in partnership with iwi, and uphold Te Tiriti o Waitangi to support the achievement of health equity.

Outbreaks have four main components – a spark, a growth phase, a peak and a decline phase. Because of the above uncertainties it is highly likely that the simple modelling assumptions used in this report will be inaccurate. It is very difficult to predict human behaviour. However it has been stated that "the point of these models is not to precisely predict the future, it's to influence the future, and choose a good course of action." (11)

Therefore the following recommendations are made:

6. The timely follow up of further confirmed cases of COVID-19 in Taranaki by the PHU is high priority and should be completed within the time frames recommended in the Verrall report "Rapid Audit of Contact Tracing for COVID-19 in New Zealand" (12).

7. Further cases of COVID-19 where there are incomplete chains of transmission and no obvious importation source into Taranaki should be treated as a public health emergency with rapid widespread case finding activities in partnership with the affected population.

8. The Medical Officer of Health should advocate for the implementation of epidemic measures, including but not limited to introducing Alert Level 4, within the Taranaki region, when there have been 2 or more unrelated confirmed cases with incomplete chains of transmission, over any five day period.

9. The thresholds for public health action should be lower if there are cases which involve vulnerable populations such as Māori and Pacifika people.

10. Achieving health equity should be a key theme in all public health activities and working in partnership with iwi, and upholding Te Tiriti o Waitangi are essential requirements when working with Maori communities.

Strengths and limitations

This paper was produced quickly and without expert statistical input. The authors do not have depth of statistical analysis or modelling. This paper has been produced during the authors' ten-week attachment as final-year medical students to the Public Health Unit at TDHB. The authors are both participant observers within the PHU during the response to COVID-19. Our role as medical students confers on us privileges that are both conscious and unconscious. Further, although we are concerned with addressing inequity, we have not commented in depth on this in the report. Future reports should look specifically at Taranaki's vulnerable populations, specifically our Māori population and the impacts of accessibility to health services and the social determinants of health on the reproductive number within these populations at different Levels of the Alert system.

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APPENDIX

Realistic scenario (R_c=1.70): Table One

Day	New Cases	New Cases that seek Assessment	New Cases hospitalised	New Deaths	New Cases notified to PHU
0	1	0	0.1	0	0
5	2	1	0.1	0	0
10	3	1	0.2	0	1
15	5	2	0.4	0	1
20	8	4	0.7	0	2
25	14	7	1.1	0	4
30	24	11	1.9	0	7
35	41	19	3.3	0	11
40	70	33	5.6	0	19
45	119	56	9.5	1	33
50	202	95	16.1	2	56
55	343	161	27.4	3	95
60	583	273	46.6	5	161

Realistic Scenario Level 2 (R_{eff}= 1.70) transitioning to Level 4 (R_{eff}= 0.75) at Day 10: Table Two

Day	New Cases	New Cases that seek Assessment	New Cases hospitalised	New Deaths	New Cases notified to PHU
0	1	0	0.1	0	0
5	2	1	0.1	0	0
10	3	1	0.2	0	1
15	2	1	0.2	0	1
20	2	1	0.1	0	1
25	1	1	0.1	0	1
30	1	1	0.1	0	1
35	1	0	0.1	0	1
40	0	0	0	0	0
45	0	0	0	0	0
50	0	0	0	0	0
55	0	0	0	0	0
60	0	0	0	0	0

Realistic Scenario Level 2 (R_{eff}= 1.70) transitioning to Level 4 (R_{eff}= 0.75) at Day 20: Table Three

Day	New Cases	New Cases that seek Assessment	New Cases hospitalised	New Deaths	New Cases notified to PHU
0	1	0	0.1	0	0
5	2	1	0.1	0	0
10	3	1	0.2	0	1
15	5	2	0.4	0	1
20	8	4	0.7	0.1	2
25	6	4	0.5	0.1	4
30	5	3	0.4	0	4

35	**4**	**2**	**0.3**	**0**	**3**
40	**3**	**2**	**0.2**	**0**	**2**
45	**2**	**1**	**0.2**	**0**	**2**
50	**1**	**1**	**0.1**	**0**	**1**
55	**1**	**1**	**0.1**	**0**	**1**
60	**1**	**1**	**0.1**	**0**	**1**

Realistic Scenario Level 2 (R_{eff}= 1.70) transitioning to Level 4 (R_{eff}= 0.75) at Day 30: Table Four

Day	New Cases	New Cases that seek Assessment	New Cases hospitalised	New Deaths	New Cases notified to PHU
0	**1**	**0**	**0.1**	**0**	**0**
5	**2**	**1**	**0.1**	**0**	**0**
10	**3**	**1**	**0.2**	**0**	**1**
15	**5**	**2**	**0.4**	**0**	**1**
20	**8**	**4**	**0.7**	**0.1**	**2**
25	**14**	**7**	**1.1**	**0.1**	**4**
30	**24**	**11**	**1.9**	**0.2**	**7**
35	**18**	**11**	**1.4**	**0.2**	**11**
40	**14**	**8**	**1.1**	**0.1**	**11**
45	**10**	**6**	**0.8**	**0.1**	**8**
50	**8**	**5**	**0.6**	**0.1**	**6**
55	**6**	**3**	**0.5**	**0.1**	**5**
60	**4**	**3**	**0.3**	**0**	**3**