MINISTÉRIO PÚBLICO ELEITORAL
PROCURADORIA-GERAL ELEITORAL

EXCELENTÍSSIMO SENHOR PRESIDENTE DO E. TRIBUNAL SUPERIOR ELEITORAL, MINISTRO LUÍS ROBERTO BARROSO

Manifestação nº 1403/20-GABVPGE

O **MINISTÉRIO PÚBLICO ELEITORAL**, pelo Vice-Procurador-Geral Eleitoral abaixo-assinado, vem à presença de Vossa Excelência, na qualidade de fiscal do processo eleitoral nacional, nos termos do art. 127 e seguintes, da Constituição Federal; art. 24, VI, do Código Eleitoral, e art. 72 e seguintes da Lei Complementar n° 75/93, expor e requerer o que segue.

Previstas para o primeiro domingo de outubro, as eleições municipais de 2020 tornaram-se objeto de especulações das mais diversas, dado o cenário decorrente da pandemia da COVID-19.

De alteração do calendário eleitoral para fins de flexibilização do prazo de filiação partidária e desincompatibilização, à extensão dos mandatos dos atuais ocupantes dos cargos públicos municipais até 2022, discussões sobre o tema não faltam.

Nas últimas semanas, o Judiciário brasileiro, em especial o e. Supremo Tribunal Federal e esse e. Tribunal Superior Eleitoral, tem recebido diversas demandas relativas ao processo eleitoral que se avizinha. Não é de se admirar. Realmente, a situação que ora se apresenta é excepcional e requer da Justiça a solução de controvérsias em torno do tema. A principal delas diz respeito à possibilidade de adiamento das eleições de 2020 e à prorrogação dos atuais mandatos.

Não por outro motivo, vale-se este órgão do Ministério Público Eleitoral do presente expediente, a fim de trazer à tona elementos que considera de suma importância ao desate da questão, visto estarem em jogo elementos fundantes da nossa República.

I – DA FORMA REPUBLICANA DE GOVERNO, DO REGIME DEMOCRÁTICO E DO VOTO PERIÓDICO

Ao abrir a Constituição Federal de 1988, o constituinte teve o cuidado de enunciar em seu art. 1° os fundamentos da República Federativa do Brasil, a qual, segundo o referido dispositivo, constitui-se em Estado Democrático de Direito.

Não tinha como ser diferente. Montesquieu, em sua clássica obra "O espírito das leis", afirma que "o governo republicano é aquele no qual o povo em seu conjunto, ou apenas uma parte do povo, possui o poder soberano (...). Quando, na república, o povo em conjunto possui o poder soberano, trata-se de uma *Democracia*."[1]

---

1 MONTESQUIEU, Charles de Secondat, Baron de. O espírito das leis. trad: Cristina Murachco. São Paulo: Martins Fontes, 1996. p. 19.

A menção expressa no texto constitucional à cláusula democrática não foi à toa. Afinal, como decorrência do princípio do legislador racional, tem-se a máxima hermenêutica de que a lei não possui palavras inúteis. Com efeito, o Estado Democrático de Direito consubstancia-se naquele em que a sociedade participa das decisões políticas, seja de forma direta – por meio de plebiscito, referendo, iniciativa popular, entre outros –, seja de forma indireta – por meio de representantes eleitos.

Daí advém a previsão do parágrafo único do art. 1° da Constituição Federal, segundo o qual "[t]odo o poder emana do povo, que o exerce por meio de representantes eleitos ou diretamente, nos termos desta Constituição".

Diante de tal quadro, não se pode perder de vista que a democracia possui como uma de suas bases a alternância de poder. Para Norberto Bobbio,

> "Quando as classes políticas se cristalizam e não se renovam, quando não existem mais classes políticas em concorrência, encontramo-nos diante de um regime que é ou tende a se tornar aristocrático. **Característica do regime democrático é a alternância das classes políticas no poder, sem que a mudança, mesmo radical, ocorra com derramamento de sangue**".[2] (grifo nosso)

Tarcísio Vieira de Carvalho Neto, por sua vez, entende que a alternância de poder é, em verdade, "um dispositivo a serviço da oposição, pronto a entrar em ação quando movimentada a gangorra do equilíbrio democrático. Note-se bem: a alternância não é propriamente um princípio fundante da democracia, mas sim elemento integrante (e vital!) da oposição."[3]

---

2 BOBBIO, Norberto. Qual democracia? Tradução de Marcelo Perine. São Paulo: Loyola, 2010.

Nesse contexto, conclui:

> "Por isso, talvez seja mais rentável conectar, do ponto de vista doutrinário, **o princípio da alternância não com a democracia propriamente dita, mas com os valores republicanos**".[4] (grifo nosso)

Com efeito, de acordo com a classificação dualista das formas de governo de Maquiavel, na República o poder é exercido de forma **temporária**, com a existência de **mandatos fixos** e os governantes são escolhidos por **eleição**.

Vê-se, portanto, que as ideias de temporariedade dos mandatos e de alternância de poder são indissociáveis da forma republicana de governo e do regime democrático, os quais se constituem em princípios constitucionais sensíveis, nos termos do art. 34, VII, *a*, da CF/88.

Inviável dentro de tal modelo, portanto, defender a prorrogação de mandatos seja por qual tempo for, ainda que diante de uma situação extrema como a pandemia que ora se apresenta.

Na recente decisão monocrática proferida nos autos da ADI 6359/DF, a i. Min. Rosa Weber bem pontuou, *in verbis*:

> "22. **Em tempos de incerteza, a preservação dos procedimentos estabelecidos de expressão da vontade popular, das instituições conformadoras da democracia, não obstante sua falibilidade, pode ser uma das poucas salvaguardas da normalidade.** A democracia, de fato, nunca se realiza sob condições perfeitas: é, sempre, a

---

3 CARVALHO NETO, Tarcísio Vieira de. *In* O princípio da alternância no regime democrático. Revista de Informação Legislativa, n. 196 out./dez. 2012.

4 Ib. idem

democracia possível, é sempre vir a ser. Na democracia, como na vida, o perfeito é inimigo do bom.

Diante das medidas excepcionais de enfrentamento à pandemia da COVID-19, a ideia de ampliar prazos eleitorais, com a antecedência buscada, pode ser tentadora. **A história constitucional, porém, recomenda que, especialmente em situações de crise, se busque, ao máximo, a preservação dos procedimentos estabelecidos.** Como pontificou Abraham Lincoln, a propósito das eleições de 1864, que ele preferiu disputar a suspender, ainda que em plena Guerra Civil: **'a eleição é uma necessidade. Não podemos ter um governo livre sem eleições'.**" (grifo nosso)

Não há como negar que o discurso que defende o adiamento das eleições e a prorrogação dos mandatos como forma de salvaguarda da saúde e da vida da população e, em última instância, da própria democracia, é sedutor.

Entretanto, não há como defender ideais democráticos com atitudes antidemocráticas, o que, no dizer de Karl Popper[5], caracteriza o chamado "paradoxo da democracia".

Em sua obra "A sociedade aberta e seus inimigos"[6], Popper afirma que:

"Podemos, efetivamente, distinguir dois tipos principais de governo. **O primeiro tipo consiste dos governos de que**

___

5 Para Popper, o paradoxo da democracia compreende a possibilidade de que a maioria possa decidir que um tirano deva reinar. Com efeito, a democracia indefesa pode ser mesmo capturada por pessoas que desejem destruí-la, mas que usem de meios aparentemente democráticos para fazê-lo. Foi o que aconteceu, por exemplo, na Alemanha com a Constituição de Weimar: segundo alguns, referida constituição era tão democrática que não conseguiu impedir a ascensão de Hitler ao cargo de primeiro-ministro por meio do voto popular.

6 POPPER, Karl Raimund. A sociedade aberta e seus inimigos. Vol. I. Tradução de Milton Amado. Belo Horizonte: Itatiaia; São Paulo: Ed. Da Universidade de São Paulo, 1974. p. 140.

nos podemos livrar sem derramamento de sangue – por exemplo, por meio de eleições gerais; vale dizer, as instituições sociais fornecem meios pelos quais os governados podem expelir os governantes, e as tradições sociais asseguram que essas instituições não serão facilmente destruídas pelos que detiverem o poder. O segundo tipo consiste governos de que os governados não podem se livrar a não ser por meio de revoluções vitoriosas – isto é, na maioria dos casos, mão se livram deles. Sugiro o termo 'democracia' como etiqueta abreviada para o primeiro tipo, e o termo 'tirania', ou 'ditadura', para o segundo.

(...)

Se fizermos uso das duas etiquetas, como sugerimos, poderemos então descrever agora, como **princípio de uma política democrática, a proposta de criar, desenvolver e proteger as instituições políticas, para evitar a tirania.**" (grifo nosso)

A proteção das instituições conformadoras da democracia, portanto, afigura-se necessária para que esta não se transforme em tirania. Entre essas instituições encontra-se inegavelmente o voto periódico, <u>cláusula pétrea prevista no art. 60, §4°, II, da CF/88</u>.

Nesse sentido, Gilmar Mendes e Paulo Gustavo Gonet Branco prelecionam:

"**O sistema democrático impõe o voto periódico.** O texto constitucional é expresso ao consagrar como cláusula pétrea a periodicidade do voto, **o que traz consigo a ideia de renovação dos cargos eletivos e da temporariedade dos mandatos** (CF, art. 60, §4°, II)".[7]

---

7 MENDES, Gilmar Ferreira; BRANCO, Paulo Gustavo Gonet. <u>Curso de direito constitucional</u>. 12. ed. rev. e atual. São Paulo: Saraiva, 2017. p. 757.

Veja que os elementos são indissociáveis. A temporariedade dos mandatos somente é alcançada por meio do exercício do voto, o qual vem a ser o método de instrumentalização da democracia. Assim, para que se garanta o fim almejado, é necessário também que se garanta o meio empregado para tanto, a saber, a periodicidade do voto. Com efeito, sem periodicidade não há temporariedade.

Releva-se frisar que os cidadãos foram às urnas em outubro de 2016 para eleger seus representantes de âmbito municipal para os quatro anos seguintes, e não mais que isso. Retirar do cidadão o direito de exercer o seu voto de forma periódica, ou seja, dentro do prazo previsto constitucionalmente, configura grave ofensa ao princípio democrático.

Assim, por se tratar de elemento fundamental à manutenção da democracia, eventual debate a respeito de alteração do calendário eleitoral deve ser feito com prudência, sendo tal alteração a última opção.

Entretanto, se inevitável a alteração das datas previstas para o pleito de 2020, necessária uma gestão desse e. Tribunal Superior Eleitoral junto ao Congresso Nacional, a fim de que haja emenda constitucional que faça inserir dispositivo no ADCT para esse fim específico, e desde que as eleições sejam realizadas ainda este ano.

Em nenhuma hipótese, porém, afigura-se viável a extensão dos mandatos em curso, uma vez que **tal proceder representaria ofensa à temporariedade dos cargos eletivos, ínsita ao regime democrático, e**, consequentemente, **supressão à periodicidade do voto**, o que é **vedado pelo inciso II do §4º do art. 60 da Constituição Federal**, *in verbis*:

> "Art. 60. A Constituição poderá ser emendada mediante proposta:
> (...)

7

§ 4° **Não será objeto de deliberação a proposta de emenda tendente a abolir:**

(...)

II – o **voto** direto, secreto, universal e **periódico**;" (grifo nosso)

No dizer de Gilmar Mendes e Paulo Gonet, "[a] cláusula pétrea não existe tão só para remediar situação de destruição da Carta, mas tem a missão de **inibir a mera tentativa de abolir o seu projeto básico. Pretende-se evitar que a sedução de apelos próprios de certo momento político destrua um projeto duradouro**"[8] (grifo nosso).

A redação dada ao §4° do art. 60 da Constituição Federal consagra tamanha proteção às cláusulas pétreas que a simples apresentação de proposta de emenda tendente a abolir os direitos ali consagrados pode ser objeto de controle de constitucionalidade preventivo, consistente na impetração de mandado de segurança, por parlamentar federal, para proteger direito líquido e certo ao devido processo legislativo[9].

Ora, se é cabível essa espécie de controle preventivo, que dirá o controle repressivo de emenda constitucional promulgada nesses termos. A emenda constitucional, não se olvide, é manifestação do poder constituinte derivado reformador e, nesse contexto, encontra seus limites materiais justamente nas cláusulas pétreas.

Ante o até aqui exposto, indubitável a **impossibilidade de prorrogação dos mandatos em curso**, em razão da adoção, pela Constituição Federal de 1988, da forma republicana de governo e do regime democrático, dos quais a temporariedade dos mandatos e a periodicidade do voto são consectários.

---

8 Ib. idem. p. 122.

9 MS 20257, Relator(a): Min. DÉCIO MIRANDA, Relator(a) p/ Acórdão: Min. MOREIRA ALVES, Tribunal Pleno, julgado em 08/10/1980, DJ 27-02-1981; MS 32033, Relator(a): Min. GILMAR MENDES, Relator(a) p/ Acórdão: Min. TEORI ZAVASCKI, Tribunal Pleno, julgado em 20/06/2013, PROCESSO ELETRÔNICO DJe-033 DIVULG 17-02-2014 PUBLIC 18-02-2014.

II – DO PRINCÍPIO DA ANUALIDADE ELEITORAL (ART. 16 DA CF/ 88)

Como já dito anteriormente, a alteração das datas do pleito eleitoral do corrente ano, se inevitável, deve ser levada a efeito por meio de emenda à Constituição, com a observância, evidentemente, das regras procedimentais do processo legislativo constitucional, **e do prazo de 4 (quatro) anos, a meu ver, improrrogável, dos mandatos em curso**, previsto no art. 29, incisos I, II e III, do texto constitucional[10].

Dentro da hipótese acima delineada e considerando a excepcional situação gerada pela pandemia da Covid-19, entende-se que a alteração das datas das eleições municipais de 2020 não ofenderá o princípio da anualidade, previsto no artigo 16 da Constituição Federal[11], conforme se demonstrará a seguir.

O princípio da anualidade (anterioridade eleitoral) preconiza que a lei que alterar o processo eleitoral, não obstante entre em vigor na data de sua publicação, não se aplicará à eleição que ocorra até um ano da data de sua vigência.

A *ratio essendi* dessa norma não é outra senão evitar que vicissitudes casuísticas do processo legislativo desequilibrem a participação

---

10Art. 29. O Município reger-se-á por lei orgânica, votada em dois turnos, com o interstício mínimo de dez dias, e aprovada por dois terços dos membros da Câmara Municipal, que a promulgará, atendidos os princípios estabelecidos nesta Constituição, na Constituição do respectivo Estado e os seguintes preceitos:
I – eleição do Prefeito, do Vice-Prefeito e dos Vereadores, para mandato de quatro anos, mediante pleito direto e simultâneo realizado em todo o País;
II – eleição do Prefeito e do Vice-Prefeito realizada no primeiro domingo de outubro do ano anterior ao término do mandato dos que devam suceder, aplicadas as regras do art. 77, no caso de Municípios com mais de duzentos mil eleitores; (Redação dada pela Emenda Constitucional nº 16, de1997)
III – posse do Prefeito e do Vice-Prefeito no dia 1º de janeiro do ano subseqüente ao da eleição;
11Art. 16. A lei que alterar o processo eleitoral entrará em vigor na data de sua publicação, não se aplicando à eleição que ocorra até um ano da data de sua vigência.

dos atores políticos no processo eleitoral, conforme preconizam Gilmar Ferreira Mendes e Paulo Gustavo Gonet Branco [12].

Tal dicção pode ser extraída da justificação da proposta de emenda à Constituição nº 45 de 1991[13], transformada na Emenda Constitucional nº 4/1993, que introduziu, nos termos atuais, o texto do artigo 16 da Carta Magna.

Alexandre de Moraes[14], ao discorrer sobre o princípio em análise, sustenta que *"o art. 16 pretende consagrar a segurança jurídica nos pleitos eleitorais, permitindo que as regras do jogo democrático sejam conhecidas antecipadamente por todos aqueles que dele participam, sejam eleitores e candidatos, sejam as autoridades responsáveis pela fiscalização do pleito eleitoral (Ministério Público e Poder Judiciário)".*

Para o Supremo Tribunal Federal[15]:

> "A norma consubstanciada no art. 16 da Constituição da República, que consagra o postulado da anterioridade eleitoral (cujo precípuo destinatário é o Poder Legislativo), vincula-se, em seu sentido teleológico, **à finalidade ético-jurídica** de obstar a deformação do processo eleitoral mediante modificações que, casuisticamente introduzidas pelo Parlamento, culminem por romper a necessária **igualdade de participação** dos que nele atuam como protagonistas relevantes (partidos políticos e candidatos), vulnerando-lhes, com inovações abruptamente estabelecidas, a **garantia básica de igual competitividade que deve sempre prevalecer nas disputas eleitorais.**" Grifo nosso)

---

12 *Ib idem.* p. 832.

13https://www.camara.leg.br/proposicoesWeb/fichadetramitacao?idProposicao=169313

14Direito constitucional / Alexandre de Moraes. – 32. ed. rev. e atual. até a EC nº 91, de 18 de fevereiro de 2016 – São Paulo: Atlas, 2016, pg.451.

15ADI 3.345, Rel. Min. Celso de Mello, j. 25-8-2005, P. DJE de 20-8-2010.

Como se pode ver dessa breve digressão, o princípio da anualidade tem por escopo evitar alterações abruptas das normas eleitorais, de forma a **garantir o equilíbrio entre os participantes do pleito, ou seja, as condições iguais de competitividade**.

Dito isso, entende-se que o cenário fático que se apresenta no Brasil[16] e no mundo[17] em razão da pandemia da Covid-19, <u>ao qual todos estão submetidos</u>, autoriza excepcionalmente a alteração das normas que regulam o processo eleitoral para serem aplicadas ainda no pleito de 2020. **Tal modificação, entretanto, somente deve ocorrer diante de sua inevitabilidade e restringir-se à postergação das datas do pleito até novembro do corrente ano, com a consequente diplomação dos eleitos ainda em 2020, de modo que a posse dos eleitos ocorra impreterivelmente no dia 1º de janeiro de 2021.**

III – DA POSSIBILIDADE DE REALIZAÇÃO DAS ELEIÇÕES EM 2020, MESMO SOB AS CIRCUNSTÂNCIAS DA PANDEMIA DE COVID-19 – ESTUDOS ESTATÍSTICOS

Esboçado o arcabouço jurídico, cumpre analisar se, diante do atual cenário pandêmico, considera-se viável a realização das eleições nas datas predeterminadas.

Inicialmente, não se ignora que a realidade fática está em constante mutação e que a concretização de previsões acerca da curva de desenvolvimento do cenário pandêmico em cada país depende de diversos fatores, inclusive das decisões políticas acerca das medidas necessárias ao seu achatamento.

---

16 Painel Coronavírus (https://covid.saude.gov.br/), do Ministério da Saúde: no Brasil já foram contabilizados 363.211 casos confirmados e **22.666 óbitos confirmado**s, atualizado em 25/05/2020, às 11h34.

17Coronavirus Resource Center, Universidade Johns Hopkins (https://coronavirus.jhu.edu/map.html), **345.467 óbitos confirmados no mundo**, atualizado em 25/05/2020, às 11h35.

Ainda assim, estudo da Universidade de Tecnologia e Design de Singapura (SUDT)[18], utilizando um modelo matemático conhecido como SIR (suscetível–infectado–recuperado), apresenta gráfico estatístico com o período de propagação e recuperação da doença. Em relação ao Brasil, a previsão de referido estudo, atualizado em 14/05/20, é de que o ponto de inflexão da curva tenha sido em 21/05/20, e que a situação esteja sob controle entre o final de julho e início de agosto, conforme se observa do gráfico a seguir ilustrado:

___
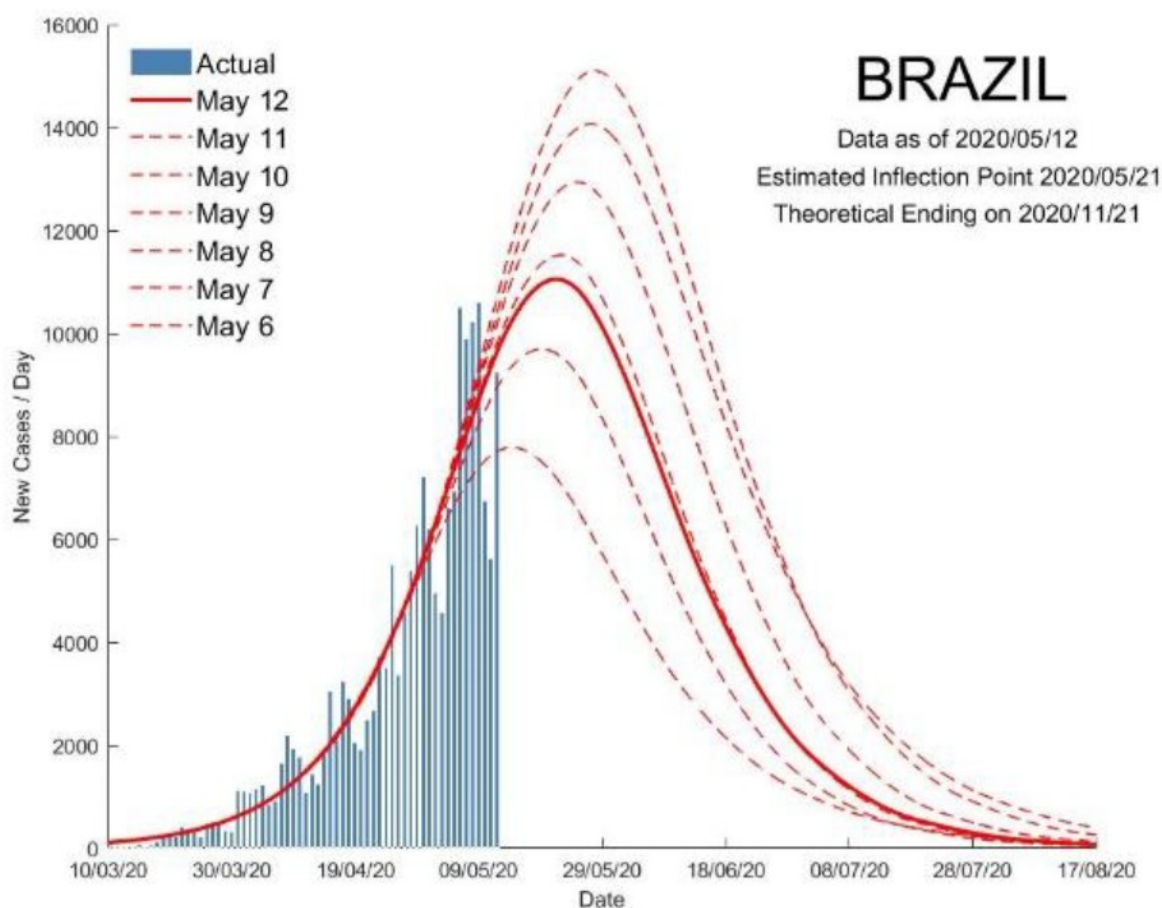
18 LUO, Jianxi. Predictive Monitoring of COVID-19. Data-Driven Innovation Lab. Singapore University of Technology and Design. Atualizado em 14/05/2020. O estudo integral está anexado à presente manifestação.

Outra pesquisa recente[19], dessa vez utilizando modelo matemático desenvolvido por pesquisadores da Coppe/UFRJ, Marinha do Brasil e Universidade de Bordeaux, na França, aponta que <u>o país deve entrar no pico da curva de contágio ainda na penúltima semana de maio e se estabilizar ao final de julho</u>. A projeção tem por base o quadro atual de isolamento social, medidas de higiene e capacidade de testagem.
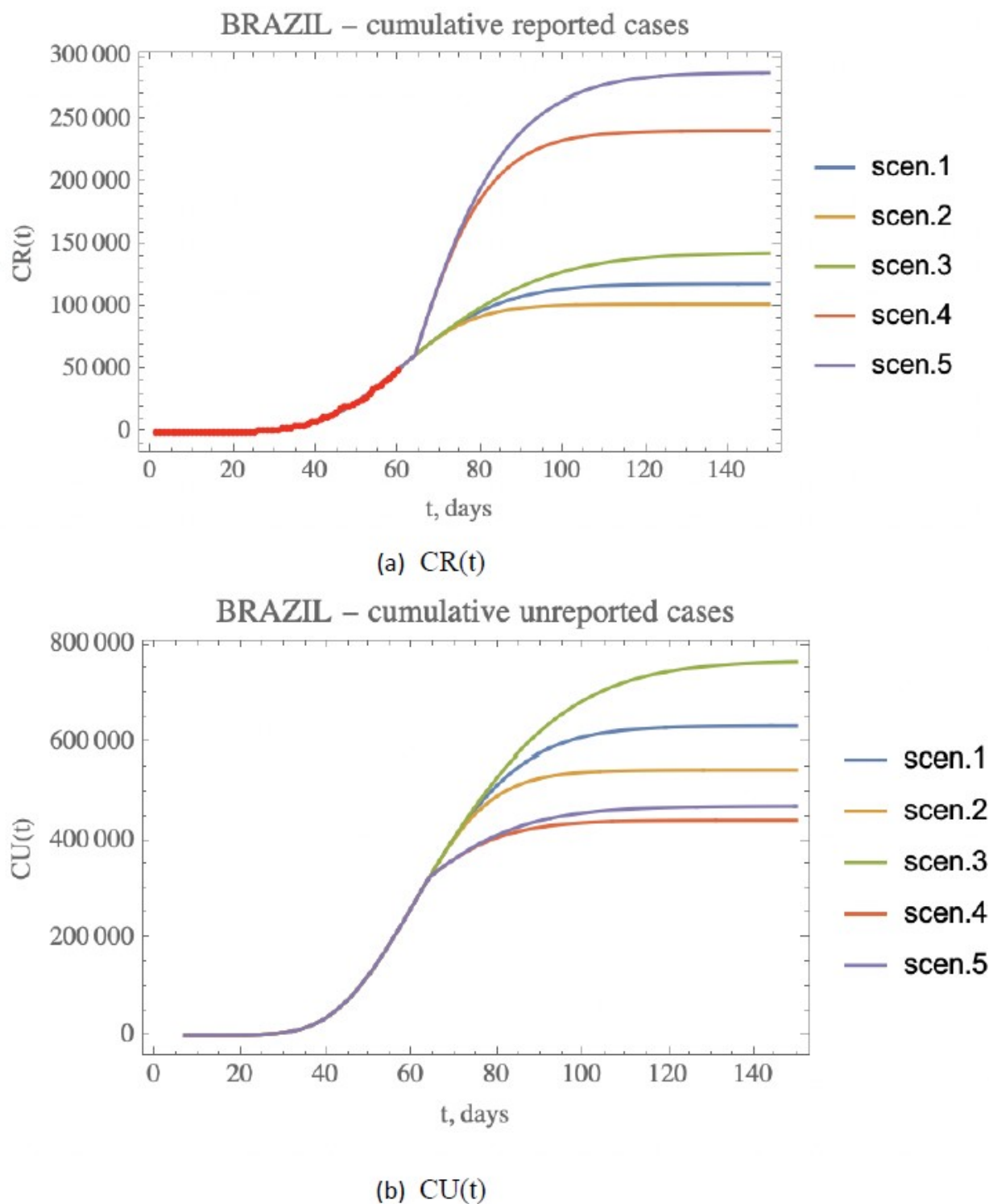
De acordo com as informações[20] constantes do site da UFRJ sobre o referido estudo, os autores consideraram 25/02/20, data do primeiro caso reportado no país, como o marco temporal para prever o pico da doença no Brasil. Assim, traçaram cinco cenários hipotéticos com medidas de saúde pública para controle da doença, a saber:

> "Os cenários estudados incluem variações em parâmetros que resultam de fatores como distanciamento social, hábitos de higiene e proteção individual, intensificação de testes para isolamento de infectados e outras medidas de reorganização social. A sensibilidade do modelo a esses parâmetros foi então avaliada por meio de cinco cenários: **1º) manter-se as medidas de contenção e mitigação no nível atual; 2º) intensificar progressivamente o distanciamento social; 3º) reduzir progressivamente o distanciamento social; 4º) intensificar o isolamento de infectados pela testagem mais numerosa da população; 5º) combinar a testagem ampliada com a intensificação do distanciamento social**", explica a pesquisadora." (grifo nosso)

Os gráficos demonstrativos da evolução da pandemia no país, de acordo com os citados cenários, são assim ilustrados:

---

19 R.M. Cotta, C.P. Naveira-Cotta, and P. Magal. <u>Parametric identification and public health measures influence on the COVID-19 epidemic evolution in Brazil.</u> <https://www.medrxiv.org/content/ 10.1101/2020.03.31.20049130v1> Acesso em 19/05/20, às 15h30.

20 <https://ufrj.br/noticia/2020/05/12/ufrj-cria-modelo-preditivo-para-evolucao-da-pandemia-de-covid-19> Acesso em 21/05/2020, às 10h55.

BRAZIL – cumulative reported cases

(a) CR(t)

BRAZIL – cumulative unreported cases

(b) CU(t)

Figures 10.a,b – Comparative predictions for a) CR(t), and b) CU(t), for the five scenarios (i) to (v). (red dots in (a) show available data of CR(t) up to April 23rd).

Como se observa dos gráficos contidos no estudo em

14

referência, o pico da doença deve ser alcançado agora no fim de maio, e o número de registros deve se estabilizar no final do mês de julho.

Diante de tal contexto, entende-se que a curva preditiva de tais estudos permite sejam mantidas as datas estabelecidas no art. 29, II, da Constituição Federal para a realização das eleições, afastando-se a hipótese de seu adiamento.

Com efeito, a história nos mostra que em outras situações extremas, o direito ao sufrágio foi garantido. Exemplos não faltam. Como mencionado anteriormente, durante a Guerra Civil americana, em 1864, Abraham Lincoln foi reeleito presidente dos Estados Unidos. Na oportunidade, afirmou que "a eleição é uma necessidade. Não podemos ter um governo livre sem eleições".

Já sob a sombra da pandemia da gripe espanhola, a qual durou de 1918 a 1920, tivemos: a) em 1918, no curso da I Guerra Mundial, eleições americanas para o Senado e para a Câmara; e b) em 1919, eleições presidenciais no Brasil. No decorrer da II Guerra Mundial, por sua vez, duas eleições presidenciais americanas foram realizadas, em 1940 e 1944.

No dia 15/04/2020, já sob as circunstâncias extremas da pandemia da Covid-19, a Coreia do Sul concluiu as eleições parlamentares na data prevista, com a participação de aproximadamente 66,2% da população, a taxa mais alta de qualquer eleição parlamentar desde 1992, de acordo com a Comissão Eleitoral Nacional daquele país[21].

Nos termos do relatório de Gestão das Eleições em Resposta ao Covid-19[22], produzido pela referida comissão, as medidas adotadas podem ser assim resumidas:

---

21 https://www.nec.go.kr/engvote_2013/main/main.jsp

22 Election Management in Response to COVID-19. Arquivo original em PDF anexado à presente petição.

1. Estabelecimento de procedimentos de votação e de contagem para prevenir e impedir a disseminação de COVID-19, por meio da criação de um sistema de desinfecção que promoveu a segurança dos cidadãos e permitiu-lhes votar com confiança;

2. Garantia do sufrágio a pessoas com diagnóstico confirmado de COVID-19, inclusive permitindo que tais pacientes se registrassem para votar em casa, além da ampliação do método de registro para votação domiciliar;

3. Implementação de uma maneira de garantir o sufrágio daqueles que receberam o diagnóstico de COVID-19 após o encerramento do período de registro para votação domiciliar; e

4. Garantia do sufrágio àqueles que estavam em quarentena e cuja movimentação era restrita no dia da eleição (15 de abril), bem como àqueles que tiveram contato com pacientes confirmados ou que entraram no país.

Sobre os procedimentos adotados, o citado relatório faz menção à possibilidade de votação antecipada, à criação e divulgação em massa de um "Código de Conduta" para os eleitores, além da instrução e treinamento dos mesários quanto aos procedimentos de desinfecção e organização dos eleitores no dia do pleito.

O relatório em referência, anexo à presente petição, possui muitos dados e orientações que podem servir de parâmetro aos procedimentos a serem adotados como forma de garantir a segurança da população brasileira durante o pleito que se avizinha.

Não se olvide, ainda, a <u>eleição presidencial americana</u>, prevista para <u>novembro do corrente ano</u>. Diante do cenário pandêmico, **o CDC – Centers for Disease Control and Prevention** formulou uma série de

recomendações para os locais de votação. Veja:

> "Com base nos dados disponíveis, as medidas mais importantes para impedir a transmissão do vírus em áreas públicas com grande concentração de pessoas incluem a limpeza cuidadosa e consistente das mãos. Portanto:
>
> • Garanta que os banheiros dos locais de votação estejam adequadamente abastecidos com sabão, água e materiais secantes, para que visitantes e funcionários possam lavar as mãos.
>
> • Forneça um desinfetante para as mãos à base de álcool, com concentração mínima de 60%, para ser usado antes ou depois de usar a máquina de votação, ou da etapa final do processo de votação. Considere colocar o desinfetante para as mãos à base de álcool em locais visíveis e frequentemente usados, como mesas de registro e saídas.
>
> • Incorpore estratégias de distanciamento social, conforme possível. Estratégias de distanciamento social aumentam o espaço entre os indivíduos e diminuem a frequência de contato entre eles, para reduzir o risco de propagação da doença. Com base no que se sabe sobre o COVID-19, o ideal é manter os indivíduos com pelo menos 1,80m de distância. Se isso não for viável, os indivíduos devem ser mantidos tão distantes quanto possível. A viabilidade das estratégias dependerá do espaço disponível no local de votação e do número de eleitores que chegam ao mesmo tempo. A equipe da seção eleitoral pode:
>
>> ✓ Aumentar a distância entre as cabines de votação.

✓ Limitar o acesso de visitantes não essenciais. Por exemplo, (...) filhos, netos etc., (...).

✓ Lembrar os eleitores na chegada sobre o espaço a ser mantido entre eles e os outros. Incentive os eleitores a manterem 1,80m de distância, se possível. Os locais de votação podem fornecer sinais para ajudar eleitores e trabalhadores a se lembrarem disso.

✓ Desencorajar os eleitores e trabalhadores de cumprimentar outros com contato físico (por exemplo, apertos de mão). Inclua esse lembrete nos sinais sobre distanciamento social".[23] (grifos no original)

Assim como o relatório da Comissão Eleitoral Nacional da Coreia do Sul, verifica-se que as orientações emanadas do CDC podem servir de parâmetro para a adequação dos procedimentos no processo eleitoral brasileiro, devendo haver gestão desse órgão superior da Justiça Eleitoral junto ao Ministério da Saúde e ao Ministério do Desenvolvimento Regional, <u>a fim de que seja estabelecido o protocolo a ser seguido no país</u>.

IV – DA NECESSÁRIA CONFORMAÇÃO LEGISLATIVA DECORRENTE DA ADOÇÃO DO PROTOCOLO DE SEGURANÇA EM SAÚDE PÚBLICA NO PROCESSO ELEITORAL DE 2020

Inicialmente, este órgão do Ministério Público não ignora que o processo eleitoral é complexo e envolve diversas fases, não estando restrito à etapa de votação propriamente dita. Nesse contexto, destaca-se, a

---

23 Livre tradução retirada do sítio eletrônico <https://www.cdc.gov/coronavirus/2019-ncov/community/election-polling-locations.html> Acesso em 25/05/20, às 11h37.

título de exemplo, a realização do teste público de segurança, a necessidade de vistoria dos locais de votação, a convocação e treinamento de mesários e colaboradores, a distribuição de alimentação e realização de transporte, a entrega e retirada das urnas, a apuração dos resultados, entre outros.

Com efeito, há diversas etapas que devem ser cumpridas previamente para que o eleitor possa exercer o seu direito de forma livre e segura. Entretanto, para assegurar o direito ao voto na presente situação, é necessário que antes sejam assegurados os direitos à vida e à saúde dos servidores que precisam desenvolver tais encargos.

Nesse contexto, tem-se por necessária a adoção, por parte desse e. TSE, de um plano próprio para garantir a segurança dos servidores e colaboradores no exercício de suas funções, sem os quais resta impossibilitado o desenvolvimento do processo eleitoral.

No que diz respeito ao calendário eleitoral estabelecido pela Resolução TSE n° 23.606/19, algumas considerações merecem registro.

Primeiramente, ainda que já tenha sido ultrapassado o prazo previsto para a realização do Teste de Confirmação[24], última etapa do Teste Público de Segurança 2019, entende-se viável a sua realização em data próxima, desde que disponibilizado aos participantes o equipamento de proteção necessário, bem como local adequado para a sua concretização. O mesmo se diga em relação à Cerimônia de Lacração e Assinatura Digital dos Sistemas Eleitorais, prevista no art. 66, §2°, da Lei n° 9.504/97, e na Resolução TSE n° 23.603/19.

Em relação às convenções partidárias, previstas para o período de 20/07 a 05/08, cumpre assinalar que há nesse e. Tribunal Superior três consultas que tratam do tema, a saber: CTA 0600479-37.2020.6.00.0000, CTA 0600460-31.2020.6.00.0000 e CTA 0600413-57.2020.6.00.0000, todos sob a relatoria do Min. Luis Felipe Salomão. Em referidas consultas,

---

24 De 27 a 29 de abril, de acordo com a Res. 23.606/19.

questionam os consulentes sobre a possibilidade de que as convenções sejam realizadas por meio eletrônico e sobre os procedimentos a serem adotados para o cumprimento do disposto nos arts. 7º e 8º da Lei nº 9.504/97.

Esta Vice-Procuradoria-Geral Eleitoral já se manifestou nas citadas consultas, oportunidade em que asseverou:

"O que primeiro deve ser dito acerca da indagação *sub oculis* é que há clara reserva da disciplina dos aspectos formais das convenções ao estatuto partidário, isto é, ao âmbito da autonomia partidária.

Como bem sublinhou a Assessoria Consultiva — ASSEC desse Tribunal Superior:

[…] da leitura das normas de regência, nota-se que não se estabelece forma específica a ser adotada pelos partidos para a realização das convenções partidárias – presencial ou virtual –, cabendo ressaltar que, de acordo com o princípio da legalidade (Constituição Federal, art. 5º, II), "ninguém será obrigado a fazer ou deixar de fazer alguma coisa senão em virtude de lei".

Não se ignora, é verdade, que a ata das convenções deve ser lavrada em livro aberto e rubricado pela Justiça Eleitoral — art. 8º da Lei nº 9.504/97 — e integrada, ademais, pelas assinaturas dos convencionais presentes (art. 6º, § 3º, da Res.-TSE nº 23.609/2019).

Todavia, ela não estabelece que tais registros devam ser materializados necessariamente na forma analógica, vindo a ser interditada, por conseguinte, o formato digital.

A arquitetura legal vigente, na realidade, não especifica a natureza do livro ata — tampouco das assinaturas — no qual devem ser documentadas as convenções partidárias, ficando este particular

aspecto formal, portanto, sujeito à regulamentação desse Tribunal Superior, nos termos do que prescreve o art. 105 da Lei das Eleições.

Disso resulta que as convenções partidárias podem, em tese, ser realizadas de forma virtual, bastando que não contrariem normas insertas nos respectivos estatutos e, ainda, que a Justiça Eleitoral regulamente a possibilidade do uso de livro ata eletrônico.

Com essas observações, responde-se afirmativamente ao primeiro questionamento.

O entendimento enseja, por necessário, a indagação seguinte, consubstanciada na necessidade de observância da antecedência mínima (180 dias) com a qual o diretório partidário — por meio do seu próprio estatuto ou, no caso de omissão, pelo órgão de direção nacional — deve estabelecer "as normas para a escolha e substituição dos candidatos e para a formação de coligações".

Conquanto seja possível discutir se o formato das convenções — virtual ou presencial — de fato se insere no conjunto de normas a que se refere o caput do art. 7º da Lei nº 9.504/97, o que sobreleva destacar, no ponto, é a antinomia havida entre as disposições legais que impõem o distanciamento social e a que exige a antecedência mínima de 180 dias, contados das eleições, para que sejam publicadas as "regras do jogo".

A solução não parece distante, eis que a ponderação dos valores jurídicos tutelados pelas normas que se colocam em rota de colisão certamente pende a favor do direito à saúde e à vida, bens estes protegidos pelas medidas de contenção do vírus Sars-Cov-2.

Ocorre que até mesmo o exame cauteloso do § 1º do art. 7º da Lei das Eleições permite concluir que a tese de relativização do prazo —

para fazer constar a previsão de convenções virtuais — é a que também preserva melhor o valor jurídico ali tutelado, a saber, a democracia interna partidária.

Isso porque eventual obrigatoriedade de que as convenções sejam presencialmente realizadas, a despeito do contexto de disseminação da doença Covid-19, fatalmente constituirá um desestímulo — senão mesmo um óbice — a que os filiados do partido delas participem.

Em outras palavras, a manutenção das convenções presenciais em tempos de pandemia, na realidade, milita contra a concretização da democracia interna, uma vez que desencoraja a participação do maior número possível de membros da agremiação partidária.

Oportuno recordar que esse Tribunal Superior Eleitoral, ao defrontar-se com o rigor excessivo com que o prazo mínimo de filiação partidária atingia determinada eleição suplementar, decidiu flexibilizá-lo, adaptando-o "à realidade, na perspectiva da prevalência do critério da razoabilidade."

À base dessas considerações, o Ministério Público Eleitoral entende que a resposta ao segundo questionamento também deve ser positiva, ressaltando-se, expressamente, o caráter pontual e excepcional da flexibilização e a necessidade de que essa Corte Superior Eleitoral, com fulcro nos arts. 1º, parágrafo único, e 23, IX, ambos do Código Eleitoral e no art. 105 da Lei nº 9.504/97, venha a fixar prazo razoável para que as alterações estatutárias sejam publicadas.

A situação de emergência de saúde incita, ainda, as dúvidas do consulente quanto ao cumprimento do art. 8º da Lei das Eleições, especialmente na parte em que este exige a lavratura da respectiva ata em livro aberto e rubricado pela Justiça Eleitoral.

Como dito alhures, a lei não impede o uso de livro ata eletrônico, mas sua materialização depende ainda de regulamentação.

Nesse contexto, não se pode deixar de assinalar, em primeiro plano, que a lavratura da ata — integrada pelas assinaturas dos convencionais que participaram das discussões —, em livro chancelado pela Justiça Eleitoral, não pode ser dispensada por esse Tribunal Superior Eleitoral.

Conquanto seja factível, em situações excepcionais, mitigar o rigor de determinada disposição legal, sempre preservando o valor jurídico que ele pretendeu tutelar, não o é simplesmente ab-rogar determinada norma, deixando inatingível o fim a que se propôs.

A lavratura da ata — acompanhada da lista de assinaturas —, em livro oficial, constitui o principal elemento de controle da legalidade dos atos partidários, na medida em que permite aos interessados, e principalmente à Justiça Eleitoral, fiscalizar o respeito à democracia interna e às normas estatutárias, resolvendo as controvérsias que venham a surgir entre os convencionais.

Por isso, o registro da ata em livro chancelado — analógico ou eletrônico — é absolutamente indispensável para o fim de assegurar a higidez e a segurança do processo eleitoral — papel institucional dessa Justiça Especializada — o que impõe, necessariamente, que se responda negativamente à quarta indagação.

Considerado o teor da terceira e quinta indagações, é preciso ter em mente que a impossibilidade de dispensa da lavratura da ata em livro oficial não implica, como mencionado alhures, a conclusão de que esse documento há de ser físico.

Admitindo-se, contudo, que as indagações referem-se ao livro ata

físico, é preciso esclarecer o que se segue.

As questões buscam saber de que forma se daria a obtenção da abertura e/ou da rubrica do livro ata físico, considerado o Regime de Plantão Extraordinário — que suspendeu o atendimento presencial — estabelecido, por prazo indeterminado, para toda a Justiça Eleitoral, pela Resolução TSE nº 23.615/2020.

Ao ver do Ministério Público Eleitoral, o próprio exame do normativo referenciado indica não haver óbice intransponível a esse serviço, visto que é expressamente assegurado o direito ao atendimento presencial nas hipóteses em que restar inviabilizado o antedimento remoto. A ver:

> Art. 3º Fica suspenso o atendimento presencial de partes, advogados e interessados, que deverá ser realizado remotamente pelos meios tecnológicos disponíveis.
>
> § 1º Cada unidade judiciária deverá manter canal de atendimento remoto, a ser amplamente divulgado pelos tribunais.
>
> § 2º Não logrado atendimento na forma do § 1º, os tribunais providenciarão meios para atender, presencialmente, advogados, públicos e privados, membros do Ministério Público e polícia judiciária, durante o expediente forense.

Portanto, é suficiente que os diretórios municipais, nas eleições que se avizinham, contatem os tribunais por meio do canal de comunicação mencionado no § 1º do artigo acima transcrito, agendando a entrega e a retirada do livro de atas, recomendado-se, na ocasião, a estrita observância dos protocolos de segurança sanitária.

De outra parte, a considerar que o livro ata referido na terceira e quinta indagações é o eletrônico, será preciso reconhecer a

impossibilidade de conhecê-las na via consultiva, por agitarem tema eminentemente operacional.

Com efeito, a viabilidade técnica da adoção do livro ata eletrônico certamente impõe a realização de pesquisas prévias e de estudos específicos, a serem desenvolvidos por expertises da área da tecnologia da informação, sendo recomendável, portanto, que constituam objeto de processo administrativo próprio, nos termos do entendimento explicitado pela Assessoria Consultiva, em seu parecer.

No entanto, a iminência da inauguração do período eleitoral e as circunstâncias sanitárias excepcionais por todos vivenciadas, exigem, desde logo, que a compreensão do Ministério Público Eleitoral sobre o tema seja externada.

Bem se sabe que o princípio da alternância de poder consubstancia elemento estruturante do regime democrático, a demandar, por isso mesmo, que eventual debate a respeito da alteração do calendário eleitoral deva ser conduzido com máxima prudência, tendo-se por norte, em qualquer cenário que venha a se concretizar, a absoluta impossibilidade de extensão dos mandatos eletivos atualmente exercidos na esfera municipal.

Na realidade, mesmo a proposição de um novo cronograma que preserve a duração dos mandatos políticos apenas haveria de ser cogitado como opção última, dada a necessidade de se tutelar o postulado da segurança jurídica, materializado, na seara eleitoral, no princípio da anualidade.

Portanto, é sumamente importante que a Justiça Eleitoral, no desempenho do seu papel constitucional, e apoiada no espírito inovador que sempre a fez reconhecida perante a sociedade, providencie os instrumentos tecnológicos capazes de permitir a

consecução das eleições sem risco à saúde das pessoas envolvidas.

É precisamente a partir dessa tessitura excepcional que o Ministério Público Eleitoral entende possível — e mesmo recomendável — a regulamentação do uso do livro ata eletrônico, disponibilizando-se, assim, instrumento tecnológico apto a garantir a segurança do registro dos atos partidários e, paralelamente, resguardar a saúde e a vida dos convencionais e dos servidores da Justiça Eleitoral.

Do mesmo modo, vê como factível a proposta de que a lista de presença — prevista tão somente na Resolução dessa Corte Superior — seja substituída pela gravação audiovisual das convenções virtuais e submetidas, as respectivas mídias, à Justiça Eleitoral, no mesmo prazo fixado para a entrega das atas."[25] (grifo nosso)

Seguindo a linha de raciocínio contida na manifestação acima, este órgão do Ministério Público não vê óbice para que os partidos políticos cumpram: a) o disposto no art. 4º da Lei nº 9.504/97, referente à necessidade de que o órgão de direção da grei partidária na circunscrição esteja devidamente anotado no tribunal eleitoral competente até a data da convenção; e b) o prazo para apresentar à Justiça Eleitoral o requerimento de registo de seus candidatos, previsto no art. 11, *caput*, da Lei das Eleições[26]. O mesmo se diga em relação ao estabelecido no §4° do art. 11 da Lei 9.504/97, quanto ao prazo dos candidatos escolhidos em convenção para solicitar seus registros à Justiça Eleitoral, se os partidos não o fizerem.

Destacada a possibilidade de manutenção das convenções partidárias e registro dos candidatos como previsto no calendário eleitoral, a consequência lógica é a desnecessidade de alteração do prazo para a impugnação dos registros de candidatura, nos termos do art. 3° da Lei

---

25 Parecer exarado na CTA N° 0600479-37.2020.6.00.0000 – BRASÍLIA/DF.
26 Art. 11. Os partidos e coligações solicitarão à Justiça Eleitoral o registro de seus candidatos até as dezenove horas do dia 15 de agosto do ano em que se realizarem as eleições.

Complementar n° 64/90[27], e do art. 97, §3°, do Código Eleitoral[28].

A propósito, ressalte-se que consta no Relatório Final da Missão de Observação Eleitoral (MOE), elaborado pela Organização dos Estados Americanos (OEA) relativamente ao pleito de 2018, recomendação de que o controle jurídico acerca das candidaturas seja exercido em fase anterior ao início da campanha eleitoral. Tal observação decorre do fato de o período de julgamento dos registros se dar de forma simultânea ao desenvolvimento da campanha eleitoral, o que gera dúvidas no eleitorado sobre a efetiva possibilidade de seus candidatos poderem participar do pleito. Dessa forma, deve ser mantido o cronograma relativo aos registros de candidatura, a fim de que seja viabilizada sua análise pela Justiça Eleitoral com a maior antecedência possível, garantindo maior segurança aos eleitores e ao próprio processo eleitoral.

Em relação ao prazo final para a publicação dos locais designados para funcionamento das mesas receptoras de votos e de justificativas, previsto para 05/08/2020, assinala-se a premente necessidade de que o protocolo de segurança para a realização das eleições seja levado a cabo com a maior brevidade possível, a fim de que a quantidade e os locais de votação estejam adequados às medidas de segurança nele previstos.

No que toca à propaganda eleitoral impressa, pelo rádio ou televisão, pela via eletrônica, por meio de uso de alto-falantes ou amplificadores, entende-se desnecessária sua alteração, eis que não se mostram fundamentalmente afetadas pelas restrições impostas pela pandemia. Tal não é, entretanto, a situação das passeatas, carreatas,

---

27 Art. 3° Caberá a qualquer candidato, a partido político, coligação ou ao Ministério Público, no prazo de 5 (cinco) dias, contados da publicação do pedido de registro do candidato, impugná-lo em petição fundamentada.

28 Art. 97. Protocolado o requerimento de registro, o presidente do Tribunal ou o juiz eleitoral, no caso de eleição municipal ou distrital, fará publicar imediatamente edital para ciência dos interessados. (...)

§ 3° Poderá, também, qualquer eleitor, com fundamento em inelegibilidade ou incompatibilidade do candidato ou na incidência dêste no artigo 96 impugnar o pedido de registro, dentro do mesmo prazo, oferecendo prova do alegado.

caminhadas ou comícios, os quais deverão seguir as normas de saúde pública estabelecidas pela União, Estados, Distrito Federal ou Municípios, nos termos do que foi decidido pelo e. Supremo Tribunal Federal na MC na ADI n° 6341/DF.

Quanto à prestação de contas parcial, realizada por meio do Sistema de Prestação de Contas Eleitorais (SPCE), não há óbice para que seja realizada dentro do prazo previsto no calendário eleitoral, em obediência ao disposto no art. 28, § 4°, II, da Lei n° 9.504/97.

Sobre as datas previstas constitucionalmente[29] para a realização das eleições municipais, este órgão do Ministério Público ressalta uma vez mais o seu entendimento acerca da possibilidade de que se mantenham inalteradas. Como afirmado anteriormente, a adoção de um protocolo de segurança, associado à redução do número de casos da doença até outubro – conforme previsto em estudos estatísticos –, permite a concretização do pleito nos dias preestabelecidos.

Como forma de evitar a aglomeração de pessoas e dar efetividade ao protocolo de segurança, propõe-se a esse e. Tribunal Superior Eleitoral que atue junto ao Congresso Nacional, a fim de que este possa deflagrar processo legislativo com a finalidade de promover a inclusão de dispositivos no Título V do Código Eleitoral – Disposições Gerais e Transitórias, para a ampliação do período de votação, de modo que o seu início se dê às 07h00min, e o encerramento às 18h00min. Seguindo a alteração legislativa acima referida, devem ser conformadas as Resoluções desse e. TSE que tratam do tema.

A corroborar a necessidade de que sejam mantidas as datas do pleito, observe-se que o art. 29 da Lei n° 9.504/97 estabelece prazo para a prestação de contas da campanha eleitoral, sem a qual o candidato eleito não poderá ser diplomado:

---

29 Art. 29, II, da CF/88.

"Art. 29. Ao receber as prestações de contas e demais informações dos candidatos às eleições majoritárias e dos candidatos às eleições proporcionais que optarem por prestar contas por seu intermédio, os comitês deverão:

(...)

III – encaminhar à Justiça Eleitoral, **até o trigésimo dia posterior à realização das eleições**, o conjunto das prestações de contas dos candidatos e do próprio comitê, na forma do artigo anterior, ressalvada a hipótese do inciso seguinte;

IV – havendo segundo turno, encaminhar a prestação de contas, referente aos 2 (dois) turnos, **até o vigésimo dia posterior à sua realização.**

(...)

§ 2º **A inobservância do prazo para encaminhamento das prestações de contas impede a diplomação dos eleitos, enquanto perdurar.**" (grifo nosso)

Ademais, o art. 30, §1º, da Lei nº 9.504/97 dispõe que "[a] decisão que julgar as contas dos candidatos eleitos será publicada em sessão **até três dias antes da diplomação**" (grifo nosso).

Partindo-se do princípio, portanto, de que os atuais mandatos devem se encerrar em 31/12/2020 – em observância à forma republicana e ao regime democrático –, parece flagrante a impossibilidade de que a eleição ocorra, por exemplo, em dezembro, eis que tal proceder inviabilizaria a observância dos prazos previstos nos arts. 29 e 30, §1º, ambos da Lei nº 9.504/97 e, consequentemente, a diplomação dos eleitos antes de 1°/01/2021.

A corroborar tal entendimento, anexa-se à presente petição quadro demonstrativo elaborado pelo Instituto Liberdade Digital, o qual comprova que, se o primeiro turno das eleições for realizado em 15/11/2020, mantido o intervalo previsto entre os marcos temporais, a

diplomação dos eleitos dar-se-á apenas em 29/01/2021, o que, uma vez mais, considera-se inadmissível.

Nesse contexto, a manutenção das datas do pleito é medida que parece mais adequada aos princípios constitucionais sensíveis previstos no art. 34, VII, *a*, da CF/88, bem como à cláusula pétrea estabelecida no art. 60, §4°, II, da CF/88.

Entretanto, **se inevitável** a modificação da data da eleição, entende-se que **esta deve se pautar em critérios científicos e jurídicos, e não simplesmente políticos. Assim, diante de fatal postergação, considera-se que esta deve se dar pelo prazo máximo de 30 (trinta) dias, a fim de que não feneçam as ações e procedimentos de controle do processo eleitoral, os quais conferem maior legitimidade ao pleito, na tutela da sua lisura e efetiva legalidade.**

Por fim, no que tange à prioridade legal dos feitos eleitorais, desde o início do registro das candidaturas até cinco dias após a realização do segundo turno, nos termos do art. 94 da Lei das Eleições (e que no calendário ora vigente para as eleições de 2020 corresponderia ao período de 20/07/2020 a 30/10/2020), verifica-se que, no caso de inevitabilidade de postergação das datas do pleito, este prazo deverá ser conformado ao novo calendário. O mesmo se diga em relação ao auxílio das polícias judiciárias, órgãos da Receita Federal, Estadual e Municipal e dos tribunais e órgãos de contas, na apuração dos delitos eleitorais.

V – DOS PEDIDOS

Ante todo o exposto, este órgão Ministério Público Eleitoral pugna a Vossa Excelência, no uso da competência que lhe foi conferida pelo art. 9°, "f", do Regimento Interno desse e. Tribunal Superior Eleitoral[30], bem

---

30 Art. 9° Compete ao presidente do Tribunal:

(...)

f) representar o Tribunal nas solenidades e atos oficiais, e corresponder-se, em nome dele, com o presidente da República, o Poder Legislativo, os órgãos do Poder Judiciário, e demais autoridades;

como na condição de Relator das Instruções para as Eleições de 2020 (Portaria TSE nº 238, de 26 de março de 2019), que:

1. sejam solicitadas informações, bem como o auxílio dos Ministérios da Saúde e do Desenvolvimento Regional, a fim de que <u>seja elaborado o protocolo de segurança a ser seguido no decorrer do processo eleitoral</u>, cujo objetivo é garantir as condições necessárias à salvaguarda dos direitos à vida, à saúde e ao voto periódico, nos termos da Constituição Federal;

2. haja articulação desse e. Tribunal Superior Eleitoral junto ao Congresso Nacional, por essa presidência, a fim de que **sejam mantidas as datas das eleições municipais em outubro do corrente ano, nos termos previstos no art. 29, II, da Constituição Federal**, tendo em vista os princípios constitucionais sensíveis previstos no art. 34, VII, *a*, da CF/88, bem como a cláusula pétrea estabelecida no art. 60, §4º, II, da CF/88, **com as consequentes alterações legislativas decorrentes da adoção do protocolo de segurança previsto no item anterior**;

3. <u>se inevitável a alteração das datas do pleito</u>, que haja articulação desse e. Tribunal Superior Eleitoral junto ao Congresso Nacional, para que a eleição <u>seja postergada em no máximo 30 (trinta) dias</u>, a fim de que sejam atendidos os prazos para a prestação de contas de campanha, nos termos do art. 29 da Lei n° 9.504/97, sem a qual resta impossibilitada a diplomação dos eleitos. Nesse contexto, sugere-se a adoção do dia **25/10/2020 para a realização do primeiro turno, e 15/11/2020 para o segundo turno**, nos municípios com mais de duzentos mil eleitores.

4. em quaisquer das hipóteses acima referidas, que o

calendário eleitoral seja adaptado às medidas a serem adotadas, e que seja defendida por esse e. Tribunal Superior Eleitoral a **impossibilidade de prorrogação de mandatos em curso, seja por qual tempo for,** ainda que diante de uma situação extrema como a pandemia que ora se apresenta, em razão do disposto no art. 1°, *caput* e parágrafo único, art. 29, I, II e III, art. 34, VII, *a*, e art. 60, §4°, II, todos da Constituição Federal.

Nestes termos, pede deferimento.

Brasília, 25 de maio de 2020.

RENATO BRILL DE GÓES
Vice-Procurador-Geral Eleitoral

Election Management in Response to COVID-19

21st National Assembly Elections in the Republic of Korea (April 15, 2020)

중앙선거관리위원회
NATIONAL ELECTION COMMISSION

Contents

1. Background and Overview of Courses of Action

Background

- Prior to the 21st National Assembly elections, the crisis level related to coronavirus disease (hereafter COVID-19) had been raised to serious (February 24, 2020).

- It was necessary to prepare measures to manage voting and counting in response to the spread of COVID-19 within communities and nationwide .

Overview of Courses of Action

- Established voting and counting procedures to prevent and block the spread of COVID-19 through the creation of a system of disinfection that promoted citizen's safety and allowed them to vote with confidence.

- Guaranteed the suffrage of persons with confirmed cases of COVID-19, including by allowing confirmed patients to register for home voting and expanded the registration method for home voting.

- Actively implemented a way to guarantee the suffrage of those who were confirmed with cases of COVID-19 after the home voting registration period had closed.

- Ensured the suffrage of those who were in quarantine and whose movement was restricted on election day (April 15) such as those who come into contact with the confirmed patients or those who entered the country.

2. Introduction to Voting Methods and Management of Voting

Home Voting

- A person who is unable to move freely on the ground of their serious physical disability or a person who has been admitted for a long time in a hospital, sanatorium or detention center could register for home voting during the home voting registration period (March 24 – March 28). They received ballot papers by mail from the relevant election commission and voted at their residence or the place they were residing.

Overseas Voting

- Overseas voters and overseas absentees voters[1] cast their ballots at overseas polling stations set up at diplomatic missions during the overseas voting period (April 1 – April 6).

Shipboard Voting

- Sailors on board vessels such as long-haul fishing boats and outbound passenger ships voted by facsimile (including electronic fax) at onboard polling stations installed on the vessel during the shipboard voting period (April 7 - April 10).

Early Voting

- Voters not able to vote on election day (April 15 6:00 am - 6:00 pm) could vote at the nearest early voting polling station without prior or separate registration for two day starting from five days prior to election day (April 10 and 11, 6:00 am - 6:00 pm)

- By establishing an election-only network (LAN and wireless) and using the integrated voters list, voters could cast their ballots at any polling station across the country regardless of their registered address.

- A total of 3,508 early polling stations were installed and operated across the country (3,484 stations at the district level and an additional 24 stations [16 stations in areas where military bases are concentrated and eight stations at care centers]).

Election Day Voting

- Voters could cast their ballots at their designated polling station according to their registered address, with one polling station installed per polling district.

- A total of 14,330 polling stations were installed and operated across the country.

Counting

- Counting stations were set up by the Gu/Si/Gun election commissions. [2]

---

[1] Overseas voters are classed as Korean citizens residing abroad, overseas absentee voters are classed as Korean citizens who are temporarily abroad during the voting period
[2] In the Republic of Korea Gu, Si and Gun are the third tier of governmental regions (national – Si/Do [City/Province] – Gu/Si/Gun)

- Postal ballot boxes (from ballots cast outside their relevant district during early voting, overseas voting, shipboard voting and home voting) together with early voting ballot boxes from those who cast their ballots inside their relevant district were transferred to the counting center after the close of voting at 6pm on election day. Election day ballot boxes were transferred from the polling station to the counting center after the close of voting.

3. Voting Methods in Response to COVID-19
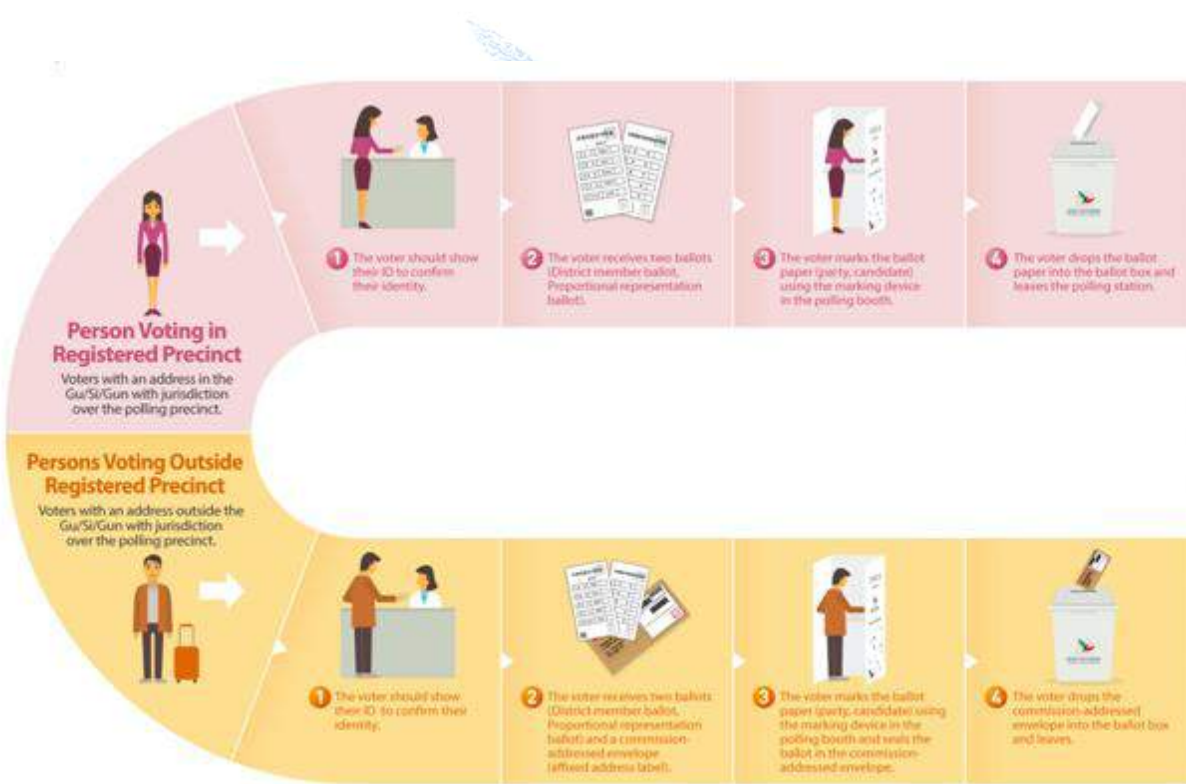
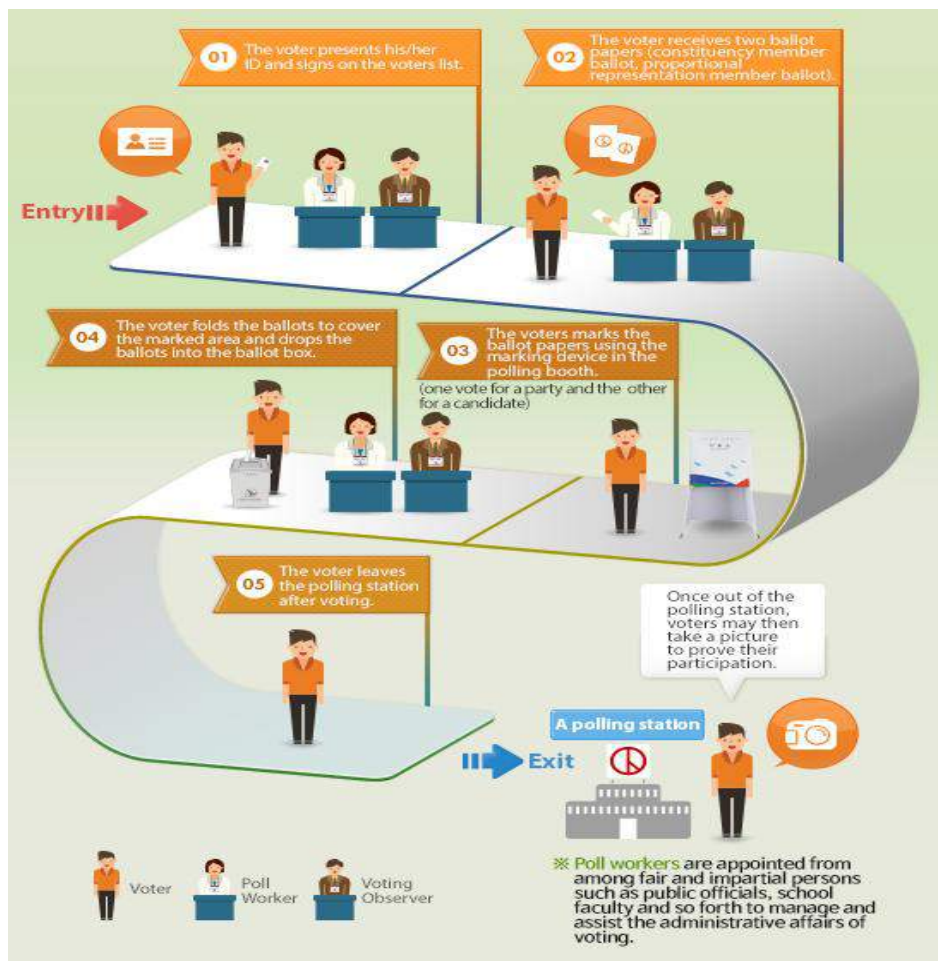## A) Voting Methods for General Voters

Figure 1 Early Voting Method

Figure 2 Election Day Voting Method

If your temperature is below 37.5 degrees

Wear your mask – Use hand sanitizer – Wear the vinyl gloves provided – Keep 1m apart – Lower or take off your mask briefly for voter identification – Receive ballot papers – Mark the ballot papers in the polling booth – Put the ballots in the ballot box

Figure 3 Additional Measures for General Voters (No symptoms or temperature)

Announcement and Promotion of 'Code of Conduct' for Voters

- Announced a 'Code of Conduct' for participating in voting and sent details enclosed in the voting information and election material sent to every household and election material sent to soldiers and police (see attachment one).

- Published the 'Code of Conduct' on various media sites including the NEC's own e-TV, the NEC website, social media and various TV channels and newspapers.

Producing Video on and Providing Training on Voting Safely Regarding COVID-19

- Posted video material on Youtube and other channels and utilized them for training polling station workers.

- Produced videos on disinfection procedures inside and outside polling stations, and the voting process.

- Produced videos on the voting procedures for temporary polling booths for voters with a high temperature or respiratory symptoms.[3]

Polling Station Preparation

- Election officials (polling station manager, polling station staff, and observers) had to wear masks and medical gloves.

- Personnel in charge of checking voter's temperatures had to wear face shields, masks, and medical gloves.

- A member of the polling station staff was designated in advance as being in charge of temporary polling booths .[4]

- The polling station manager provides training to the designated staff members to prevent the spread of COVID-19.

Polling Station Set Up

- Signs and equipment for keeping at least one meter distance between voters.

---

[3] Early voting video: https://youtu.be/HPvLnfT4GQc
  Election day video: https://youtu.be/V2rYxQaX07M
[4] Voters with a high temperature or with respiratory symptoms cast their ballot at dedicated temporary polling booths away from other voters.

- Attached 'Information on COVID-19' at the entrance of polling stations (see attachment 3).

Figure 5 Guides and Stickers Used

Figure 4 Collapsible Belts and Plastic Cones Used

- A separate route for voters with a high temperature or with respiratory symptoms away from other voters was marked out with arrows on the floor.

- Bins for the disposable vinyl gloves were placed at the exits of polling stations.

Voting Process

Voters with a normal temperature (under 37.5 degrees Celsius) and no respiratory symptoms went through the polling station in the following manner:

1. Voters wore a mask to the polling station.

2. Voters kept at least one meter distance from others in the vicinity of the polling station.

3. The polling station staff responsible for temperature checks checked all voters' temperatures at the entrance of the polling station (see attachment 3).

4. Voters with no temperature or symptoms disinfected their hands with the hand sanitizer and wore vinyl gloves provided prior to entering the polling station.

5. For identification purposes, polling station staff instructed voters to lower or take off their masks briefly.[5]

---

[5] Voters refusing to follow instructions were not allowed to vote, except for those identifiable even with their masks on

6. While wearing the gloves, voters signed their name on the voters list, received their ballot papers, marked their ballot papers in the polling booth, and placed them inside the ballot box.

7. Voters placed their gloves into the bin set up at the exit of the polling station prior to leaving.

Voters with a high temperature (above 37.5 degrees Celsius) or with respiratory symptoms voted in the following manner (see attachment 4):

1. The voter disinfected their hands with the hand sanitizer provided and wore vinyl gloves.

2. The polling station staff checked the voter's identification.

3. The polling station staff checked the voter's name on the voters list and signed to confirm identification (for early voting they sign on the identification check machine). The polling station staff then received the ballot papers (for voting outside the voters registered district during early voting, they also received the relevant addressed envelope) and went to pass the ballot papers to the voter together with a temporary polling station envelope. [6]

4. The voter went inside the temporary polling booth and marked the ballot papers, with observers present outside.

5. The voter put the marked ballot papers inside the temporary polling station envelope and sealed it before they passed it to the polling station worker.

6. The polling station staff, in the presence of observers, passed the envelope to the polling station manager. The polling station manager placed the ballot papers into the ballot box in the presence of observers.[7]

7. The polling station staff contacted the relevant public health center about the voter's symptoms (or calls 1339 or area code + 120) and guided them to follow the measures of the relevant agency.

---

[6] On the notes column of the voters list, the polling station worker writes 'temporary polling booth voter' and records them as a person who used a temporary polling booth in the voting records.
[7] During the process, staff should take care not to accidently show the marked ballot paper

8. Voting office staff sterilized and ventilated temporary voting booths and equipment using disinfection tissues.

COVID-19 Precautions

- Polling station staff provided guidance to maintain a distance of one or more meters between voters inside and outside of polling stations. If a polling station was crowded inside, a voter who had their temperature checked at the entrance of the polling station was allowed to enter the polling station after waiting until the number of voters in the polling station had reduced.

- Polling station staff regularly disinfected election equipment using disinfection tissues such as polling booths, marking devices and ballot boxes that were regularly touched by voters.

- Provided guidance to polling station staff and observers on refraining from unnecessary conversations, even between voters.

B) Voting Methods for Confirmed COVID-19 Patients

Method One: Home Voting

> Procedure:
>
> Instructions for home voting by National Election Commission [NEC] and local government) → Voter registration → Eligibility check → Ballot paper delivery → Home voting → Returning the ballots by mail → Counting.

Expanding Voters Eligible for Home Voting

- On March 5, the NEC decided that voters who had been confirmed as COVID-19 patients before the end of the home voting registration period and who were hospitalized, in a care center or in isolation at home would be eligible for home voting.

- The NEC provided information to and asked for cooperation from the head of facilities that accommodated COVID-19 patients through the related agencies (The NEC → Ministry of the Interior and Safety and the Ministry of Health and Welfare → Hospitals and local governments).

Home Voting Registration

- When a voter registered to home vote, they had to submit an application in writing (original copy), but for these elections the head of Gu/Si/Gun local governments allowed home voting registrations related to COVID-19 if received as a copy (by e-mail, facsimile, KakaoTalk, or text message) after checking the registration status.

※ The head of the Gu/Si/Gun recorded confirmation of home voting registration in the margin of the voters list (including a signature or seal).

※ When sending a home voting application, the "Guidelines for Applying for Home Voting for Confirmed COVID-19 patients" was enclosed, text messages were sent, and the information was published on the website.

Receiving Home Voting Ballot Papers

- When receiving home voting ballot papers (mail ballots), staff wore masks and the NEC strengthened hygiene controls, including using hand sanitizer regularly.

Main Information Provided by the NEC on Home Voting

1. Information on home voting and registration as well as home voting registration forms provided by the NEC for confirmed COVID-19 patients.

➢ The NEC provided information on home voting and a home voting application form to confirmed COVID-19 patients staying in a hospital, care center or quarantined at home.

2. Information regarding the home voting applications for confirmed patients

➢ Those in a hospital had to receive proof they are hospitalized from the director of the hospital and then submit it to the head of the relevant Gu/Si/Gun.
➢ Those in a care center had to receive proof they were under the care of the care center from the relevant Mayor or Governor or the Minister of Health and Welfare and then submit it to the head of the relevant Gu/Si/Gun.
➢ For those in quarantine at home, the neighborhood office skipped the verification process and the voter submitted the application to the head of the Gu/Si/Gun. The Gu/Si/Gun then checked the list of confirmed patients to confirm whether they are eligible to use home voting.

3. Information provided to home voters

➢ Voters were asked to wear a mask, disposable gloves and take other measures during the home voting process (including when receiving the ballot papers)
➢ After the voter had marked their ballots and put it into the envelope, the return envelope was handed over to relevant officials, for example at the hospital.

---

4. Requests made to related organizations, for example hospitals

➢ Requested that action was taken to ensure the ballot was properly delivered to the voter.
➢ Asked to ensure that, after disinfection and sterilization, the return envelopes with the ballots inside were put into the mailbox or handed over to the post office.

Method Two: Special Early Voting Polling Stations

Facilities with Installed Special Early Voting Polling Stations

- Facilities where patients who had cases of COVID-19 confirmed after the home voting registration period ended (March 28) and were isolated and could not vote by any other method and

- Care centers where patients with mild cases of COVID-19 were housed and where patients could move within the facility.[8]

- Eight care centers were selected that were caring for patients who had cases of COVID-19 confirmed after the home voting registration period ended.

Operating period

- One-day operation during the early voting period (April 10-11) for each care center, and for 4-8 hours according to the number of voters.

Eligible Voters

- Patients confirmed with COVID-19 in care centers and medical and support staff who were working at the facilities.[9]

Voting Method

- Voting was conducted in the same way as early voting, but due to fears of being infected through a ballot paper, the same method for voters casting their ballots

---

[8] Care centers are facilities that support the care and treatment of patients by isolating those with mild symptoms (total of 27 nationwide).
[9] Medical and support staff were included as eligible voters because restricted during their two-week long shifts working at the facilities.

outside their relevant district was used using a return envelope (the envelopes with ballots inside were disinfected after the close of voting). [10]

- Voting was conducted at different times for confirmed patients and medical and support personnel.

Voting Process

1. Voters went to early polling stations individually, following broadcasted instructions or polling station staff, to prevent patients confirmed with COVID-19 from overlapping.

2. Patients confirmed with COVID-19 wore masks before entering the polling station, used hand sanitizer, and wore vinyl gloves.

3. Voters presented their identification, signed an identification form[11], received atheir ballot papers, and marked the ballot papers in the polling booth.

4. Voters placed the ballot paper inside the return envelope, sealed the envelope, inserted the envelope into the ballot box, placed the gloves into the provided bin, and returned to their room.

5. The polling staff were responsible for making sure patients confirmed with COVID-19 did not overlap while voting and instructed each voter to wait while the previous voter was casting their ballot.

6. Early voting ballot boxes were handed over to the post office after counting the number of returned envelopes in the presence of voting observers.

Installation and Management Personnel

- Cooperated with personnel from the facility to ensure voters did not overlap and had the facility installed where there was sufficient ventilation (In most cases outdoors).

- For each of the special early polling stations, one special early voting polling station manager (from the NEC), four polling station staff (two from the NEC and two the facility itself), and two or more observers were dispatched.

---

[10] A wireless communications network was used.

[11] For identification purposes, voters used the provided pen with gloves on. Voters were prohibited from using the automatic finger printer scanner.

COVID-19 Precautions

- The polling station manager and staff wore level D protective clothing worn by medical personnel.

- Items such as polling booths and stationary used at early voting polling stations were disposed of, and relevant equipment used at special early voting stations such as early voting IT equipment, ballot boxes, marking devices and return envelopes were transferred after disinfection and sterilization.

Figure 6 Voting Process

Figure 7 Voting Process

Figure 8 Level D PPE for Polling Station Staff

Figure 9 Disinfecting Return Envelopes with Ballot Papers Inside

C) Voting Method for Voters in Quarantine

Eligibility

- People in close contact with patients confirmed with COVID-19, people who had returned from abroad and whose movements were restricted on election day, and voters who had been requested to quarantine (for 14 days) by the local government (or health center) starting any time between April 1 until 6pm on April 14.

- Asymptomatic people who were quarantined in an area less than 30 minutes away from a polling station, had the right to vote, and intended to vote on Election Day.[12]

- Civil servants (from local governments) dedicated to dealing with quarantined persons confirmed with the voter their intention to vote and checked they were eligible by contacting them via text message or other forms of message and notified the relevant Gu/Si/Gun election commission and polling station manager by 7pm on April 14, the day before election day.

---

[12] Voting was allowed only if the travel time from the quarantined location to the polling station was less than 30 minutes by car (without other passengers) or on foot (without using public transportation)

Voting Preparation

- Civil servants (from local governments) dedicated to dealing with quarantined persons informed the applicant via text message or in other ways of the period they were temporarily allowed outside of their residence (April 15, 5:20pm to 7:00 pm), their suggested arrival time at polling stations, and where the waiting area was.

- Upon arrival at the polling station before 6pm on election day, the voter in quarantine received a numbered ticket from the staff and waited to be summoned.

- After the closing of voting, a temporary polling booth was installed in a well-ventilated place or outdoors and a member of polling station staff designated to the temporary polling booth wore personal protective gear 10 minutes prior to the closing of voting.[13]

Voting Process

1. After the regular voters finished voting and had left the premises, the voters list, ballot papers and temporary polling booth envelope were prepared and moved together with the designated observers and temporary polling booth.

   The polling station staff stuck numbered tickets by the quarantined voters names on the voters list ready to give it to the voter on arrival.

   Ballots were pre-prepared according to the number of quarantined voters, with the polling station managing affixing their signature and the serial number on the corner of the ballots cut in advance in the presence of observers.

2. The polling station staff, with the assistance of the support staff, ushered the quarantined voters to the temporary polling booth, individually, according to the number on their tickets.

3. The quarantined voter used hand sanitizer and wore vinyl gloves prior to entering the temporary polling booth (no temperature check).

4. The polling station staff designated to the temporary polling booth checked for identification and instructed the voter to sign or attach their seal to the voters list.

---

[13] Personal protective equipment: Type 4 protective clothing, face shields, masks, surgical gloves, and shoe covers

5. The polling station staff provided ballot papers and temporary polling booth envelope to the quarantined voter, and instructed the voter to go to the temporary polling booth.[14]

6. After voting, the quarantined voter put the ballot papers inside the envelope and gave it to the staff designated to the temporary polling booth. Then, the voter placed the gloves inside the bin at the exit of the polling station and left after using the hand sanitizer.[15]

7. When all quarantined voters finished voting, the staff designated to the temporary polling booth transported the temporary polling booth envelopes, ballot papers, and the voters list back to the polling station in the presence of voting observers.

8. The staff designated to the temporary polling booth took out the ballot papers from the envelopes and placed them inside the ballot box in the presence of the polling station manger and voting observers, whilst paying special attention not to disclose inside the ballots.

9. The staff designated to the temporary polling booth took off their personal protective equipment and discarded them into a disposal box.

Figure 11 Voters Wait Outside a Polling Station

Figure 10 Voting in Progress

---

[14] At the temporary polling booth, the staff sanitized items which were in contact with the self-quarantined voter, such as pens, with sanitizing tissue
[15] The staff at the temporary polling station sanitized the polling booth and the polling instruments with sanitizing tissue, every time a voter finishes voting

COVID-19 Precautions

- Voting observers kept two meters or more away from voting when observing.

- Only the designated polling station staff, quarantined voter and observers were allowed to enter the temporary polling booth and refrained from dialogue as much as possible.

4. Human Resources and Facility Management

A) Securing Human Resources and Training

Securing Human Resources for Voting and Counting Management and Training

- In the case that a voting on counting staff could not perform their duties because they were infected with COVID-19 or came into close contact with an infected patient, the election commission secured reserve personnel from among staff from public institutions or schools or individuals considered fair and neutral.[16]

- Operated various kinds of training on a limited scale including using video conferencing systems, training material or videos, staff visiting the local election commission or visiting trainees. If training was held, hygiene rules such as using temperature checks, using hand sanitizer and wearing of masks were upheld.

Step-by-Step Procedures for Cases of Election Commission Staff being Isolated

Step One: If less than 50% of the employees of an election commission office were quarantined and their legally-required work could be handled by existing personnel, work was adjusted.

Step Two: If 50% or more of the employees of an election commission office were unable to carry out their legally-required duties due to being quarantined or for any other reason, the Si/Do[17] office carried out the tasks directly or provided support from a nearby commission.

Step Three: If it was deemed that it was difficult for a nearby commission or the Si/Do commission to carry out the legally-required duties, the NEC provided human resources.

---

[16] NEC secures preliminary lists from local governments in preparation for retaining essential personnel such as polling station managers.

[17] The NEC has a 4 tier structure. The NEC is at a national level, Si/Do offices at the provincial or metropolitan city level, Gu/Si/Gun offices at the local government level and Eup/Myeon/Dong offices at the most local level.

B) Rules on the Closure of Polling Stations

The closure of any facility related to a case of COVID-19 takes into account the movements of COVID-19 confirmed patients and the length of time they were at the facility. The epidemiological surveyors of each Si/Do determine the facilities, scope, and duration of disinfection required and the decision is made by notifying the local health center where the facility is located

The NEC set the following guidelines related to the closure of polling stations related to COVID-19:

Measures Prepared Regarding the Closure of Early Voting Polling Stations by Time

Closing Polling Stations before Voting

- If an early voting polling station had been disinfected and it was deemed there were no safety issues, the early voting polling station could be used without changing location.

- If it was deemed it was unavoidable to change the location of the early voting polling station, it could have been moved to an alternative location or a temporary facility such as a tent could have been installed on site, for example on a school playground.

Closing Polling Stations during Voting

- The Chairperson of the relevant Gu/Si/Gun election commission had to decide to 'suspend operations at the early voting polling station'

- Voting would have been suspended at the early voting polling station and a notice on the website and at the polling station would be placed guiding voters to other early voting polling stations.

- The polling station manager would have had to immediately block and seal the slot of the ballot box in the presence of voting observers, affix a special seal and transfer the ballot box to the relevant Gu/Si/Gun election commission.

Measures Prepared Regarding the Closure of Election Day Polling Stations by Time

Closing Polling Stations before Voting

- Even if the closure of the facility has not been lifted before the start of voting, if a polling station had been disinfected and it was deemed there were no safety issues, the polling station could be used without changing location.

- If it was deemed as unavoidable to change the location of the polling station, it could have been moved to an alternative location or a temporary facility such as a tent could have been installed on site, for example on a school playground. [18]

Closing Polling Stations during Voting

- Another alternative location for a polling station should have been secured quickly and election equipment such as ballot boxes, marking devices, ballot papers and the voters list would have be transferred in the presence of voting observers and voting would have been restarted.

- If there was no alternative location, a temporary facility such as a tent could have been installed at a nearby vacant spot and voting restarted.

Measures Prepared Regarding the Closure of Election Day Counting Centers by Time

- If a counting center was closed, even if there was an alternative location available it was not possible to change the location of the counting center due to the need to install counting equipment and facilities and due to the supply of materials. [19]

- If the facility was forced to close, the NEC would have secured a place to receive and store ballot boxes transferred from polling stations on election day and once the closure of the facility had been lifted, the counting center would hold counting.

---

[18] If the equipment for the polling station had already been installed, the relevant Gu/Si/Gun election commission would have distributed additional equipment (polling station equipment sets, polling booths etc) to support the setting up of a new polling station.

[19] The NEC asked the facility managers to control access to the facility for the during of the lease period and take precautionary measures in order to avoid a counting center being closed

__Example of an Early Voting Polling Station Closed due to one of the Polling Station Staff Experiencing a High Temperature__

Polling Station Location: Bora-dong early voting polling station (located in Giheung-gu, Yongin-si)

- At midday on April 11 (2nd day of early voting), one of the polling station staff who have checking the identity of voters on April 10 and April 11 morning experienced chills and anxiety and was found to have a high temperature of 39 degrees centigrade after entering the hospital. At 1:20pm, the member of staff visited the Giheung-gu welfare center to test for COVID-19.

- Early voting was suspended. In cooperation with the welfare center, the disinfection of the inside of early voting polling station was completed at 3:30pm.

- Vehicles were provided (five 25-seater vehicles) to take waiting voters to another early voting polling station nearby (Sanggal-dong, Giheung-dong).

- The early voting polling was ventilated, the polling station staff were asked to keep a distance from each other and outside access was regulated

- At the closing of voting at 6pm, the polling station manager closed and sealed the ballot boxes and handed them over to the relevant election commission.

- At 9pm the member of staff from the polling with a high temperature received a 'negative' test result for COVID-19.

5. Management of Counting

Securing Counting Center and Facilities

- Secured counting centers with large open areas, adjusted the counting sections and process to distribute and deploy people more evenly, and maintained a proper distance between sections and counting center staff. [20]

- Maintained a proper distance between counting observers and the counting staff by establishing an observation area using tape and other materials on the floor.

- Checked and used ventilation systems in the facility or installed temporary ventilation systems.

Temperature Checks before Entering Counting Centers

- Designated counting center staff at entrances or outside counting centers (wearing face shields, masks and medical gloves) checked every person related with counting before entering the counting center. [21]

- Anybody with a high temperature was banned from entering the counting center. The person was then asked to return home, and if they needed treatment were guided to visit the welfare center or the treatment center at the nearest relevant organization. [22]

- In the case any of the counting observers transferring with mail ballots were found to have a high temperature or had symptoms at the relevant Gu/Si/Gun election commission, they were guided in the same manner as above.

Wearing Masks and Disinfection

- Counting center staff had to wear a mask inside from when they were guided into a counting center until they had left the counting center.

- Hand sanitizer was placed inside and outside the entrance of the counting center and within the counting center for regular hand sanitizing.

---

[20] Counting station staff seats were 1.5m or more apart, and the seats on both sides were set up at as wide a distance apart as possible.

[21] If a thermal imaging camera was used, it was installed at a location where power to and from the building could be inspected.

[22] If a temporary medical center was operated at the counting center with the cooperation of the relevant public welfare center, guided to visit the temporary medical center.

- Equipment and items were regularly disinfected after use including door handles, election equipment (ballot sorting machine, tabulation machine, envelope opener) and containers.

Maintaining Order at Counting Centers

- Re-checked a person's temperature who was suspected of having a high temperature during the vote counting process and took the same action as if a person had a high temperature on entry if any symptoms developed.

- The commission issued warnings on conduct, but observers or other persons were ordered to leave if they were deemed to be a danger to others' safety, for example if they spoke out loud without a mask on.

COVID-19 Precautions

- Snacks were distributed sequentially and people were asked to refrain from talking whilst eating.

- Frequent instructions were given on conduct for counting center staff through the counting station broadcasting facilities.[23]

- Disinfection tread-plate mats were liberally installed at the entrance of the facility or at the entrance of the counting center.

- Hand sanitizer was placed in suitable locations, including at the entrance of the counting center.

- Requested facility managers to keep the ventilation system, including air conditioners and ventilators, in the counting center facility running continuously.

- Circulated air from outside into the center by opening windows periodically (or at all times) to the extent that it did not interfere with the counting of votes.

- For facilities with no or insufficient ventilation facilities, after checking whether temporary ventilation systems could be installed, then necessary equipment was leased.

---

[23] Messages included 'Wear a mask at all times', 'refrain from unnecessary conversation', 'wash your hands frequently', 'observe at a proper distance'

6. Disinfectant and Disinfecting Polling Stations and Counting Centers

A) Disinfectant

Disinfectant Supplies

Item	Relevant Picture	Location Used	Usage
Masks (disposable-type, medical-type)		Polling Station	Polling station staff, voting observers Person's with symptoms not wearing masks
		Counting Center	Election Commissioners, election commission staff, counting center staff, counting center observers
Hand Sanitizer		Polling Station	Voters
		Counting Center	Counting center staff, counting observers
Contactless Thermometers		Polling Station	Voters
		Counting Center	Counting center staff, counting observers
Disinfection Tissues		Polling Station	Disinfecting polling station equipment, temporary polling booths
		Counting Center	Disinfecting counting center equipment and items
Medical Gloves		Polling Station	Polling station managers, polling station staff
		Counting Center	Counting center staff
Disposable Vinyl Gloves		Polling Station	Voters
Face Shield		Polling Station	Staff checking temperatures, staff designated to temporary polling booths
Type 4 Protective Clothing		Polling Station	Polling station staff designated to temporary polling booths for quarantined voters
Temporary Polling Booth Envelopes		Polling Station	Temporary polling booths for quarantined voting
Tape for Entrances and Exits		Counting Center	Tape for entrance and exits (40m per roll)

Distribution Guidelines for Disinfectant and Supplies

- Masks (Total of 3,000,000)

Category	Distribution Guidelines	Purpose
Election Commissions	• Si/Do: 800 each • Gu/Si/Gun: For the day before election day (varied proportionately to the number of voters) • Eup/Myeon/Dong: For distributing campaign material - according to the number of households: less than 2,500: 10 2,500 - 5,000: 15 5,000 - 7,500: 25 7,500 - 10,000: 30 10,000 - 12,500: 35 12,500 or more: 40	• For operation counting situation room • For people who participated in sending home voting ballot papers, voting management training, and simulation tests for ballot sorting machines • For actual workers including administrators, clerks, and day laborers
Polling Stations	• Two each per polling station staff, 1.5 each per observer • Temporary polling booth*: Number of early voters in the 7th local election × 5% (approx.)	* Reserved amount for temporary polling booth: Only provided in a case where there is a concern about the spread of COVID-19, including for a voter with a high temperature
Counting Centers	• According to the number of voters less than 100,000: 450 100,000 - 200,000: 700 200,000 - 300,000: 1,000 300,000 - 400,000: 1,200 400,000 or more: 1,600	• For election commissioners and staff, counting staff, counting observers, etc.

- Hand sanitizer (286,725 in total)

Category	Distribution Guidelines	Purpose
Election Commissions	• Thirty each Si/Do and Gu/Si/Gun Office	• For training, public service etc.
Polling Stations	• **28 bottles per early voting polling station** - For voters: 12 x two days (Assumed early voting turnout of 23%, assumed amount of use: 4ml per voter) - For polling station staff: two x two days (Assumed amount of use: 50ml per early polling staff or observer) • **12 bottles per election day polling station** - For voters: 10 (Assumed voter turnout of 37% on election day, assumed amount of use: 4ml per voter) - For polling station staff: two (Assumed amount of use: 50ml per polling station staff or observer)	• For voting management
Counting Centers	• **Approximately 35 bottles per counting center on average** - Varied proportionately to the number of counting staff (Assumed amount of use: 50ml per counting center staff or observer)	• For counting management

- Thermometers (20,730 in total)

Category	Distribution Guidelines	Purpose
Election Commissions	• Four each per Si/Do and Gu/Si/Gun	• For training, public service etc.
Polling Stations	• One or two per station - Reusing the ones used at early voting polling stations on election day	• For voting management
Counting Centers	• Reusing the ones distributed to the Gu/Si/Gun offices	• For counting management

- Sanitizing tissues (315,381 packs in total / 75 sheets per pack)

Category	Distribution Guidelines	Purpose
Election Commissions	• Possible adjustment within the total amount of distribution according to Si/Do	• For sanitizing election supplies and equipment
Polling Stations	• Twenty four packs per early voting polling station (Assumed early voter turnout of 23%, one per voter x 0.8 x two days) • Ten packs per polling station (Assumed voter turnout of 37% on election day, one per voter x 0.8)	• For sanitizing polling station supplies and temporary polling booths
Counting Centers	• Approximately eight packs on average - Varied proportionately to the number of counting staff	• For sanitizing counting station supplies and equipment

- Medical gloves (26,350 packs in total / 100 sheets per pack / Sizes S, M, L)

Category	Distribution Guidelines	Purpose
Election Commissions	• Possible adjustment within the total amount of distribution according to Si/Do	• For public service staff
Polling Stations	• ***One hundred per early voting polling station*** [One set of two for early voting polling station managers and staff x two times + reserved amount] • ***Fifty each per election day polling station*** [One set of two for voting polling station managers and staff x two times + reserved amount]	• For polling station managers and staff
Counting Centers	• Approximately 1,000 on average: Varied proportionate to the number of counting staffs (One set per counting staff x two times + reserved amount)	• For counting staff

- Single-use vinyl gloves (1,256,300 packs in total / 50 sheets per pack)

Category	Distribution Guidelines	Purpose
Polling Stations	• Early voting polling stations: Number of early voters per polling station in the 7th local election x two x 1.2 • Election Day Polling stations: Number of voters per polling station in the 7th local election x 40% x two x 1.2	• Provided to the voters

- Face shields (182,840 in total)

Category	Distribution Guidelines	Purpose
Election Commissions	• Twenty each per Si/Do and Gu/Si/Gun	• For counting situation rooms, staff responsible for fever checks, and public service
Polling Stations	• Number of early polling station staff × two days × 0.3 × 1.1 • Number of polling station staff × 0.4 × 1.1	• For polling station staff responsible for fever checks and temporary polling booths (around three)
Counting Centers	• Number of counting center staff x 1.1	• For all the counting staff

- Type 4 protective clothing (14,330 in total)

Category	Distribution Guidelines	Purpose
Polling Stations	• One per polling station	• For temporary polling station staff for quarantined voters

B) Disinfecting Polling Stations and Counting Centers

Disinfection Method

- Disinfection was carried out before and after voting and counting, and after the first day of early voting.

- Disinfection was carried out immediately after polling stations and counting centers were set up, and disinfection of the facility was preferably done six hours before voting or counting began.

- Disinfection was carried out immediately after voting and counting was finished.[24]

- Disinfection was done overnight to minimize the disinfection period

- Sanitization was carried out inside and outside of polling stations and counting centers, on the routes persons used (pathways, etc.) and in bathrooms, lifts etc.

- Used ultrafine particle disperser (ULV) to sterilize floating bacteria inside and outside of polling stations and counting centers, and used an electric compression sprayer to sterilize the bacteria attached to surfaces of the facility, such as the entrance and in lifts.

- Used disinfectants approved by the Ministry of Environment for COVID-19 that allowed the facility to be used for six hours after disinfection.

- After the disinfection of polling stations was completed, no external persons were allowed to enter the polling place until the voting began.

- Used polling stations and counting centers after sufficient ventilation

---

[24] Facilities that needed to be used the next day, such as community centers for senior citizens or schools were disinfected first.

7. General Summary

- The NEC devoted all its efforts to successfully manage the 21st National Assembly elections and prevent the spread of COVID-19 even during the period when the COVID-19 epidemic was spreading around the world.

- The NEC prepared and implemented systematic and specific voting procedures to block and prevent the spread of COVID-19 through close mutual cooperation with related agencies such as the Korea Centers for Disease Control and Prevention and the Ministry of Interior and Safety.

- The NEC put a great deal of effort into minimizing blind spots in the voting rights of citizens by expanding and providing various voting methods, including home voting and special early voting polling stations for confirmed COVID-19 patients receiving treatment in hospitals or other facilities and allowing quarantined voters to cast their ballot after the close of voting on election day.

- In order to effectively inform the general public that they can vote safely because the NEC was disinfecting every part of the voting process and conducting thorough disinfection of polling stations, the NEC published the 'Code of Conduct' for the 21st National Assembly elections and continuously promoted it through press releases and notices.

- In these elections, early voting turnout reached 26.69 percent (around 11.74 million ballots cast), the highest ever early voting turnout since the introduction of the early voting system, and the overall turnout (including the early voting turnout) stood at 62.2 percent (around 29.12 million ballots cast), the highest in 28 years since the 14th National Assembly elections held in 1992.

- Contrary to the prediction that COVID-19 would lower voter turnout, this high turnout was the result of the mature civic consciousness where citizens understood and followed the new procedures even though they were slightly inconvenient, the NEC's thorough and detailed disinfection plans and the huge effort of election officials and staff who put those plans into practice.

Attachments

Attachment One: Code of Conduct for Voters

Attachment Two: Guidelines Sent to Voters

코로나19 관련 안내 및 예방수칙

코로나19 집단·확산방지를 위하여 사전에 투표소를 철저히 소독하였음을 알려드립니다.
또한, 선거인은 아래사항에 대하여 적극 협조하여 주시기 바랍니다.

☑ 마스크 착용하기
☑ 앞사람과 1m 이상 거리 두기
☑ 불필요한 대화 자제하기
☑ 발열 체크 받기
☑ 손 소독 후 비닐장갑 착용하기
☑ 발열 또는 호흡기증상이 있는 경우, 임시기표소에서 투표

1 ☑ 마스크를 착용하여 주시기 바랍니다.
☑ 투표소에 입장하려는 모든 선거인은 투표사무원에게 체온을 확인받으세요.
※ 앞사람과 1m 이상 측정 거리를 유지하고, 불필요한 대화를 자제합니다.

2 ☑ 이때, 발열 또는 호흡기증상이 있는 선거인은 투표사무원의 안내에 따라 임시기표소로 이동합니다.

3 ☑ 투표소 입구 등에 비치된 손소독제로 손 소독을 꼼꼼히 실시한 후 일회용 비닐장갑을 양손에 착용합니다.
☑ 이때, 신분증을 미리 준비하시면 편리합니다.

4 ☑ 투표소로 입장합니다.
※ 본인확인 시에는 투표사무원 안내에 따라 마스크를 벗거나 내려주시기 바랍니다.

5 ☑ 투표를 마친 선거인은 투표소 출구에 비치된 일회용 비닐장갑 처리함에 일회용 비닐장갑을 넣고 퇴소합니다.

아름다운 선거 행복한 대한민국
중앙선거관리위원회 NATIONAL ELECTION COMMISSION

Attachment Three: Guidelines for Staff Conducting Temperature Checks on Helping Voters

For voters with no temperature:	
1. Temperature Check	➢ Say "Please let me check your temperature" (As it is a contactless thermometer, do not make contact and take the temperature on the forehead, wrist or back of the ear) ➢ (If the voter rejects) Explain that the temperature check is in accordance with government guidelines and ask for cooperation
2. Temperature Check Result	➢ Say "There is no problem" ➢ Ask the voters to maintain a distance of at least 1m from the person in front and suggest that the voter prepares their ID in advance for their convenience
3. Hand Sanitizing and Wearing Disposable Vinyl Gloves	➢ Ask the voter to follow the guidelines of the staff and ask the voter to carefully wash their hands and then wear the disposable vinyl gloves.

For voters with a high temperature:	
1. Temperature Check	➢ Say "Please let me check your temperature" (As it is a contactless thermometer, do not make contact and take the temperature on the forehead, wrist or back of the ear)
2. Temperature Check Result	➢ Say "your temperature is over 37.5 degrees, and so I would like to ask for your cooperation in moving to a temporary polling booth for you to vote." ➢ Contact the staff designated to temporary polling booths ➢ Guide the voter to the area the temporary voting booth is set up ➢ (if the voter rejects) Explain the purpose of setting up a temporary polling booth and ask for the voter's cooperation ➢ (if the voter still rejects) Contact the polling station manager ⇨ Polling station manager asks for the voter's cooperation ⇨ If they still reject the polling managers asks voters waiting inside the polling station to wait and allow the voter with a high temperature to vote first ⇨ Disinfect and ventilate the polling booth and equipment used
3. Take Charge of the Voter and Bring in the Polling Station Staff Designated to Temporary Polling Booths	➢ Say "Please wear disposable gloves on both hands after thoroughly disinfecting your hands with the hand sanitizer placed near the temporary polling booth" ➢ Say "Please sit comfortably here and fill out this identity confirmation form." (From then on, follow the 'Temporary Polling Booth Voting Process for Voters with a High Temperature or Symptoms"
4. Provide Information on Welfare Center	➢ Say "Please contact your welfare center on 1339 or (area code) + 120 and ask about your symptoms and follow their advice"

Attachment 4-1 Temporary Polling Booth Voting Procedure
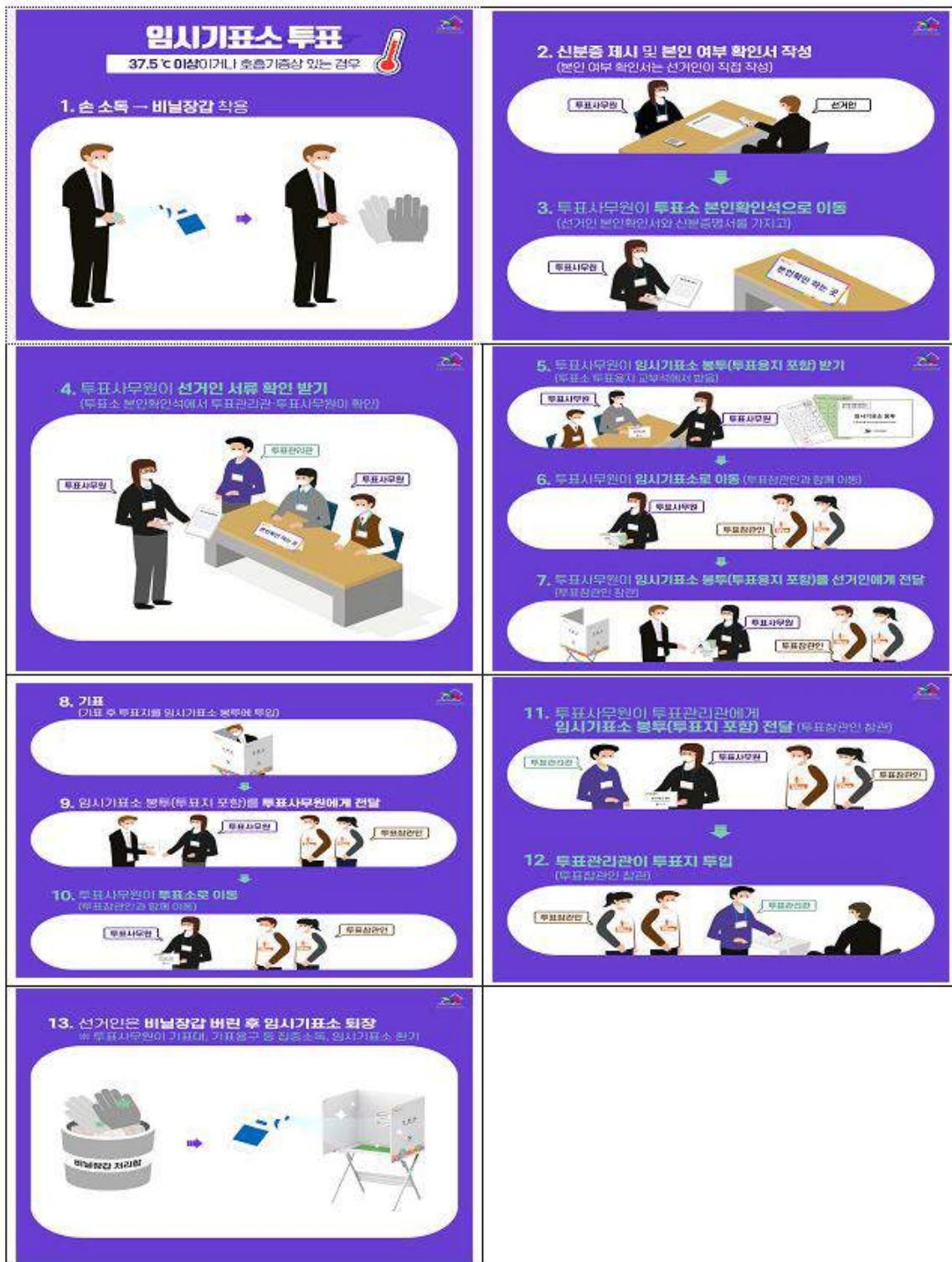
Attachment 4-2 Guidelines for Polling Station Staff Designated to Temporary Polling Booths on Helping Voters

Temporary Polling Station Guidelines	
1. Receive Form of ID (e.g. National ID Card)	➢ Say "Please submit your identity confirmation form and your ID card."
2. Receiving Ballot Papers	➢ Go into the polling station and receive the relevant ballot papers
3. Delivering the Ballot Papers, including the Temporary Polling Booth Envelopes	➢ (Pass the ballots and envelope to the voter) Say "Please vote inside the temporary polling booth and put the ballots inside the temporary polling booth envelope"
4. Take the Ballots (that are inside the envelope) from the Voter	➢ Receive the temporary polling booth envelope with the ballots inside from the voter
5. Transfer the Ballots (that are inside the envelope) to the Polling Station Manager	➢ Hand over the temporary polling booth envelope with the ballot inside to the polling station manager
6. Disinfect the Temporary Polling Booth and Ventilate the Area	➢ Disinfect the temporary polling booth using disinfectant tissues and ventilate the area

Attachment 5 Voting Process for Quarantined Voters

Guidelines for Polling Station Staff Designated to Temporary Polling Booths	
Preparing the Temporary Polling Booths	➢ The polling station staff designated to temporary voting booths should prepare the list of the quarantined voters from the voters list and receive numbered tickets from the polling station ➢ 10 minutes before the end of voting the designated member of polling station staff wears the PPE provided ➢ After all regular voters have cast their ballot, the designated member of polling station staff prepares the voters list, ballot papers and temporary polling booth envelopes and in the presence of voting observers moves them to the temporary polling booth[25]
Begin the Voting	➢ Instruct the quarantined voters to enter the temporary polling booth one by one in the order of their number
ID Check	➢ Check the identity of the quarantined voter and ask them to sign or place their seal on the voters list ➢ Pass the ballot papers and temporary polling booth envelope to the quarantined voter and ask them to enter the temporary polling booth. Then disinfect the pen and any other equipment the quarantined voter came in contact with using disinfectant tissue
Voting	➢ After the quarantined voter has left the temporary polling booth, disinfect the polling booth, marking device and other equipment using disinfectant tissue ➢ After all quarantined voters have finished marking their ballots, take the temporary polling booth envelopes with the ballots inside and the voters list into the polling station in the presence of observers ➢ In the presence of the polling station manager and observers, the ballots should be taken out of the temporary polling booth envelopes and put into the ballot box, being careful not to show the mark on the ballot paper

---

[25] Ballots were pre-prepared according to the number of quarantined voters, with the polling station managing affixing their signature and the serial number on the corner of the ballot cut in advance in the presence of observers.

Guidelines for Quarantined Voters	
Moving to the Polling Station	➢ Move to the waiting area at your polling station before the close of voting (6pm). Wear a face mask and travel by walking, driving alone, accompanied by your designated local government officer or using an emergency vehicle (not allowed to use public transportation) ➢ Follow the directions of the designated member of polling station staff and wait safely to vote. Maintain a gap of 2 meters with others
Begin the Voting	➢ Enter one by one according to the directions given by the designated member of polling station staff. Wear a mask, use the hand sanitizer and wear the disposable gloves
ID Check	➢ Submit your ID to the designated member of polling station staff and after having your identity confirmed, sign or place your seal on the voters list
Voting	➢ After marking the ballots in the temporary polling booth, place the ballots in the temporary polling booth envelope and transfer it to the designated member of polling station staff ➢ Dispose of the vinyl gloves in the box provided at the exit, use the hand sanitizer and leave

Attachment 6 Guidelines for Counting Officials

Counting Center Workers

- Wear a mask and medical gloves to perform counting. If you change or take off the gloves, use hand sanitizer.

- Complete the training for your section before the start of counting and during counting refrain from unnecessary conversations.

- Refrain from personal contact or conversation in the counting center during breaks.

Counting Observers

- Observe from an appropriate distance from the counting center staff and refrain from conversation as much as possible, including by raising your hand when raising an objection.

- If you need to speak to other observers (or other persons on the phone for a long period), conduct those conversations outside the counting center.

- Be careful not to make close contact with counting center staff or other observers when moving around the counting center.

Supporting Staff

- An organization that received a request from the election commission had to recommend a number of people that was not more than the number requested by the election commission.

- Stand at the designated place without taking a seat and conduct tasks in accordance with the election commission's instructions.

Media and Others Watching Counting

- Prohibited from entering the internal section of the counting center and view or report from the designated place.

Attachment 7 Related Data and Statistics

Historical Home Voting Use

Election	Total	Military, Police, Civil Servants	Register Persons Residing in Hospitals and Nursing Homes	Persons with Movement Impediments	Persons on Remote Islands
21st National Assembly Elections	100,529	40,005	29,364	30,326	834
7th Nationwide Simultaneous Local Elections	82,225	30,633	27,331	23,485	776
20th National Assembly Elections	97,354	46,098	31,750	18,648	858

✧ *364 confirmed COVID-19 patients registered as home voters*

Historical Turnout for Early Voting and Election Day

Election	21st National Assembly Elections (April 15, 2020)	7th Nationwide Simultaneous Local Elections (June 13, 2018)	19th Presidential Election (May 9, 2017)	20th National Assembly Elections (April 13, 2016)
Number of Eligible Voters	43,994,247	42,907,715	42,479,710	42,100,398
Number of Early Voting Ballots Cast (Turnout)	11,742,677 (26.69)	8,640,897 (20.14)	11,072,310 (26.06)	5,131,721 (12.19)
Total Number of Ballots Cast (Turnout)	29,126,396 (66.2)	25,832,076 (60.2)	32,807,908 (77.2)	24,430,746 (58.0)

✧ *Home voters and voters casting their ballot outside their registered district during early voting are included in the Total Number of Ballots Cast (Turnout)*

Status of Special Early Voting Polling Stations at Care Centers

Special Early Voting Station	Total	COVID-19 Patients	Medical Staff etc.
Total	446	147	299
Seoul Metropolitan City, Nowon-gu (Gongneung 2-dong)	50	50	0
Gyeonggi Province, Yongin-si, Cheonin-gu	20	9	11
Daegu Metropolitan City, Dong-gu (Ansim 3.4-dong)	148	20	128
North Gyeongsang Province, Gyeongsan-si (Nambu-dong)	29	13	16
North Gyeongsang Province, Gyeongju-si (Bodeok-dong)	70	22	48
North Gyeongsang Province, Gyeongju-si (Yangnam-myeon)	57	24	33
North Gyeongsang Province, Andong-si (Dosan-myeon)	38	7	31
North Gyeongsang Province, Andong-si(Imdong-myeon)	34	2	32

Status of Quarantined Voters

Details	Seoul	Busan	Daegu	Incheon	Gwangju	Daejeon	Ulsan	Sejong
Number of Voters who Register to Vote	4,609	837	474	754	168	288	243	80
Number of Voters who Cast a Ballot	3,640	722	405	637	130	239	184	71
Gyeonggi	**Gangwon**	**North Chung cheong**	**South Chung cheong**	**North Jeolla**	**South Jeolla**	**North Gyeong sang**	**South Gyeong sang**	**Jeju**
4,322	228	234	352	181	117	326	466	110
3,415	192	186	318	158	97	275	393	89

✧ *11,151 cast their ballot out of the 13,789 voters who registered (turnout 80.9%)*

✧ *Total number of 59,918 were in quarantine (as of April 15)*

Predictive Monitoring of COVID-19

Jianxi Luo
Data-Driven Innovation Lab
Singapore University of Technology and Design

Updated on May 14, 2020

Abstract

During the current COVID-19 pandemic, there have been many efforts to forecast the infection cases, deaths and other medical indicators, with a variety of statistical or epidemiological models. Some forecasting projects have influenced policies in some countries. However, the prediction of the COVID-19 pandemic as a "wicked problem" is uncertain by nature. The uncertainty is rooted in the many unknown unknowns about the contagious virus itself and the complexity, heterogeneity and dynamism of human behaviours, government interventions and testing protocols. The wicked and uncertain nature of this pandemic makes the intent for prediction accuracy misleading. Herein, we propose to be cautious about the intent for "accurate" predictions or models, but instead, to explore the potentials of "<u>predictive monitoring</u>" with the aim to capture and make sense of the changes in theoretical predictions for meaningful signals of the uncertainty and changes in the real-world scenarios. Such signals from predictive monitoring are expected to make the planning, behaviours and mentality at the present time more "future-informed" and possibly initiate and guide pre-cautionary actions now to shape the real future.

Introduction

Since the outbreak of COVID-19 in January 2020, researchers around the world have adopted or developed various data-driven models to predict or forecast the next developments and trends of COVID-19 in different countries or regions. Noticeable efforts include the continually updated forecasts by Institute of Health Metrics and Evaluation (IHME) at University of Washington [1] and MRC Centre for Global Infectious Disease Analysis at Imperial College London [2], among others. Table 1 is a list of publicly accessible COVID-19 forecasting programs. Some forecasts focus on future deaths and hospitality needs [3,4,5] and infection cases and peaks [6,7,8], while others focus on the impact of social distancing, travel restrictions, and mitigation and suppression strategies [7,9,10].

Table 1. Public COVID-19 forecasting initiatives around the world, as of May 11, 2020

Organization	URL	Methods
Imperial College London	https://www.imperial.ac.uk/mrc-global-infectious-disease-analysis/covid-19/	Mechanistic transmission models
University of Geneva, ETH Zürich & EPFL	https://renkulab.shinyapps.io/COVID-19-Epidemic-Forecasting/	Statistical models
Massachusetts Institute of Technology	https://www.covidanalytics.io/projections	Modified SEIR model
Los Alamos National Laboratories	https://covid-19.bsvgateway.org/	Statistical dynamical growth model
The University of Washington, Seattle	https://covid19.healthdata.org/projections	Statistical model

The University of Texas, Austin	https://covid-19.tacc.utexas.edu/projections/	Statistical model
Northeastern University	https://covid19.gleamproject.org/	Spatial epidemic model
University of California, Los Angeles	https://covid19.uclaml.org/	Modified SEIR model

Some published studies attempted to validate the accuracy of specific prediction methods [3,4,5,6]. However, even the most cited forecasting method from the IHME has been found with model design issues [5,11] and that for 70 percent of time the actual death numbers fell outside its next-day predictions' 95 percent confidence intervals [12]. The IHME team later revised the model [4] but the prediction errors remain high. In any case, researchers are learning and improving the methods and tools on the go in order to make more and more accurate predictions on the next developments of the COVID-19 pandemic [12]. Despite the intrinsic complexity and uncertainty of COVID-19 predictions, some efforts have influenced policies or informed policy makers in some ways [13, 14].

The uncertainty that we face for work and life planning during the COVID-19 pandemic makes data-driven predictions desirable. However, it is also naturally difficult to do the predictions well. The fundamental challenge is rooted in the nature of the COVID-19 pandemic as a classic "wicked problem", formulated by Horst Rittel and Melvin Webber [15] almost 50 years ago. The wicked problems are those novel, unique, complex and evolving problems with incomplete, contradictory, and changing requirements that are often difficult to recognize. Some of the characteristics of wicked problems are below:
- Often strongly associated with moral, political, economic and professional issues;
- Involve sets of complex and interacting issues, evolving in a dynamic social context;
- Cannot be solved with traditional analytical approaches;
- Involve stakeholders with different views to understand and treat the problem;
- Have no solution that can be objectively tested or evaluated as being correct or wrong;
- It makes no sense to talk about "optimal" solutions;
- Every attempt to solve a wicked problem is a "one-shot operation";
- The effort to solve one aspect of a wicked problem may create other problems.

Wicked problems contrast with a "tame problem", which has stable agreements and requirements and can be solved by choosing and applying the correct methods. The COVID-19 pandemic is clearly wicked and naturally unpredictable in a general sense. However, this does not mean objective analyses and predictions based on science and data are totally useless. It is just that the traditional mindset for optimality and accuracy in modelling and predictions should be avoided in this context. For example, in some of the COVID-19 forecasting efforts [3,4,5,11,12], there exist obvious intents or goals to optimize the prediction models based on margins of errors, confidence intervals, hold-out sample testing, and other standard statistic techniques. Without a definitive correct answer, talking about errors and confidence intervals makes no sense and might create "false sense of certainty". Furthermore, when real-world scenarios in terms of government interventions and human behaviours are dynamically changing, it would be simply naïve and probably wrong to evaluate the accuracy of a model trained with data from a past scenario in terms of how accurately it hits the "facts" in a later and different scenario.

Instead, the wickedness of COVID-19 demands an experimental mindset, heuristic approach, and creative strategy to derive data-driven insights. Here, we experiment a heuristic approach, namely "predictive monitoring", to address the wickedness of the context and make use and sense of the untestable data-driven predictions to understand uncertainty and capture changes, instead of certainty or accuracy. Predictive monitoring means the monitoring of the changing predictions continually updated with the latest data, jointly with the monitoring of the actual history developed to date. The fundamental assumption for predictive monitoring is that real-world scenarios are changing and thus predictions on the same variable should also change over time rather than staying fixed. Here, changes in updated predictions are not viewed as errors or inaccuracy, but valuable signals of the changes in the present real-world scenarios which are often difficult to recognize. Moreover, with acknowledging the complexity of the reality, abstractness of the model and the limitation of data, we focus predictive monitoring on patterns, such as the shape of the pandemic life cycle curve, and theoretical future events, such as the ending of the pandemic, instead of exact numbers of infection cases.

Therefore, predictive monitoring differs fundamentally from the common forecasting practices that attempt to make a prediction now that can be accurate about the future. Traditional prediction practices subconsciously view the future as fixed and are done like weather forecasts where the future weather cannot be changed by the humans as stakeholders. However, the future of COVID-19 is not fixed and can be changed by human behaviours and government interventions. Predictive monitoring is aimed to detect such changes and understand the evolution as it evolves. In addition, predictive monitoring also differs from the common monitoring of actual past cases of infection, recovery and death, which may stimulate reactive and responsive actions. By contrast, predictive monitoring may inform, initiate and guide future-informed planning, policies and actions to shape the real future. Table 2 presents a taxonomy that explicates the differences of predictive monitoring from traditional prediction and monitoring.

Table 2. The taxonomy for predictive monitoring, traditional prediction, and monitoring

		What Value Does It Deliver?	
		Future-Informed	Past-Informed
When Is It Suitable?	Wicked Problem	*Predictive Monitoring*	*Monitoring*
	Tame Problem	*Prediction*	

The Predictive Monitoring Experiment

- Theory

We experimented predictive monitoring in the realistic context of the on-going COVID-19, in order to explore its potentials and develop guidelines and strategies for the right use of it.

To run the experiment, the first is to choose a prediction model and data source, before we can update and monitor the predictions with daily new data coming in over time. The propagation of infectious diseases often follows a life cycle pattern, from the outbreak to the acceleration phase, inflection point, deacceleration phase and eventual ending. Such a life cycle is the result of the infection process, property of the virus, the nature of a population and the adaptive and countering behaviours of agents including individuals (avoiding physical contact) and governments (locking down cities) in the population. However, the pandemic life cycles vary by countries (or regional populations), and different countries might be in different phases of the life cycles at a same point in time.

For instance, on April 21, in Singapore, Prime Minister Hsien-Loong Lee announced the extension of circuit breaker to June 1 in response to the spikes of COVID-19 cases. On the same day, Prime Minister Giuseppe Conte announced the plan to reopen businesses in Italy from May 4. Ideally speaking, such decisions and planning would be rationalized by well knowing where our own country is in its own pandemic life cycle, when the turning point is coming if it has yet come, and when the pandemic will end. Adjustments may be made according to the changes in the estimations and predictions on these fronts. The basis for such actionable estimation is the pandemic's overall life cycle.

- Model

The pandemic life cycle pattern is expected to appear as a S-shape curve when one plots the accumulative count of infection cases over time or equivalently as a "bell-shape" curve of the daily counts over time (see examples in Figure 1). Note that the bell here is not expected to be symmetrical with no expectation of a normal or Gaussian distribution, but a skewed long tail to the right. Such patterns as well as the underlying dynamics have been well studied in various domains including population growth, diffusion of new technologies in the society and infectious diseases, and have theoretically established mathematical models, such as the logistic model that describes a general life cycle phenomenon and the SIR (susceptible-infected-recovered) model [16,17,18] that describes the dynamic epidemic process of the spread of infectious diseases.
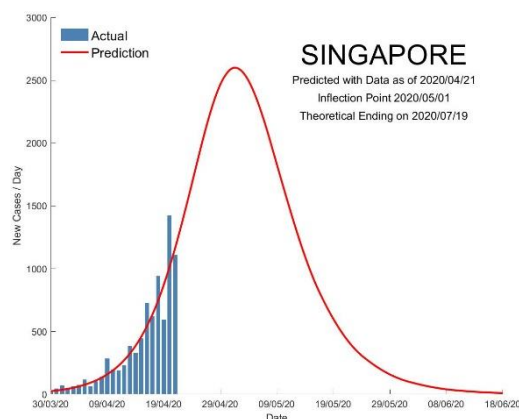
| A) Singapore as of April 21 | B) Singapore as of April 28 |
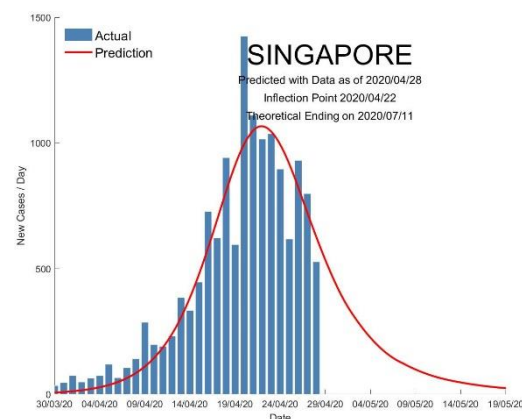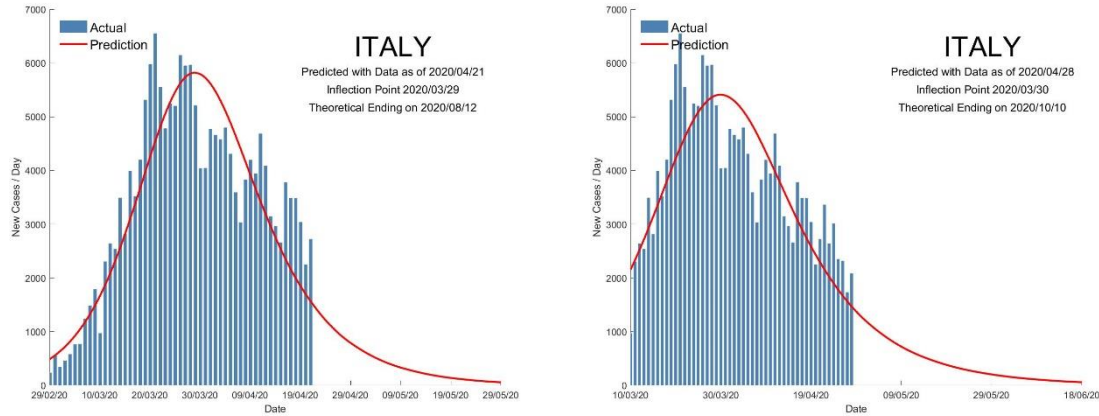
C) Italy as of April 21   D) Italy as of April 28

Figure 1. Continuous Data-Driven Estimations of COVID-19 Life Cycle, Turning and Ending Dates for Singapore and Italy as of April 21 versus April 28, 2020

The SIR model is employed in this experiment for a few reasons. One, it is context-specific and models the dynamic process of inflections in a population over time. Second, it requires simple data inputs that are publicly available. Third, there are open source computer codes available for quick adoption. Here we will not repeat the details of the SIR model in this paper, which can be easily found in many mathematics textbooks. Essentially, the SIR model use three ordinary differential equations to describe the dynamic flows of people between three compartments of a population: S for the number of susceptible people, I for the number of infectious people, and R for the number of removed people (either recovered, died or immured). The SIR model incorporates two main parameters, beta and gamma. Gamma is the number of days one is contagious and a property of the virus. Beta is the average number of people infected by a previously infected person and is related to not only the interaction patterns of people in the society (which social distancing can influence) but also the infection process property of the virus.

- Implementation

The values of these two parameters determine the shape of an infectious disease's specific life cycle curve for a population. In particular, the model, which is a system of three differential equations for S, I and R in its original form, can be reduced to one function about the total infection count, or equivalently the daily new infection counts. This key variable is the sum of I and R and has publicly available data reported by official channels every day. Please refer to the paper [19] by Milan Batista for the model reduction. Therefore, only the data of the daily new infection cases over time (which can be used to derive the accumulative counts, alternatively) are required to regress the key parameters and other constants and thus train a model to derive the overall pandemic life cycle curve.

Batista also developed open-source computer codes to implement the regression [20]. In our experiments, we applied the codes of Batista to the data of daily new COVID-19 cases for each country from "Our World in Data" [21] to regress the parameters and constants of the original SIR model. Note that, more sophisticated derivative versions of the SIR model with more compartments, such as the SEIR model, have also been used in COVID-19 forecasting (such as ref. [6] and several listed in Table 1), but additional increased equations

5

and parameters also require more sophisticated data inputs or parameter estimates. Regressions are run for individual countries and updated daily with the newest infection case count data becoming available daily. Not the data for all countries can produce statistically meaningful regression results. Only the countries with satisfactory goodness-of-fit between model and data as measured by R^2 greater than 0.8 are accepted, analysed and reported. For these countries, the regressed model for each of them is used to estimate the full pandemic life cycle and plot the life cycle curve.

Makes Sense of Prediction Changes via Monitoring

- Monitor Predictions and Actual Data Together

As shown in the examples in Figure 1, the initial segment of the curve is fitted with the data to date and the remaining segment of the curve is "predicted". With the estimated full life cycle curve, one can easily observe which phase of the pandemic life cycle a specific country is in (with actual data plotted together), when the inflection point (the peak in the bell-shape curve) is coming (for the interests of the countries still in the accelerating phase), and when the pandemic will end (for the interests of all countries). Our predictive monitoring is focused on such high-level transitioning characteristics of the pandemic's total life cycle [7], instead of the specific numbers of accumulative or daily cases on a specific day, which the traditional forecasting efforts ([3,4,5] and some others in Table 1) try to predict with confidence.

The inflection point of the pandemic life cycle curve is specific and appears as the peak in the bell-shape curve. However, estimating the "ending date" is not straight-forward and may be done differently for different considerations. Most theoretically, one can define the pandemic's end date as the day with the last infection case of the pandemic, and thus operationalize the estimation of the end date as the day with the last predicted infection at the right most end of the estimated pandemic life cycle curve. Alternatively, one may consider an earlier date when predominately most predicted infections have been actualized, e.g., the case of Australia as of May. The total predicted epidemic population size is the area under the entire curve. So, one can monitor the predicted date to reach 99% of the total expected cases, or the predicted date to reach 97% of the total expected cases. For flexibility, one may also simply exploit the estimated life cycle curve, especially its right most tail segment, to screen and sense when the pandemic gradually vanishes to which extent.

It is noteworthy that the bell-shape curve (of daily cases, instead of the S-shape of accumulative cases) is chosen to visualize the life cycle because it allows easy detection of the inflection point as the peak of the curve to distinguish countries in acceleration and deacceleration phases. For instance, Figure 1A visually reveals on April 21 Singapore was still in its acceleration phase, whereas Figure 1C shows Italy has passed its inflection point. At the time, the estimated "future" turning date (i.e., the inflection point of the curve) for Singapore would be May 1. However, as shown in Figure 1B, on April 28, Singapore has already past its inflection point based on the updated curve with newer data from April 21 to 28, earlier than the turning date predicted on 21 April (in Figure 1A). In contrast, from April 21 (Figure 1C) to April 28 (Figure 1D), the updated curve of Italy is extended more toward the right and points to later theoretical ending dates.

- Capture Changes

These changes are discovered through predictive monitoring of the actual developments and estimations together holistically. We continually monitor the predictions, not hoping the previous predictions to be true or accurate later when the real "future" comes, but for detecting the changes of the predictions over time. From a traditional perspective, the difference between a future prediction and a previous one for the same variable would be considered a bad thing and a proof of error or failure of the prediction model [11,12]. Instead, here we tend to make sense of such changes from the earlier to later predictions for meaningful signals as to what are happening in the dynamically changing real-world scenarios, based on the fundamental assumption that predictions made over time should be different when the real-world scenarios are changing. For wicked problems, such changes are often difficult to recognize, but are detectable via predictive monitoring.

For example, the changed predictions of the inflection dates and theoretical ending dates of Singapore in the last week of April (see Figure 1A and 1B) may reveal the effects of the strengthened control measures of the government and more cautions of the local citizen from Prime Minister's announcement of circuit breaker extension on 21 April. However, the later updated estimations of Singapore became unstable and gave a prolonged pandemic life cycle. Please see Figure 2A for Singapore's curve estimated on May 8 and Figure 3 for the volatility of the predictions for Singapore among other countries. While the estimated pandemic curves of Singapore shifted obviously from April 28 to May 8, the curves of Italy estimated on these two dates are almost the same (Figure 1D and Figure 2B). In any case, it would be wrong to expect the curve estimated with data from the previous scenario to represent the curve for a later scenario. Instead, the curves should be continually re-estimated with the latest data, the predictions based on these curves should be continually monitored, and the changes in the predictions may reveal changes in real-world scenarios over time. Monitoring and detecting such changes in the predictions provides the main value of predictive monitoring.
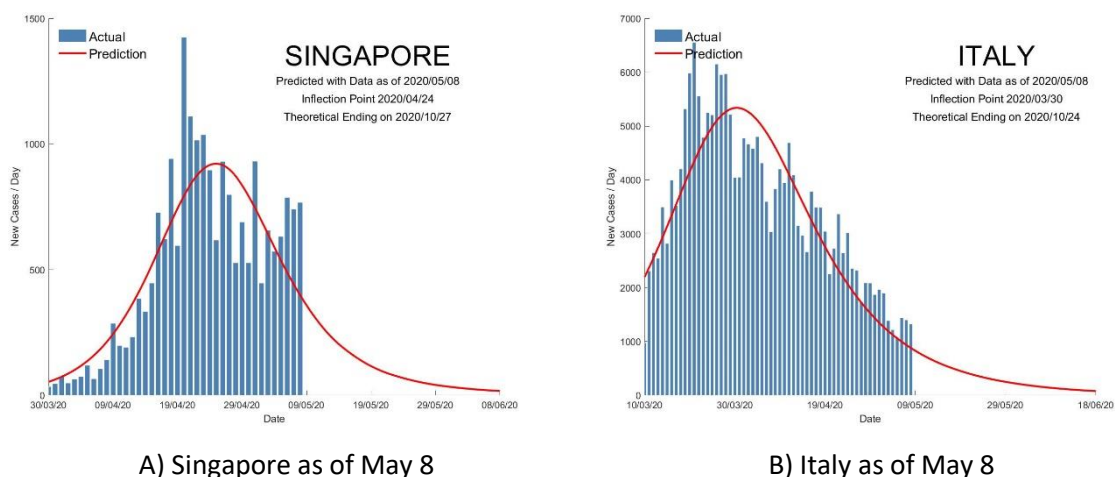

A) Singapore as of May 8   B) Italy as of May 8
Figure 2. Continuous Data-Driven Estimations of COVID-19 Life Cycle, Turning and Ending Dates for Singapore and Italy as of May 8, 2020

7

In other words, our default expectation in predictive monitoring is that predictions will change, especially when the real-world scenarios, such as government policies, testing protocols and human behaviours, are also rapidly changing. In such cases, it would be unreasonable to expect the model trained with data as of today to be true for a different scenario later. It would be unreasonable to test the accuracy of a model trained with earlier data with later data. When considering the dynamics of human behaviours and government policies and other real-world scenarios that are also in the loop and the mathematical model and training data cannot fully represent, predictive monitoring is more meaningful and valuable than the traditional exercises of making a prediction now to see if it is a hit or miss in the future.

- Sense Uncertainty

The changes in the predicted theoretical future events, such as the theoretical ending dates, may also allow us to sense or measure the uncertainty rooted from the real-world scenarios on the ground. For instance, we may examine the standard deviations of the N latest and connectively predicted theoretical end dates as an indicator of uncertainty. Standard deviation measures the dispersion of values. Such a measure is often called "volatility" in finance when used to evaluate the uncertainty associated with stock prices. If the volatility of the connective predictions of theoretical ending dates is small (regardless of their accuracy), it indicates the present real-world scenarios are not changing. High volatility of connective predictions indicate radical changes in the real-world scenarios might be taking place presently on the ground. Figure 3 reports the past 5-day volatilities of the theoretical ending date estimates of some major countries with model-data (of daily new cases) fits $R^2 > 0.8$, throughout the period of examination.
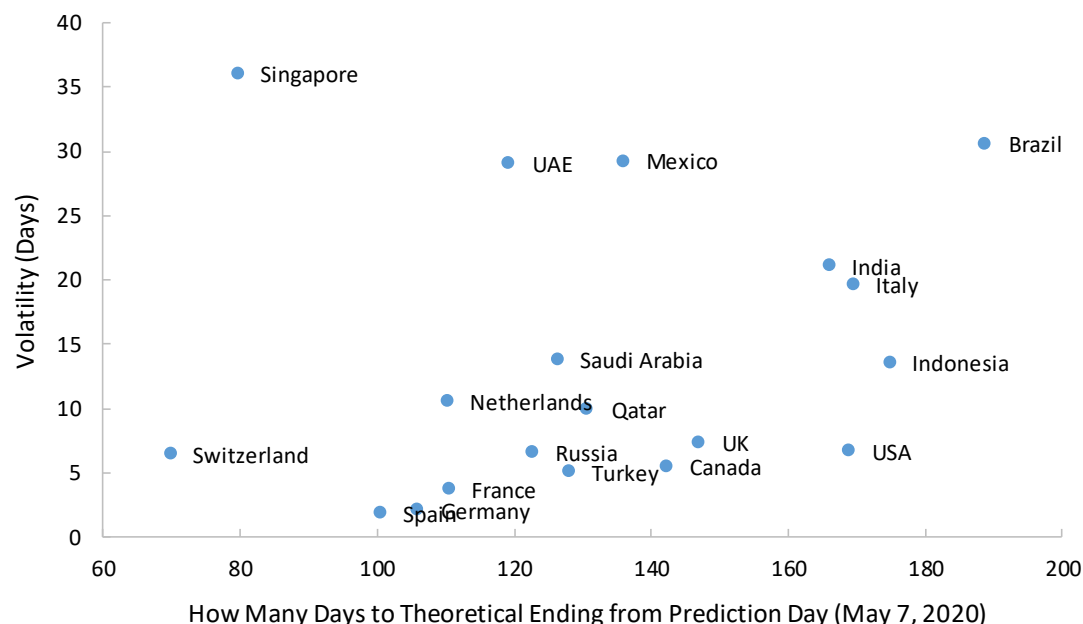
Figure 3. Prediction Volatility against Length of Time to Predicted Ending Dates

Some dots in Figure 3 are noteworthy. There appears a general correlation between the ending and volatility across countries, and also exist outliers, such as Singapore with a relatively close ending date but extremely high volatility, indicting uncertainty in the real-world scenarios, which might be related to the changing testing protocols in the contained

8

in dormitories of foreign workers. Also, Brazil stands out with a very far ending date and high volatility, indicating an both undesirable and uncertain real-world scenario on the ground in Brazil now and demanding cautionary actions. Figure 4A plots the estimated curves of Brazil, showing radical changes, in a week. By contrast, for the USA, its rather stable predictions all suggest a long time to reach its theoretical ending of the pandemic. Figure 4B plots the estimated curves of USA for a week together, showing a high stability, while one might still want additional policies or actions to further shorten the tails of the curves. Switzerland presents a desirable case with the closest ending date and low volatility.
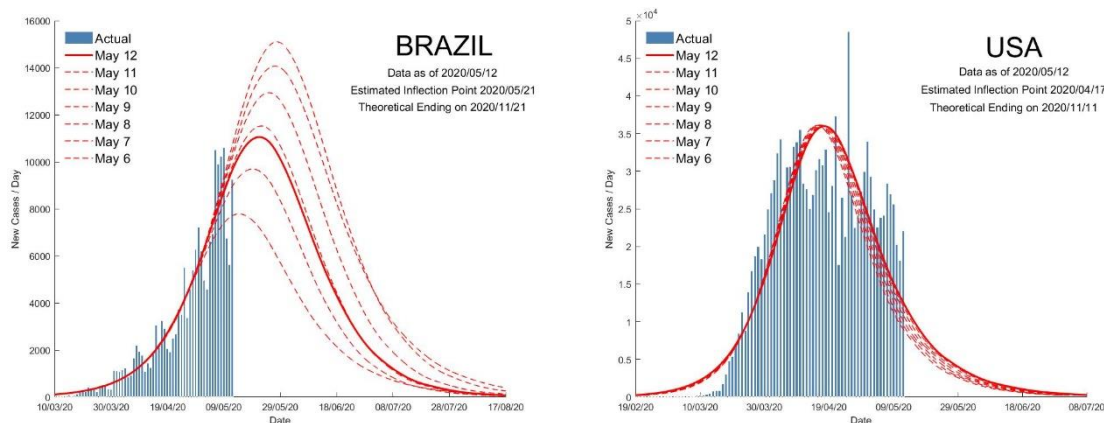
Figure 4. Predictive Monitoring of Estimated Pandemic Life Cycle Curves of Brazil and United States from May 6 to 12, 2020

Here, we have purposefully avoided such metrics as "margin of errors" and "confidence intervals", because our assumption is the pandemic's real-world scenarios are uncertain and evolving by nature and thus there is no target value to define an "error". In contrast, the confidence intervals are called "uncertainty bands" in some of the ongoing COVID-19 forecasts [3,5,12]. Such a calling might be theoretically questionable and cause "false sense of certainty". The COVID-19 pandemic has so many unknown unknowns, which results in extreme uncertainty. The concept of unknown unknowns was plausibly attributed to NASA and popularized by Donald Rumsfeld, United States Secretary of Defense at the time, in a press conference in 2002.

> "There are known knowns. There are things we know that we know. There are known unknowns. That is to say, there are things that we now know we don't know. But there are also <u>unknown unknowns. There are things we do not know we don't know."</u>

In the case of the COVID-19, there are many things we do not know we do not know. Such uncertainty from the unknown unknowns is not quantifiable. Only the "known unknowns" are quantifiable and are often called "risk". Most of the "uncertainty quantification" metrics in the literature are in fact risk measures. For COVID-19 predictions, it is also a question whether the risk measures, such as "margin of errors" and "confidence intervals with 95% accuracy", are suitable, because there exist no fixed target or fact in the wicked context. Risk measurement is only suitable when we "know" there is a definitive target but just "do not know" to what extent our solution might hit the target, i.e., known unknowns.

In sum, the foregoing sections are aimed to explicate the values and potentials of predictive monitoring to proactively address uncertainty and changes in the wicked context of the COVID-19 pandemic. We show with case examples how predictive monitoring may help

capture changes and sense uncertainty in the present real-world scenarios, despite the assumed inaccuracy of individual predictions.

Discussion

Predictive monitoring for each country should be read and interpreted together with what are happening in the real world, especially government intervention policy changes. For instance, Singapore government's strengthened restrictions in April may have bended its curve earlier than the previously predicted ones, and the early relaxation of social distancing and lockdown in Italy and Germany might increase infection rates and thus delay the pandemic ending as predicted earlier. Also, the predictive monitoring of a country should not be read in isolation, but together with the predictions and real time situations of other countries. No country is in isolation in the global pandemic.

For example, while the predictive monitoring in early May 2020 shows the pandemic life cycle curve has "theoretically" ended (despite a small number of domestic cases reported daily) in China, South Korea and Australia, it also shows many other countries (such as Brazil, USA) and the world as a whole will still suffer till the end of 2020 if we remain in our present trajectories of government policies and individual behaviours and without medical cures and vaccines for COVID-19. Therefore, the governments of China, South Korea and Australia may not want to open their international ports so soon and lift the domestic restrictions completely, until the pandemic ends in the world as whole. Although it is the time for all of us to isolate and distance physically from each other, to combat the global pandemic also demands more sharing of data, information and knowledge and more close collaboration across disciplines, professions and regions.

For countries that are still early in their own pandemic life cycles (such as Brazil still in the acceleration phase as of May 8), the prediction of the rest of the curve, inflection point and ending dates will be more teasing, but also inherently less relevant to the "real future" to come given that the actual data only cover a smaller and early portion of the total life cycle and many real-world scenarios are expected to evolve. By contrast, for countries that have been approaching ending phases, prediction is less useful whereas monitoring remains crucial. In such cases, the trained model and estimated life cycle curve are more about explaining the history. For those countries, uncertainty still exists. For example, a new epidemic wave might come if the governments and individuals lift controls and disciplines too early, especially when the pandemic is still prevalent in other countries.

Summary

The COVID-19 pandemic is a wicked problem and the predictions for its course of development are meant to be inaccurate. Especially for the countries still in the early and middle phases of their pandemic life cycles, adaptive human behaviours and responsive policy interventions are entering the loop and change the earlier predicted patterns. Here predictive monitoring is proposed to capture the changes down the road, in contrast to traditional predictions aimed for accuracy assuming a fixed future. We still need to continually experiment and explore the heuristics of predictive monitoring for novel and valuable signals of the uncertainty and changes in the evolving real-world scenarios.

In the meantime, readers must take any specific prediction with caution. Over-optimism based on some specific predictions will be dangerous because it may loosen our disciplines and controls and cause the turnaround of the virus and infection. No model and data can accurately nor fully represent the complex, evolving, and heterogeneous realities of the pandemic in different countries. Acknowledging the extreme uncertainty and wicked nature of the ongoing COVID-19 pandemic, what are eventually and fundamentally needed are the robustness, flexibility, resilience, creativity and entrepreneurship of people, organizations and governments, as well as sharing and collaboration across disciplines, professions and regions, to deal with any unpredictable undesirable future scenarios.

References

[1] Institute of Health Metrics and Evaluation (IHME) at University of Washington
https://covid19.healthdata.org/united-states-of-america
[2] MRC Centre for Global Infectious Disease Analysis at the Imperial College. https://mrc-ide.github.io/covid19-short-term-forecasts/index.html
[3] IHME COVID-19 Health Service Utilization Forecasting Team and Christopher JL Murray. "Forecasting COVID-19 impact on hospital bed-days, ICU-days, ventilator-days and deaths by US state in the next 4 months," 2020. MedRxiv
https://doi.org/10.1101/2020.03.27.20043752
[4] IHME COVID-19 health service utilization forecasting team and Christopher JL Murray. "Forecasting the impact of the first wave of the COVID-19 pandemic on hospital demand and deaths for the USA and European Economic Area countries," 2020. MedRxiv
https://doi.org/10.1101/2020.04.21.20074732
[5] Woody S., et al. "Projections for first-wave COVID-19 deaths across the US using social-distancing measures derived from mobile phones," 2020. MedRxiv
https://doi.org/10.1101/2020.04.16.20068163
[6] Yang Z., et al. "Modified SEIR and AI prediction of the epidemics trend of COVID-19 in China under public health interventions." J Thorac Dis, 12(3): 165-174, 2020. DOI: 10.21037/jtd.2020.02.64
[7] Ferguson N.M., et al. "Report 9: Impact of non-pharmaceutical interventions (NPIs) to reduce COVID-19 mortality and healthcare demand. Imperial College London." 16 March 2020. Accessed at www.imperial.ac.uk/media/imperial-college/medicine/mrc-gida/2020-03-16-COVID19-Report-9.pdf.
[8] Petropoulos F., Makridakis S. "Forecasting the novel coronavirus COVID-19," PLoS ONE, 15(3): e0231236, 2020. https://doi.org/10.1371/ journal.pone.0231236
[9] Kissler S,M. et al. "Projecting the transmission dynamics of SARS-CoV-2 through the postpandemic period." Science, 14 April 2020. DOI: 10.1126/science.abb5793
[10] Chinazzi M., et al. "The effect of travel restrictions on the spread of the 2019 novel coronavirus (COVID-19) outbreak." Science, 24 April 2020, 395-400
[11] Jewell N.P., et al. "Caution Warranted: Using the Institute for Health Metrics and Evaluation Model for Predicting the Course of the COVID-19 Pandemic." Ann Intern Med, 14 April 2020. DOI: https://doi.org/10.7326/M20-1565
[12] Marchant R., et al. "Learning as we go: An examination of the statistical accuracy of covid19 daily death count predictions," 2020. DOI:
https://doi.org/10.1101/2020.04.11.20062257

[13] Grey S. and MacAskill A. "Special Report: Johnson listened to his scientists about coronavirus - but they were slow to sound the alarm." Reuters, April 7, 2020. https://reut.rs/2Rk3sa7

[14] Resnick B. "The White House projects 100,000 to 200,000 Covid-19 deaths." Vox, March 31, 2020. https://www.vox.com/science-and-health/2020/3/31/21202188/us-deaths-coronavirus-trump-white-house-presser-modeling-100000

[15] Rittel H.W.J. and Webber M.M. "Dilemmas in a General Theory of Planning." Policy Sciences, 4 (2): 155–169, (1973). doi:10.1007/bf01405730

[16] Hethcote H.W. "The mathematics of infectious diseases." SIAM Review 42, 599–653 (2000).

[17] Smith D. and Moore L. "The SIR Model for Spread of Disease - The Differential Equation Model." Convergence (December 2004)

[18] Newman, M.E.J. "The structure and function of complex networks." SIAM Review, 45, 167-256 (2003)

[19] Batista, M. "Estimation of the final size of the COVID-19 epidemic." 2020. MedRxiv https://doi.org/10.1101/2020.02.16.20023606

[20] Batista, M. fitVirusCOVID19, 2020. MATLAB Central File Exchange. Retrieved on May 1, 2020. https://www.mathworks.com/matlabcentral/fileexchange/74658-fitviruscovid19

[21] Our World in Data https://ourworldindata.org/coronavirus-source-data

Parametric identification and public health measures influence

on the COVID-19 epidemic evolution in Brazil

R.M. Cotta[1,2], C.P. Naveira-Cotta[2], and P. Magal[3]

[1] General Directorate of Nuclear and Technological Development, DGDNTM, Brazilian Navy, Rio de Janeiro, RJ, Brazil

[2] Laboratory of Nano & Microfluidics and Microsystems, LabMEMS, Mechanical Engineering Dept., POLI & COPPE, UFRJ, Federal University of Rio de Janeiro, Brazil

[3] Institut de Mathématiques de Bordeaux, Université de Bordeaux, 351 cours de la libération 33400 Talence, France

[§]Correspondence author. Email: cotta@mecanica.coppe.ufrj.br

ABSTRACT

A SIRU-type epidemic model is employed for the prediction of the COVID-19 epidemy evolution in Brazil, and analyse the influence of public health measures on simulating the control of this infectious disease. Since the reported cases are typically only a fraction of the total number of the symptomatic infectious individuals, the model accounts for both reported and unreported cases. Also, the model allows for a time variable functional form of both the transmission rate and the fraction of asymptomatic infectious that become reported symptomatic individuals, so as to reflect public health interventions, towards its control, along the course of the epidemic evolution. An analytical exponential behaviour for the accumulated reported cases evolution is assumed at the onset of the epidemy, for explicitly estimating initial conditions, while a Bayesian inference approach is adopted for parametric estimations employing the present direct problem model with the data from the known portion of the epidemics evolution, represented by the time series for the reported cases of infected individuals. The direct-inverse problem analysis is then employed with the actual data from China, with the initial phase of the data been employed for the parametric estimation and the remaining data being used for validation of the predictive capability of the proposed approach. The full dataset for China is then employed in another parameter identification, aimed at refining the values for the average times that asymptomatic infectious individuals and that symptomatic individuals remain infectious. Following this validation, the available data on reported cases in Brazil from February 15th till March 29th, 2020, is used for estimating parameters and then predict the epidemy evolution from these initial conditions. As for the China analysis, the data for the reported cases in Brazil from March 30th till April 23rd are reserved for validation of the model. Finally, public health interventions are simulated, aimed at evaluating the effects on the disease spreading, by acting on both the transmission rate and the fraction of the total number of the symptomatic infectious individuals, considering time variable exponential behaviours for these two parameters, usually assumed constant in epidemic evolutions without intervention. It is demonstrated that a combination of actions to affect both parameters can have a more effective result in the control of the epidemy dynamics.

KEYWORDS

Epidemics modelling, SIRU model, Bayesian Inference, MCMC, COVID-19

NOMENCLATURE

$CR(t)$	cumulative number of reported infectious symptomatic cases at time t
$CU(t)$	cumulative number of unreported infectious symptomatic cases at time t
$DR(t)$	daily number of reported infectious symptomatic cases at time t
$f(t)$	time-variable fraction of asymptomatic infectious who become reported symptomatic infectious
f_0	initial fraction of asymptomatic infectious who become reported symptomatic infectious
f_{max}	second value of fraction of asymptomatic infectious who become reported symptomatic infectious
f_{max2}	third value of fraction of asymptomatic infectious who become reported symptomatic infectious
$I(t)$	number of asymptomatic infectious individuals at time t
I_0	asymptomatic infectious individuals at initial time t_0
N	time in days of application of the first public health intervention that changes transmission rate
N_2	time in days of application of the second public health intervention that changes transmission rate
N_f	time in days for application of the first public health intervention that changes the fraction of asymptomatic infectious that become reported symptomatic infectious
N_{f2}	time in days for application of the second public health intervention that changes the fraction of asymptomatic infectious that become reported symptomatic infectious
NP	total number of parameters in estimation algorithm
M	total number of measured data used in the estimation
$R(t)$	number of reported symptomatic infectious individuals at time t
R_0	reported symptomatic infectious individuals at initial time t_0
$\mathbf{P}$	vector of parameters under estimation ($P_1, P_2, ..., P_{NP}$)
$S(t)$	number of individuals susceptible to infection at time t
S_0	number of individuals susceptible to infection at initial time t_0
t	time variable, in days
t_0	beginning date of the epidemic, in days
$U(t)$	number of unreported symptomatic infectious individuals at time t
U_0	unreported symptomatic infectious individuals at initial time t_0
$\mathbf{Y}$	vector of measured data (Y_m at time t_m, m = 1, …, M)

Greek Symbols	
$1/\eta$	average time in days that the symptomatic infectious remain with symptoms
$1/\nu$	average time in days that the asymptomatic infectious remain asymptomatic
ν_1	rate at which asymptomatic infectious become reported symptomatic infectious
ν_2	rate at which asymptomatic infectious become unreported symptomatic infectious
μ	argument of the $\tau(t)$ function
μ_2	argument of the $\tau(t)$ function
μ_f	argument of the $f(t)$ function
μ_{f2}	argument of the $f(t)$ function
$\pi(\mathbf{Y})$	marginal probability density
$\pi(\mathbf{Y}|\mathbf{P})$	likelihood function
$\pi_{posterior}$	posterior probability density
π_{prior}	prior probability density
$\tau(t)$	time-variable transmission rate
τ_0	initial amplitude of the $\tau(t)$ function
χ_1	fitting parameter in the early exponential phase of the epidemic
χ_2	fitting parameter in the early exponential phase of the epidemic
χ_3	fitting parameter in the early exponential phase of the epidemic

INTRODUCTION

A new human coronavirus started spreading in Wuhan, China, by the end of 2019, and turned into a pandemic disease called COVID-19 as declared by the World Health Organization on March 11th, 2020. The affected countries and cities around the world have been reacting in different ways, towards locally controlling the disease evolution. These measures include general isolation through quarantine and massive testing for focused isolation, with varying degrees of success so far, as can be analysed from the limited data available. Naturally, China offers the longest time series on reported infected cases and the resulting effects of combining different public health interventions. As of March 26th, 2020, there were no reports in China of further internal contaminations, and all the new cases are associated with infected individuals that (re)entered in the country. Despite the apparent success of the interventions in China, each region or country might require a specific combination of measures, due to demographic spatial distribution and age structure, health system capabilities, and social-economical characteristics. In this sense, it urges to have a mathematical model that would allow for the simulation of such possible interventions on the epidemic evolution within the following weeks or months. This article presents a collaborative research effort towards the construction of an epidemic evolution prediction tool, which combines direct and inverse problem analysis and is both reliable and easy to implement and execute, initially motivated by offering some insight into the control of COVID-19 within Brazil.

The classical susceptible-infectious-recovered (SIR) model describes the transmission of diseases between susceptible and infective individuals and provides the basic framework for almost all epidemic models. At the onset of the coronavirus epidemy in China, there were some initial studies for the prediction of its evolution and the analysis of the impact of public health measures [1], which however did not consider in the modelling the presence of unreported infectious individuals cases, which are in practice inherent to this process. The present work is first based on the SIRU-type model proposed in [2], which deals with the epidemic outbreak in Wuhan by introducing the unreported cases in the modelling, and evaluating the consequences of public health interventions. It was a direct application of previous developments [3,4] on the fundamental problem of parameter identification in mathematical epidemic models, accounting for unreported cases. This same modelling approach was more recently employed in the analysis of the epidemic outbreak in different countries, including China, South Korea, Germany, Italy,

and France [5-7]. Besides identifying unreported cases, this simple and robust model also allows for introducing a latency period and a time variable transmission rate, which can simulate a public health orientation change such as in a general isolation measure. In addition, an analytical exponential behaviour is assumed for the accumulated reported cases evolution along an initial phase just following the onset of the epidemy, which, upon fitting of the available data, allows for the explicit analytical estimation of the transmission rate and the associated initial conditions required by the model.

Here, the SIRU-type model in [2-7] is implemented for the direct problem formulation of the COVID-19 epidemic evolution, adding a time variable parametrization for the fraction of asymptomatic infectious that become reported symptomatic individuals, a very important parameter in the public health measure associated with massive testing and consequent focused isolation. The same analytical identification procedure is maintained for the required initial conditions, as obtained from the early stage exponential behaviour. However, a Bayesian inference approach is here adopted for parametric estimation, employing the Markov Chain Monte Carlo method with the Metropolis-Hastings sampling algorithm [8-12]. At first, the goal of the inverse problem analysis was estimating the parameters associated with the transmission rate and the fraction of asymptomatic infectious that become reported symptomatic individuals, which can be quite different in the various regions and countries and may also vary according to the public health measures. Then, in light of the success in this parametric identification, an extended estimation was also employed which incorporates the average time the asymptomatic infectious are asymptomatic and the average time the infectious stay in the symptomatic condition, due to the relative uncertainty on these parameters in the literature. The proposed approach was then applied to the data from China, first by taking just the first portion of these data points in the estimation, while using the second portion to validate the model using the estimated parameters with just the first phase of the epidemy evolution, and second by employing the whole time series in the MCMC estimation procedure, thus identifying parameters for the whole evolution period. This second estimation was particularly aimed at refining the data for the average times that asymptomatic infectious individuals and that symptomatic individuals remain infectious. Upon validation of the approach through the data for China, we have proceeded to the analysis of the epidemic dynamics in Brazil, employing about 36 days (February 15th till March 29th) of collected information on reported infected individuals. First, the available data was employed in the parametric estimation, followed by the prediction of the

epidemy evolution in Brazil. For this purpose, the following 20 days (from March 31st to April 19th) were reserved to be used in the validation of the proposed model for the COVID-19 evolution in Brazil. Finally, we have explored the time variation of both the transmission rate and the fraction of asymptomatic infectious that become reported symptomatic individuals, so as to reflect public health interventions, in simulating possible government measures, as described in what follows.

DIRECT PROBLEM

The implemented SIRU-type model [2-7] is given by the following initial value problem:

$$\frac{dS(t)}{dt} = -\tau(t)S(t)[I(t) + U(t)] \tag{1.a}$$

$$\frac{dI(t)}{dt} = \tau(t)S(t)[I(t) + U(t)] - \nu I(t) \tag{1.b}$$

$$\frac{dR(t)}{dt} = \nu_1(t)I(t) - \eta R(t) \tag{1.c}$$

$$\frac{dU(t)}{dt} = \nu_2(t)I(t) - \eta U(t) \tag{1.d}$$

where,

$$\nu_1(t) = \nu f(t); \quad \nu_2(t) = \nu(1 - f(t)) \tag{2.a,b}$$

with initial conditions

$$S(t_0) = S_0; \quad I(t_0) = I_0; \quad R(t_0) = 0; \quad U(t_0) = U_0; \tag{3.a-d}$$

Here, t_0 is the beginning date of the epidemic in days, S(t) is the number of individuals susceptible to infection at time t, I(t) is the number of asymptomatic infectious individuals at time t, R(t) is the number of reported symptomatic infectious individuals (i.e., symptomatic infectious with severe symptoms) at time t, and U(t) is the number of unreported symptomatic infectious individuals (i.e., symptomatic infectious with mild symptoms) at time t. Asymptomatic infectious individuals I(t) are infectious for an average period of $1/\nu$ days. Reported symptomatic individuals R(t) are infectious for an average period of $1/\eta$ days, as are unreported symptomatic individuals U(t). We assume that reported symptomatic infectious individuals R(t) are reported and isolated immediately, and cause no further infections. The asymptomatic individuals I(t) can also

be viewed as having a low-level symptomatic state. All infections are acquired from either I(t) or U(t) individuals. The fraction f(t) of asymptomatic infectious become reported symptomatic infectious, and the fraction 1-f(t) become unreported symptomatic infectious. The rate asymptomatic infectious become reported symptomatic is $v_1(t) = f(t)v$, the rate asymptomatic infectious become unreported symptomatic is $v_2(t) = (1-f(t))\, v$, where $v_1(t) + v_2(t) = v$. The transmission rate, $\tau(t)$, is also allowed to be a time variable function along the evolution process. Figure 1 below illustrates the infection process as a flow chart.
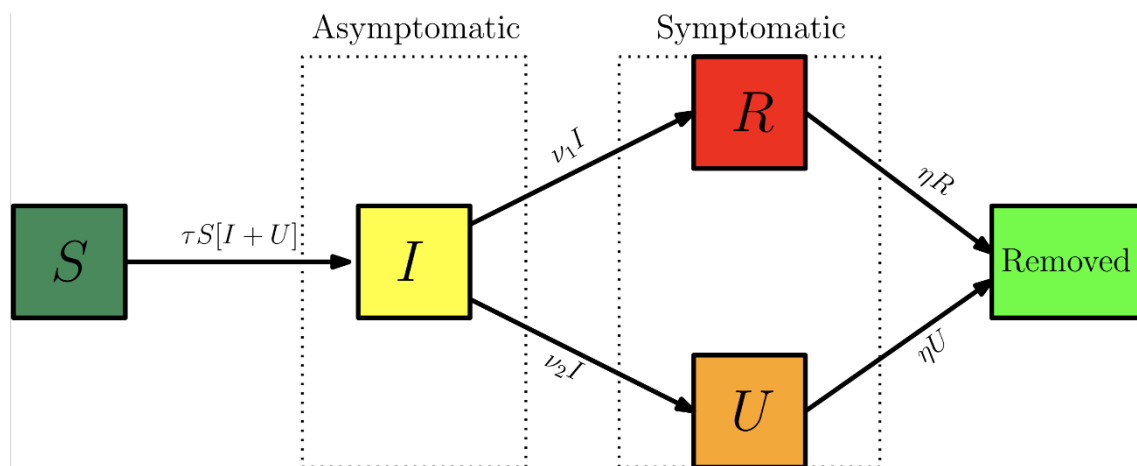
Figure 1 – Flow chart illustrating the infection path process [3].

The time variable coefficients, $\tau(t)$ and f(t), are chosen to be expressed as:

$$\tau(t) = \tau_0 , \qquad 0 \leq t \leq N \tag{4.a}$$

$$\tau(t) = \tau_0 \exp\left(-\mu(t - N)\right), \qquad t > N \tag{4.b}$$

$$f(t) = f_0 , \qquad 0 \leq t \leq N_f \tag{4.c}$$

$$f(t) = (f_{max-}f_0)\left[1 - \exp\left(-\mu_f\left(t - N_f\right)\right)\right] + f_0, \qquad t > N_f \tag{4.d}$$

These parametrized functions are particularly useful in interpreting the effects of public health interventions. For instance, the transmission rate, $\tau(t)$, is particularly affected by a reduced circulation achieved through a general isolation or quarantine measure, while the fraction f(t) of asymptomatic infectious that become reported, thus isolated, cases can be drastically increased by a massive testing measure with focused isolation. In the above relations, μ is the attenuation factor for the transmission rate, N is the time in days for

application of the public health intervention to change transmission rate, μ_f is the argument of the $f(t)$ variation between the limits (f_0, f_{max}). The first time variable function has been previously considered, while the second one has been introduced in the present work, so as to allow for the examination of combined measures.

The cumulative number of reported cases at time t, $CR(t)$, which is the quantity offered by the actual available data, and the a priori unknown cumulative number of unreported cases, $CU(t)$, are given by:

$$CR(t) = \int_{t_0}^{t} v_1(s)I(s)ds \qquad (5.a)$$

$$CU(t) = \int_{t_0}^{t} v_2(s)I(s)ds \qquad (5.b)$$

The daily number of reported cases from the model, $DR(t)$, can be obtained by computing the solution of the following equation:

$$\frac{dDR(t)}{dt} = vf(t)I(t) - DR(t) \qquad (6.a)$$

with initial conditions

$$DR(t_0) = DR_0 \qquad (6.b)$$

INVERSE PROBLEM

Inverse problem analysis is nowadays a common practice in various science and engineering contexts, in which the groups involved with experimental data and numerical simulation collaborate so as to obtain the maximum information from the available data, towards the best possible use of the modelling for the problem under study. Here, as mentioned in the introduction, we first review an analytical parametric identification described in more details in [4-7], that from the initial phases of the epidemic evolution allows to explicitly obtain the unknown initial conditions of the model, while offering a reliable estimate for the transmission rate at the onset of the epidemy. Nevertheless, even after these estimates, a few other parameters in the model remain uncertain, either due to the specific characteristics of the physical conditions or response to the epidemy in each specific region, or due to lack of epidemiological information on the disease itself. Therefore, an inverse problem analysis was undertaken aimed at estimating the main

parameters involved in the model, as summarized in Table 1 below. First, for the dataset on the accumulated reported cases for China, the focus is on the parametrized time variation of the transmission rate (τ_0 and μ) and the fraction of asymptomatic infectious that become reported (f_0), in this case assumed constant, followed by an effort to refine the information on the average times ($1/\nu$ and $1/\eta$) through a simultaneous estimation of the five parameters. Then, employing the dataset for Brazil just up to March 29th, the parametrized time variation of the transmission rate (τ_0 and μ) and the fraction of asymptomatic infectious that become reported $f(t)$, assumed time-variable, are estimated by parametrization of an abrupt variation that requires just the estimation of f_{max} and N_f.

Table 1 – Summary of the estimated parameters on each inverse problem analysis.

China		
Case	**Parameter under estimation**	**Data range used in the Inv. Prob.**
case 1: CH3p	f_0, μ, τ_0	January 19th up to February 17th
case 2: CH5p-full	$f_0, \mu, \tau_0, 1/\nu, 1/\eta$	January 19th up to April 16th
Brazil		
case 3: BR5p	$f_0, \mu, \tau_0, f_{max}, N_f$	February 25th up to March 29th

The statistical inversion approach here implemented falls within the Bayesian statistical framework [8-12], in which (probability distribution) models for the measurements and the unknowns are constructed separately and explicitly, as shall be briefly reviewed in what follows.

As explained in previous works employing this model [4-7], it is assumed that in the early phase of the epidemic, the cumulative number of reported cases grows approximately exponentially, according to the following functional form:

$$CR(t) = \chi_1 \exp(\chi_2 t) - \chi_3, \ t \geq t_0 \qquad (7.\text{a})$$

After fitting this function to the early stages of the epidemic evolution, one may extract the information on the unknown initial conditions, in the form [4-7]:

$$t_0 = \frac{1}{\chi_2} [\ln(\chi_3) - \ln(\chi_1)] \tag{7.b}$$

$$I_0 = \frac{\chi_3 \chi_2}{f_0 \nu} \tag{7.c}$$

$$U_0 = \frac{(1 - f_0)\nu}{\eta + \chi_2} I_0 \tag{7.d}$$

In addition, an excellent estimate for the initial transmission rate can be obtained from the same fitted function, in the form:

$$\tau_0 = \frac{\chi_2 + \nu}{S_0} \frac{\eta + \chi_2}{(1 - f_0)\nu + \eta + \chi_2} \tag{7.e}$$

Also, the basic reproductive number for this initial phase model is estimated as:

$$\mathcal{R}_0 = \frac{\tau_0 S_0}{\nu} [1 + \frac{(1 - f_0)\nu}{\eta}] \tag{7.f}$$

The statistical approach for the solution of inverse problems here adopted employs the Metropolis-Hastings algorithm for the implementation of the Markov chain Monte Carlo (MCMC) method [8-9]. The MCMC method is used in conjunction with the numerical solution of the ordinary differential system, eqs.(1-3), for estimating the remaining model parameters. Consider the vector of parameters appearing in the physical model formulation as:

$$\mathbf{P}^T \equiv [P_1, P_2, ..., P_{NP}] \tag{8}$$

where NP is the number of parameters. For estimating $\mathbf{P}$, we assume that a vector of measured data is available ($\mathbf{Y}$) containing the measurements Y_m at time t_m, $m = 1, \ldots, M$. Bayes' theorem can then be stated as [8-9]:

$$\pi_{posterior}(\mathbf{P}) = \pi(\mathbf{P}|\mathbf{Y}) = \frac{\pi_{prior}(\mathbf{P})\pi(\mathbf{Y}|\mathbf{P})}{\pi(\mathbf{Y})} \tag{9}$$

where $\pi_{posterior}(\mathbf{P})$ is the posterior probability density, that is, the conditional probability of the parameters $\mathbf{P}$ given the measurements $\mathbf{Y}$, $\pi_{prior}(\mathbf{P})$ is the prior density, that is, the coded information about the parameters prior to the measurements, $\pi(\mathbf{Y}|\mathbf{P})$ is the likelihood function, which expresses the likelihood of different measurement outcomes $\mathbf{Y}$ with $\mathbf{P}$ given, and $\pi(\mathbf{Y})$ is the marginal probability density of the measurements, which plays the role of a normalizing constant. If different *prior* probability densities are assumed for the parameters, the posterior probability distribution may not allow an analytical treatment. In this case, Markov chain Monte Carlo (MCMC) methods are used to draw samples of all possible parameters, and thus inference on the posterior probability becomes inference on the samples [8-9]. The main merit of the MCMC method is about providing a picture of the posterior distribution, without solving the mathematical integrals in Bayes' rule. The idea is to approximate the posterior distribution by a large collection of samples of values. This method is especially suitable when it is unfeasible to yield an analytical solvable posterior distribution and/or a large space of parameters is involved, allowing one to do Bayesian inference even in rich and complex models. The idea behind the Metropolis-Hasting sampling algorithm is illustrated below, and these steps should be repeat until it is judged that a sufficiently representative sample has been generated.

1)   Start the chain with an initial value, that usually comes from any prior information that you may have;

2)   Randomly generate a proposed jump aiming that the chain will move around and efficiently explores the region of the parameter space. The proposal distribution can take on many different forms, in this work a Gaussian random walk was employed, implying that the proposed jumps will usually be near the current one;

3)   Compute the probability of moving from the current value to the proposed one. Candidates moving to regions of higher probability will be definitely accepted. Candidates in regions of lower probability can be accepted only probabilistically. If the proposed jump is rejected, the current value is tally again. For more details on theoretical aspects of the Metropolis-Hastings algorithm and MCMC methods and its application, the reader should refer to [8-12].

RESULTS AND DISCUSSION

Model Validation: China

Before proceeding to the analysis of the COVID-19 epidemic evolution within Brazil, which is the major concern in the present contribution, the need was felt in validating the proposed direct-inverse problem analysis approach. In this sense, due to the availability of the largest dataset on this pandemic, we have chosen to use the information from China in terms of the accumulated confirmed infectious cases. The data for China was extracted from [6], complemented by the most recent data from [13] from January 1st up to April 17th, 2020. The exponential fit for the early phase of the China CR(t) dataset provided the estimates of the three parameters, $\chi_1 = 0.14936, \chi_2 = 0.37680, \chi_3 = 1.0$, from which we have estimated $t_0 = 5.046$. The remaining data for the initial conditions, I_0 and U_0, and the early stage transmission rate, τ_0, are in fact recalculated from within the MCMC algorithm, since the changing values of f will affect them, according to eqs. (7.c-e). The average times in the model were taken as $1/\nu$=7 and $1/\eta$=7 days and the isolation measures were taken at N=25 days [6]. First, experimental data from China from the period of January 19th up to February 17th was employed in demonstrating the estimation of three parameters, $f_0, \mu,$ and τ_0, assuming there is no significant time variation in the function $f(t)$ ($\mu_f = 0$). In the absence of more informative priors, uniform distributions were employed for all three parameters under estimation. Table 2 presents the prior information and the initial guesses for the parameters. If the initial guesses were used to predict the CR(t) behavior, an over-estimation of the accumulated reported infected individuals would occur, especially in the long term, as can be noticed in Figure 1, confirming the need for a proper parameter estimation.

The central tendency (mean value) of the posteriors here sampled, after neglecting the first 20,000 burning in states of the chain, are called the estimated values. Both the estimated values and their 99% confidence intervals are presented in Table 3. It should be mentioned that these values are fairly close to those employed in [6], where τ_0 was estimated as 4.51×10^{-8}. Once a value of $f_0 = 0.8$ was assumed, which means that 20% of symptomatic infectious cases go unreported, it led to a good agreement with the data by taking μ=0.139 in [6].

Table 2 – Prior distributions and initial guesses for the parameters to be estimated

$f_0, \mu,$ and τ_0 (Wuhan, China).

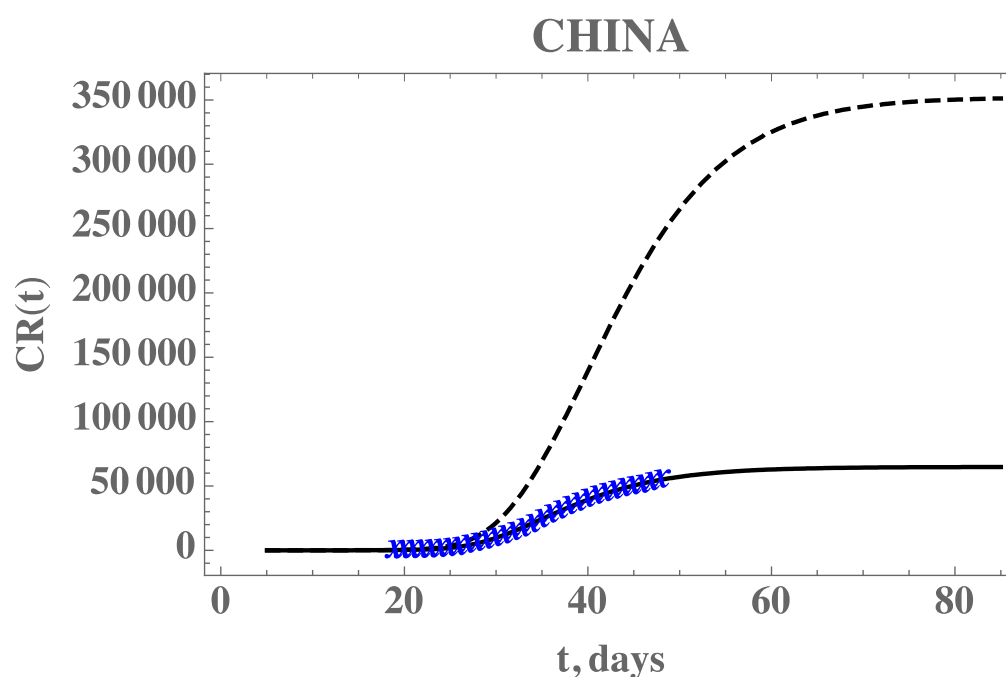| Case 1: CH3p			
Param.	**Prior distribution**	**Initial Guess**	
f	$U[0, 1]$	0.5	estimated
μ	$U[0, 5]$	0.1	estimated
$\tau 0$	$U[0, 1 \times 10^{-6}]$	4.478×10^{-8}	estimated
S_0	11.0x10^6		fixed
t_0	5.04617		fixed
$1/\nu$	7 days		fixed
$1/\eta$	7 days		fixed
N	25		fixed
χ_1	0.14936		fixed
χ_2	0.37680		fixed
χ_3	1.0		fixed

Figure 1 – Comparison of the theoretical model for CR(t) with the initial guesses from
Table 2 (black dashed line), against the model prediction with the estimated values from
Table 3 (solid black line), and actual data from China from January 19th to February 17th
(blue cross) -- Case 1: CH3p

Figure 1 also demonstrates the adherence of the model with the data within this portion of the dataset, once the estimated values in Table 3 are employed in the direct problem solution, as can be seen from the excellent agreement between the estimated CR(t) (solid line) and the experimental data from China (blue stars). The desired model validation is illustrated in Figure 2, confirming the excellent agreement of China's full dataset (period from January 19th till April 16th) with the mathematical model predictions, after adopting the estimated values for the parameters in Table 3. It should be recalled that non-informative priors were adopted for the three parameters, as presented in Table 2, and except for the transmission rate, when eq.(7.e) provides an excellent initial guess, the remaining guesses were completely arbitrary.

Table 3 – Estimated values and 99% confidence intervals for three parameters, $f_0, \mu,$ and τ_0 (Wuhan, China).

Case 1: CH3p		
Parameter	**Estimated values**	**99% confidence interval**
f	0.780719	$[0.77956, 0.7818]$
μ	0.135635	$[0.135219, 1.136153]$
τ_0	4.47793×10^{-8}	$[4.47793 \times 10^{-8}, 4.47793 \times 10^{-8}]$

Although the present estimated parameters have led to a good prediction of the second phase of the China epidemic evolution data, there are still uncertainties associated with the average times here assumed both equal to 7 days, according to [6]. This choice was based on early observations of the infected asymptomatic and symptomatic patients in Wuhan, but more recent studies have been refining the information on the epidemic evolution and the disease itself, such as in [14-17]. For this reason, we have also implemented a statistical inverse analysis with the full dataset of China, but now seeking the estimation of five parameters, so as to simultaneously estimate the average times ($1/\nu$ and $1/\eta$). Both uniform and Gaussian distributions were adopted for the two new parameters, with initial guesses of $1/\nu=7$ days and $1/\eta=7$ days, and N=25 days, as employed in [6]. Table 4 presents the prior information and the initial guesses for the parameters.
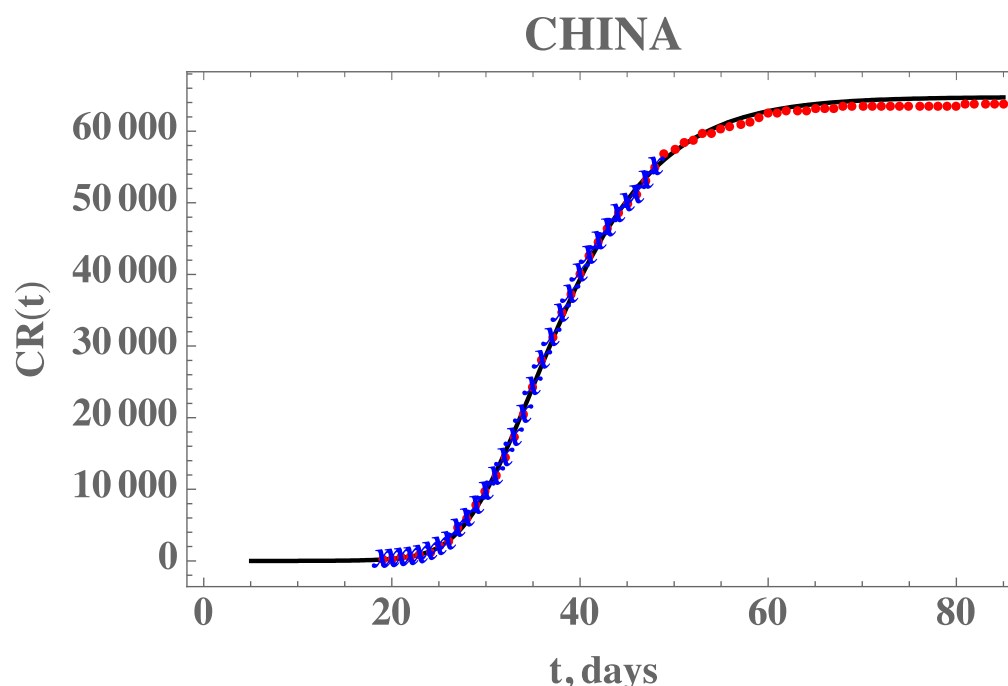
Figure 2 – Comparison of the theoretical model for CR(t) with the three estimated parameter values from Table 3 (solid line), against the dataset for China from January19[th] to February17[th] (blue stars) and from February18[th] to April 16th (red dots) -- Case 1: CH3p

Table 5 provides the estimated values and 99% confidence intervals for all five parameters, with Gaussian priors for the two average times with data obtained from [14,17], after neglecting the first 15,000 burn in states of the chain. The most affected parameter in comparison with the previous estimates is the average time $1/\eta$, which is also the one with widest confidence interval. This behaviour is also evident from the Markov chains for this parameter, now simultaneously estimated. Figure 3 compares the theoretical predictions with the model incorporating the five estimated parameters as in Table 5, against the full CR(t) dataset for China, confirming the improved agreement. The 99% confidence interval bounds for this predicted behavior is lso shown in Fig.3, bounded by the gray lines.

Table 4 – Prior distributions and initial guesses for the 5 parameters to be estimated, $f_0, \mu, \tau_0, 1/\nu$ and $1/\eta$, (Wuhan, China)

Case 2: CH5p			
Param.	**Prior distribution**	**Initial Guess**	
f_0	$U[0,1]$	0.8	estimated
μ	$U[0,5]$	0.131	estimated
$\tau 0$	$U[0, 1 \times 10^{-6}]$	4.4779×10^{-8}	estimated
$1/\nu$	$N[5.2, \sigma = 2.1]$ (Min=1, Max=21)	7	estimated
$1/\eta$	$N[10.4, \sigma = 2.6]$ (Min=1, Max=21)	7	estimated
S_0	11.0×10^6		fixed
t_0	5.04617		fixed
N	25		fixed
χ_1	0.14936		fixed
χ_2	0.37680		fixed
χ_3	1.0		fixed

Table 5 – Estimated values and 99% confidence intervals for five parameters, $f_0, \mu, \tau_0, 1/\nu$ and $1/\eta$ (Wuhan, China).

Case 2: CH5p		
Parameter	**Estimated values**	**99% confidence interval**
f_0	0.718491	$[0.711595, 0.723138]$
μ	0.132032	$[0.131789, 0.13227]$
$\tau 0$	4.47793×10^{-8}	$[4.47793 \times 10^{-8}, 4.47793 \times 10^{-8}]$
$1/\nu$	6.20798	$[6.12574, 6.25764]$
$1/\eta$	11.2784	$[10.4379, 12.3593]$

CHINA
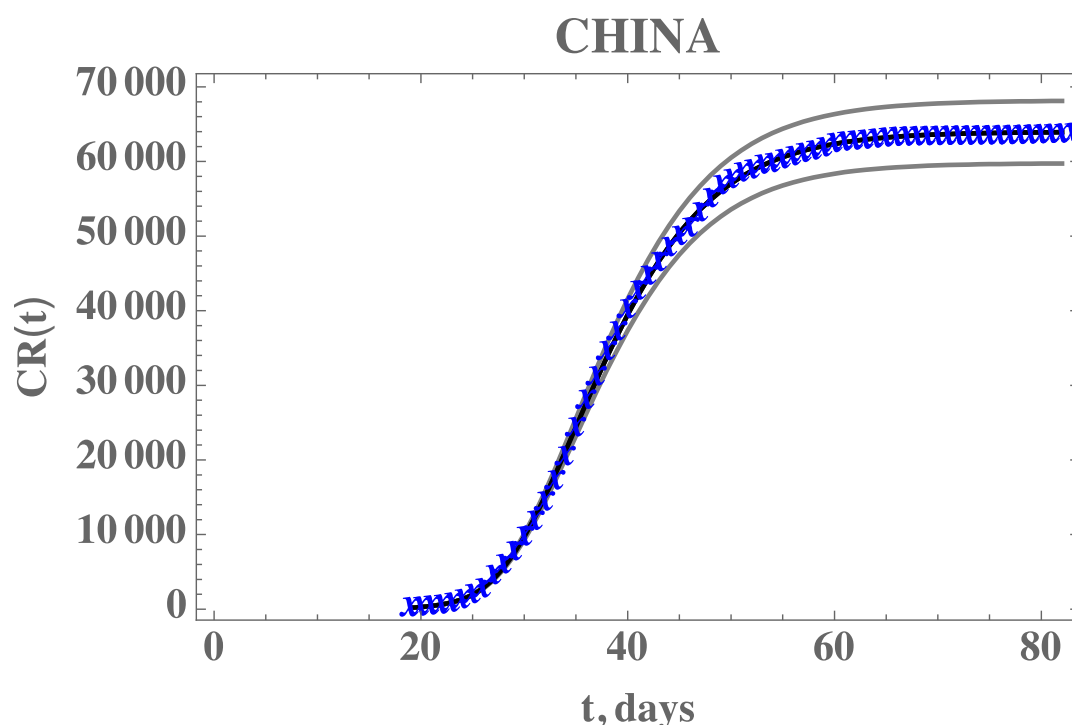

Figure 3 – Comparison of the theoretical model for CR(t) with the five estimated
parameter values (black solid line) and 99% confidence intervals (gray lines), against
the complete dataset for China from January 19th up to April 16th (blue cross) -- Case
2: CH5p

Model Application: Brazil

The CR(t) data for the accumulated reported infectious in Brazil, from February
25th, when the first infected individual was reported, up to April 23rd, is presented in the
Appendix. Similarly to the previous example with the data from China, a portion of the
available data on accumulated reported infectious was employed in the model parameters
estimation, up to March 29th. Then, the second portion of the data, from March 30th up to
April 23rd, was utilized in validating the constructed model.

First, the exponential phase of the evolution was fitted, taking the data from day
10 to 25, yielding the estimates of the three parameters, $\chi_1 = 0.42552, \chi_2 = 0.293696, \chi_3 = 3.2335$, from which we have estimated $t_0 = 6.9051$. The remaining
data for the initial conditions, I_0 and U_0, and the early stage transmission rate, τ_0, are in
fact recalculated from within the MCMC algorithm, since the changing values of f_0 will

affect them, according to eqs. (7.c-e). The average times in the model were taken as $1/\nu=$ 6.20798 days and $1/\eta=$ 11.2784 days, which were obtained from the MCMC simulation on the full dataset for China (Table 5), as discussed in the previous section.

The Brazilian government took isolation measures starting on N=21 days, which was enforced throughout the country. Also, there were initially only 30,000 exam kits available, and an additional 30,000 were later acquired, but till mid April at least, the resulting rather small ration of testing per million inhabitants in Brazil and the retardation in the exam results confirmation due to a centralized operation, has caused a perceptible change in the data structure for the reported infectious cases, which can only be represented by a time varying function $f(t)$. The progressive reduction on the number of executed exams of the symptomatic individuals and the delay of the results availability, has certainly affected the partition of reported to unreported cases by the end of this period covered by the present dataset. Therefore, the more general model including the time variation of the partition $f(t)$, eqs.(4.c,d), is here implemented for a more refined inverse problem analysis. It is then expected that a reduction on the f value can be identified $(f_{max}<f_0)$, with an abrupt variation on the exponential behaviour, here assumed as a sharp functional time dependence (large μ_f). Therefore, a statistical inverse problem analysis is undertaken, this time for estimating five parameters, namely, $f_0, \mu, \tau_0, f_{max}$, and N_f (Case 3 – BR5p) aimed at enhancing the overall agreement with the CR(t) data behaviour, with a likely reduction on the partition of the reported and unreported infectious cases.

With uniform distributions for all five parameters, guided by the previous estimates for the first three parameters, and arbitrary guesses for f_{max}, and N_f, the prior distributions and initial guesses for the 5 parameters are presented in Table 6 and the five estimated quantities, after neglecting the first 80,000 burning in states of the chain are shown in Table 7, together with the 99% confidence interval for each parameter

Table 6 – Prior distributions and initial guesses for the 5 parameters to be estimated,

$f_0, \mu, \tau_0, f_{max}, N_f$ (Brazil)

Case 3 - BR5p			
Param.	**Prior distribution**	**Initial Guess**	
f_0	$U[0, 1]$	0.300	estimated
μ	$U[0, 5]$	0.04	estimated
$\tau 0$	$U[0, 1 \times 10^{-6}]$	1.66755×10^{-9}	estimated
f_{max}	$U[0, 1]$	0.165	estimated
N_f	$U[10, 35]$	30.5	estimated
$1/\nu$	6.20798 days		fixed
$1/\eta$	11.2784 days		fixed
S_0	211.3×10^6		fixed
t_0	6.90514		fixed
N	21		fixed
μ_f	10		fixed
χ_1	0.42552		fixed
χ_2	0.293696		fixed
χ_3	3.2335		fixed

Table 7 – Estimated values and 99% confidence intervals for five parameters,

$f_0, \mu, \tau_0, f_{max},$ and N_f (Brazil).

Case 3 – BR5p		
Parameter	**Estimated values**	**99% confidence interval**
f_0	0.303671	$[0.302624, 0.304697]$
μ	0.0389639	$[0.0388438, 0.0390961]$
$\tau 0$	1.66755×10^{-9}	$[1.66755 \times 10^{-9}, 1.66755 \times 10^{-9}]$
f_{max}	0.156734	$[0.156146, 0.157217]$
N_f	30.4197	$[30.3522, 30.4915]$

Figure 4 presents the predicted evolution of the accumulated reported infectious cases in Brazil, CR(t), from February 25th up to April 23rd, plotted as the black dashed line. Also shown in this figure are the red dots in the first portion of the available data, up to March 29th, which were employed in the estimation of the parameters in Table 7 that compose the present model. In addition, the blue dots represent the second portion of the available data from March 30th till April 23rd, that were not employed in the parametric estimation, but saved for the present validation. It is clear that the built model has an excellent predictive feature, reproducing the epidemic evolution up to the available date at the time of this work submission, with a mean relative error of 5.8% during this phase.

One can see the marked reduction on the $f(t)$ parameter from the estimates in Table 7, which results in the increase of the unreported to reported infectious cases, as is shown in Figure 5 for CR(t) and CU(t) predictions up to 150 days. Clearly, the reduction on the testing, and thus on the isolation of reported infectious individuals, leads to an impressive increase on the total number of infected symptomatic individuals after 150 days (752,888 cases), including unreported (633,698) and reported cases (119,190). Both the reported and unreported infectious individuals curves, R(t) and U(t), show a peak at around the 70th day (May 3rd).
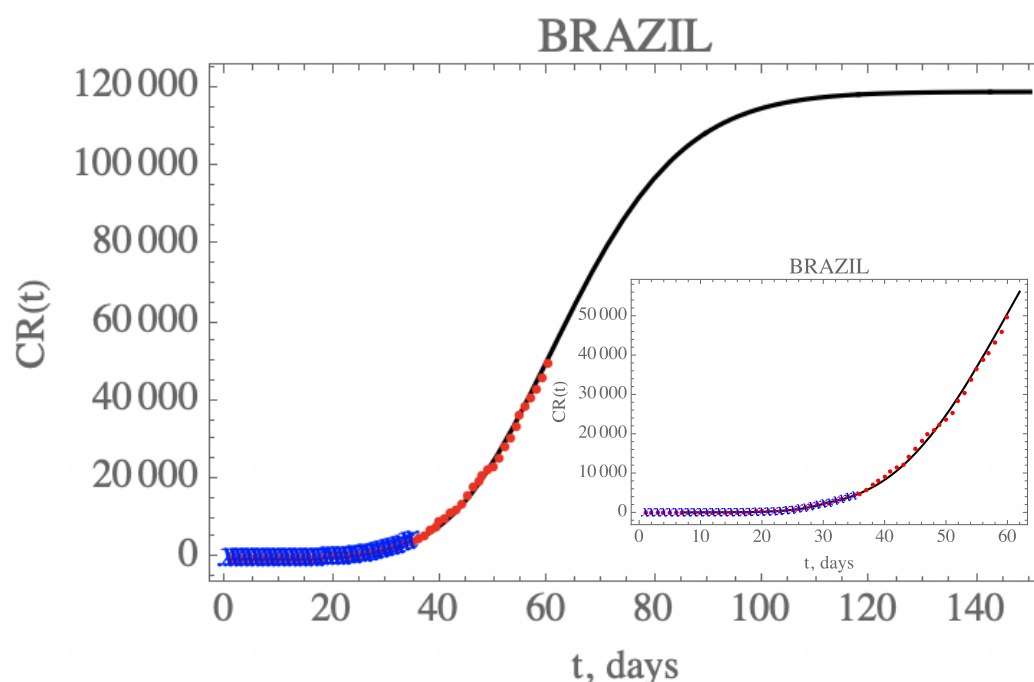
Figure 4 – Prediction of the accumulated reported infectious, CR(t), with the five estimated parameter values from the available dataset for Brazil from February 25th up to March 29th (blue cross) and validated with the data up to April 23rd (red dots).

Figure 5 – Comparison of the theoretical model for CR(t) (black dashed curve), CU(t) (red dashed curve), R(t) (cyan solid c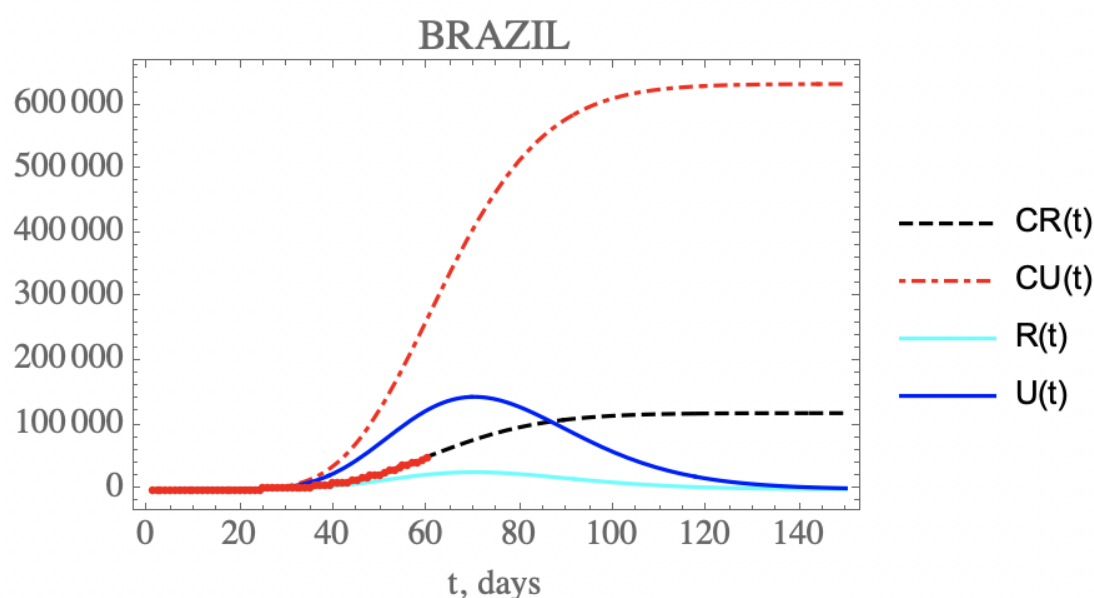urve) and U(t) (blue solid curve) with the five estimated parameter values from the available dataset for Brazil from February 25th up to March 29th. (red dots show 60th available data of CR(t) up to April 23rd)

Scenarios analyses: Brazil

Next, the model constructed with this parametric estimation is employed in the prediction of the COVID-19 evolution in Brazil under different hypothesis. Five scenarios were here explored: (i) the present public health interventions remain active, with the same transmission rate decay; (ii) a stricter social distancing and/or prevention measures are implemented from now on, further reducing the transmission rate decay; (iii) an attenuation on the social distancing and/or prevention measures, leading to a more mild reduction on transmission rate; (iv) an increment on the fraction of reported cases, through a more intensive blood testing, for instance, leading to more unreported cases to become reported ones, thus isolating them earlier; (v) a combination of public health measures acting on reducing the transmission rate, though with some relaxation of the social distancing, but simultaneously increasing the conversion factor of unreported to reported cases.

Table 8 summarizes both the fixed and variable parameter values adopted for these five scenarios. The additional public health interventions simulated in the above scenarios act on either the time variation of the transmission coefficient or on the reported to unreported partition coefficient. Since April 23rdcorresponds to t=59 days, the parametric changes are assumed to start at a chosen date further ahead, in the present case t=64 days ($N_2 = N_{f2} = 64$), and the scenarios analysis are undertaken by acting on either or both coefficients, $\tau(t)$ and $f(t)$, according to the following parametrizations:

$$\tau(t) = \tau_0 , \qquad 0 \le t \le N \tag{10.a}$$

$$\tau(t) = \tau_0 \exp(-\mu(t - N)), \qquad N < t \le N_2 \tag{10.b}$$

$$\tau(t) = \tau_{02} \exp(-\mu_2(t - N_2)), \qquad t > N_2 \tag{10.c}$$

$$\text{with} \quad \tau_{02} = \tau_0 \exp(-\mu(N_2 - N)) \tag{10.d}$$

$$f(t) = f_0 , \qquad 0 \le t \le N_f \tag{10.d}$$

$$f(t) = (f_{max} - f_0)\left[1 - \exp\left(-\mu_f(t - N_f)\right)\right] + f_0, \qquad N_f < t \le N_{f2} \tag{10.e}$$

$$f(t) = (f_{max2} - f_{02})\left[1 - \exp\left(-\mu_{f2}(t - N_{f2})\right)\right] + f_{02}, \qquad t > N_{f2} \tag{10.f}$$

$$\text{with} \quad f_{02} = (f_{max} - f_0)\left[1 - \exp\left(-\mu_f(N_{f2} - N_f)\right)\right] + f_0 \tag{10.g}$$

In the first scenario, it is assumed that no additional public health interventions are implemented, other than those already reflected by the data up to April 23rd, which would then be fully maintained throughout the control period, and the epidemics should evolve from the present stage, under the parameters above identified. Figure 5 has already shown the evolution of the accumulated and instantaneous reported, $CR(t)$ and $R(t)$, unreported, $CU(t)$ and $U(t)$, infectious individuals, up to 150 days. Due to the fairly low value of $f(t)$ starting with $f_0 \approx 0.30$ and reaching $f_{max} \approx 0.16$, the accumulated number of unreported infectious cases is quite high, as already discussed. No predictions on casualties are here proposed, since these are highly dependent on age structure, social-economical conditions, and health system response.

Table 8 – Input data in each scenario for epidemic evolution in Brazil

Fixed parameters					
f_0	0.303671				
μ	0.0389639				
N	21				
τ_0	1.66755×10^{-9}				
f_{max}	0.156734				
μ_f	10				
N_f	30.4197				
$1/\nu$	6.20798 days				
$1/\eta$	11. 2784 days				
S_0	211.3×10^6				
t_0	6.90514				
χ_1	0.42552				
χ_2	0.293696				
χ_3	3.2335				
Changing parameters: (64th – 150th day)					
Scenario	(i)	(ii)	(iii)	(iv)	(v)
μ_2	0	0.0779278	0.019482	0	0.019482
N_2	-	64	64	-	64
f_{max2}	-	-	-	0.607342	0.607342
μ_{f2}	0	0	0	10	10
N_{f2}	-	-	-	64	64

Next, the second scenario explores the implementation of more strict distancing and sanitary habits to further reduce the transmission rate by assuming, after day $N_2=64$ (eq.10.c), by doubling the value of μ here identified, thus around, $\mu_2=0.0779$, still well below that achieved in China (0.132). The time variable transmission rate is then computed from eq.(10.c) after $t > N_2$. The changes in the accumulated reported and unreported cases, as shown in Figure 6, are quite significant. The predicted number of unreported symptomatic infectious cases is now much lower reaching after 150 days around 545,324 individuals, while the reported cases should reach 102,764 individuals, with an impressive reduction to a total of around 648,088 infectious symptomatic cases. The predicted evolution of the reported infectious cases would then show a peak at around t=69 days.
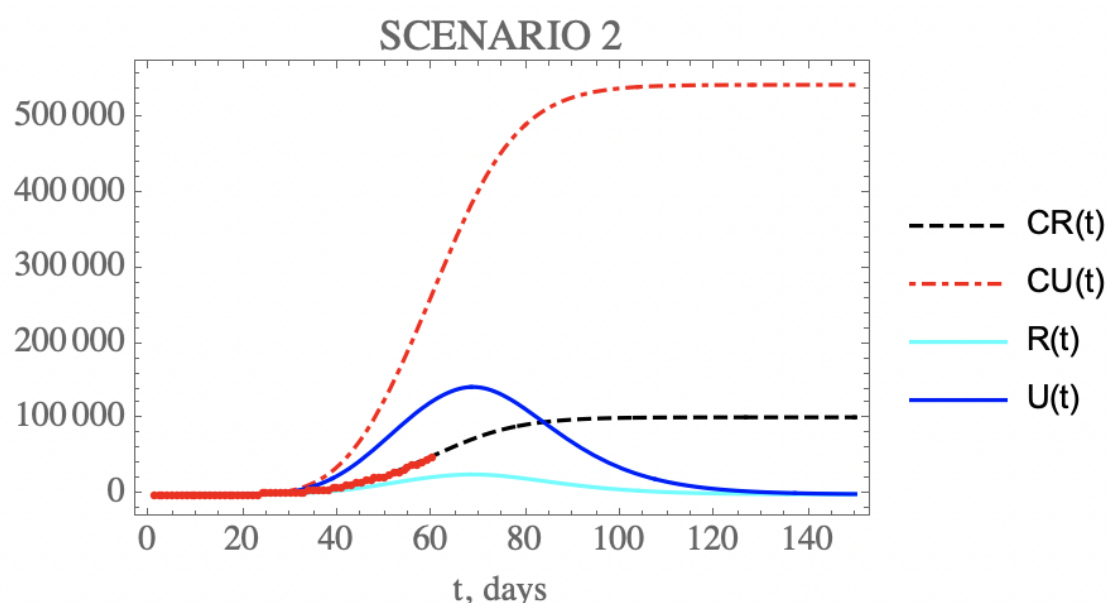

Figure 6 – Scenario (ii) predictions for CR(t) (black dashed curve), CU(t) (red dashed curve), R(t) (cyan solid curve) and U(t) (blue solid curve) with the five estimated parameter values from the available dataset for Brazil from February 25th up to March 29th. (red dots show available data of CR(t) up to April 23rd).

Through the third scenario, one can predict the consequences of mildly relaxing the public health measures that affect transmission rate, for instance through reduction of isolation measures. This is simulated here by reducing the identified transmission rate attenuation factor, by assuming, after day $N_2=64$, half the value of μ here identified, thus

around, μ_2=0.0195. The changes in the accumulated and instantaneous reported and unreported symptomatic cases, as shown in Figure 7, are worse than in the base scenario (i), Figure 5. The predicted number of accumulated unreported infectious cases is now higher reaching after 150 days around 765,612 individuals, while the reported cases would reach 143,708 individuals, with an increase to a total of around 909,319 infectious symptomatic cases. The predicted evolution of the instantaneous reported infectious cases would then show a peak at around t=72 days.
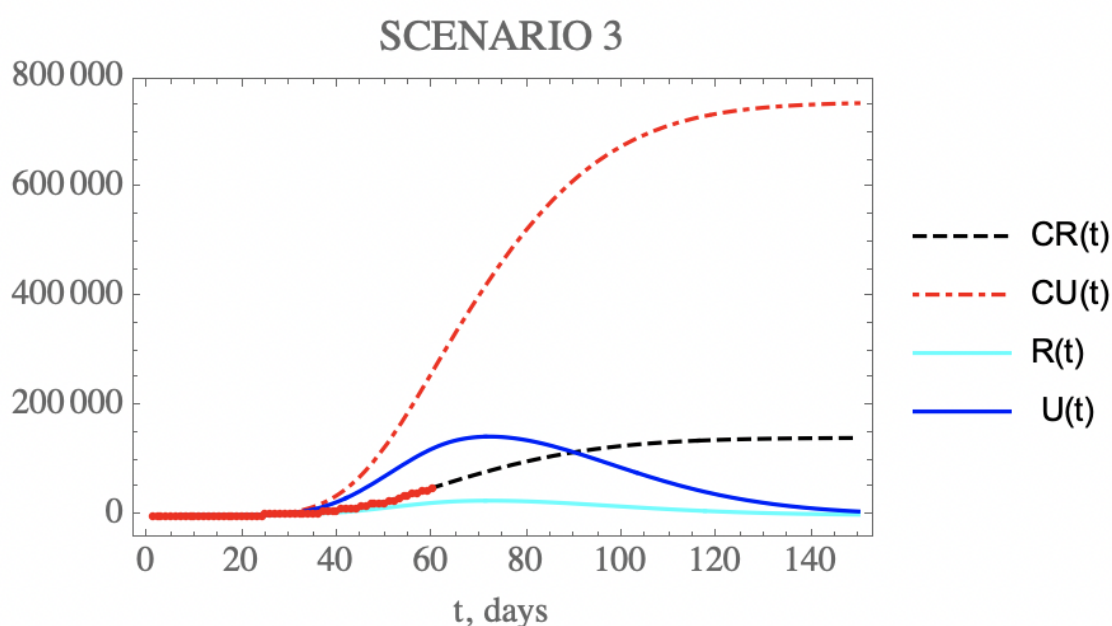

Figure 7 – Scenario (iii) predictions for CR(t) (black dashed curve), CU(t) (red dashed curve), R(t) (cyan solid curve) and U(t) (blue solid curve) with the five estimated parameter values from the available dataset for Brazil from February 25th up to March 29th. (red dots show available data of CR(t) up to April 23rd).

Besides acting on the transmission rate along time, public health measures may also be effective in reducing the ratio of reported to unreported infectious case, since the reported cases are, according to the model, directly isolated and thus interrupting the contamination path, as analyzed in the fourth scenario. For instance, one may double the initial fraction of reported and unreported infectious cases parameter, f_0, to reach $f_{max2} = 0.607$, after $N_{f2} = 64\ days$, somehow closer to the value previously obtained from the China dataset. Therefore, Figure 8 shows the behavior of CR(t), R(t) and CU(t), U(t), which according to the value of $\mu_{f2} = 10$, occurring after the day $N_{f2} = 64$, leads to the

crossing of instantaneous reported and unreported cases, R(t) and U(t), that can be observed. The predicted number of unreported infectious cases would now reach, after 150 days, around 441,949 individuals, while the reported cases should reach 241,931 individuals, with an also marked reduction to a total of around 683,880 infectious cases. The predicted evolution of the reported infectious cases would then show a peak at around t=76 days. Although this peak value is higher than for the base case scenario (i), before further public health intervention, a number of these are of mild symptomatic cases that were moved from the unreported to the reported cases evolution, thus isolated earlier.
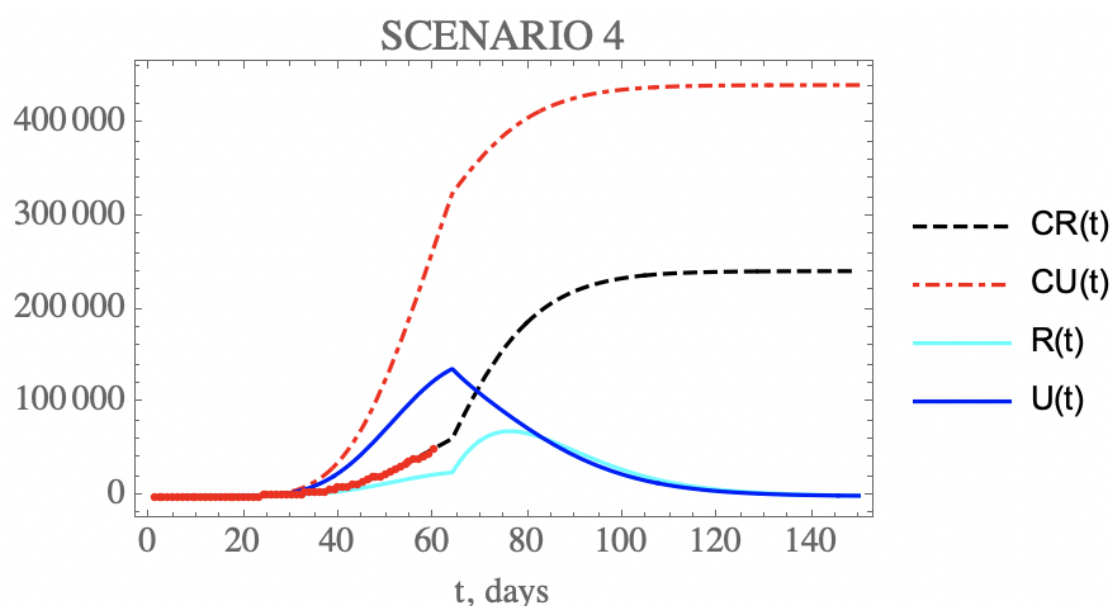

Figure 8 – Scenario (iv) predictions for CR(t) (black dashed curve), CU(t) (red dashed curve), R(t) (cyan solid curve) and U(t) (blue solid curve) with the five estimated parameter values from the available dataset for Brazil from February 25th up to March 29th. (red dots show available data of CR(t) up to April 23rd).

In the fifth scenario, the combination of public health measures affecting both the transmission rate and the conversion factor of unreported to reported cases is analyzed for Brazil. Let us consider after day N_2=64, some relaxation of social distancing leading to half of the μ value here identified, thus around, μ_2=0.0195, and simultaneously doubling the fraction of reported and unreported infectious cases, to become $f_{max2} = 0.607$, also after $N_{f2} = 64\ days,$ with μ_{f2}=10. The changes in the accumulated and instantaneous reported and unreported cases are shown in Figure 9. The predicted number of unreported infectious cases is now reaching after 150 days around 471,320 individuals,

while the reported cases should reach 287,360 individuals, with a total of 758,680 infectious symptomatic cases, less than 1% increase with respect to the base case. The predicted evolution of the daily reported infectious cases would then show a peak at around t=78 days. Again, though this peak value is higher than for the base case, before the public health improvements, a number of these are of mild symptomatic cases that were moved from the unreported to the reported cases evolution, thus moved to monitored isolation earlier, and not necessarily requiring hospitalization. In overall terms, the results for scenario (v) are not markedly different from those for the base scenario (i), thus offering a perspective of combining the social distancing relaxation measures with more intensive testing to reach a similar final effect.
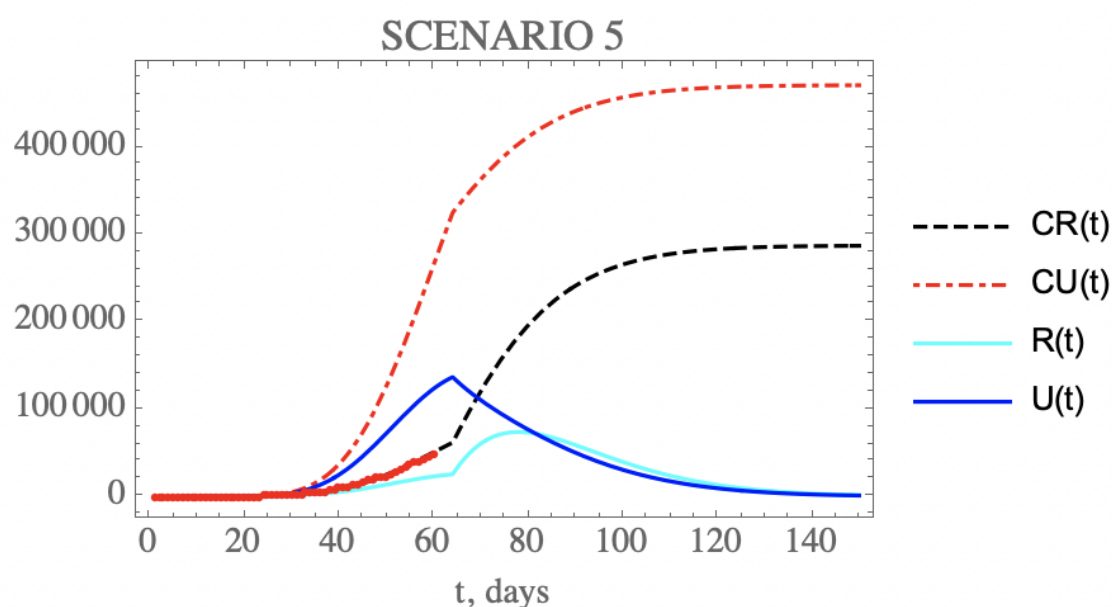
Figure 9 – Scenario (v) predictions for CR(t) (black dashed curve), CU(t) (red dashed curve), R(t) (cyan solid curve) and U(t) (blue solid curve) with the five estimated parameter values from the available dataset for Brazil from February 25th up to March 29th. (red dots show available data of CR(t) up to April 23rd).

Figures 10.a,b combine the data on accumulated reported and unreported infectious symptomatic individuals, respectively, for the predictions provided through the five scenarios here considered. Clearly, scenario (ii), which involves further restrictions on social distancing and sanitary habits, and scenario (iv) which involves more intensive testing while maintaining the present public health actions, lead to the smaller

accumulated values of symptomatic individuals in the long term, while the plain relaxation of social distancing, without any other intervention, would result in the largest number of infected symptomatic cases, either reported or unreported. On the other hand, when examining the curves for scenarios 1 and 5, it is clear that the proper combination of public health interventions, which would involve relaxation of social distancing and intensification of testing, could result in similar results as a more strict quarantine process.
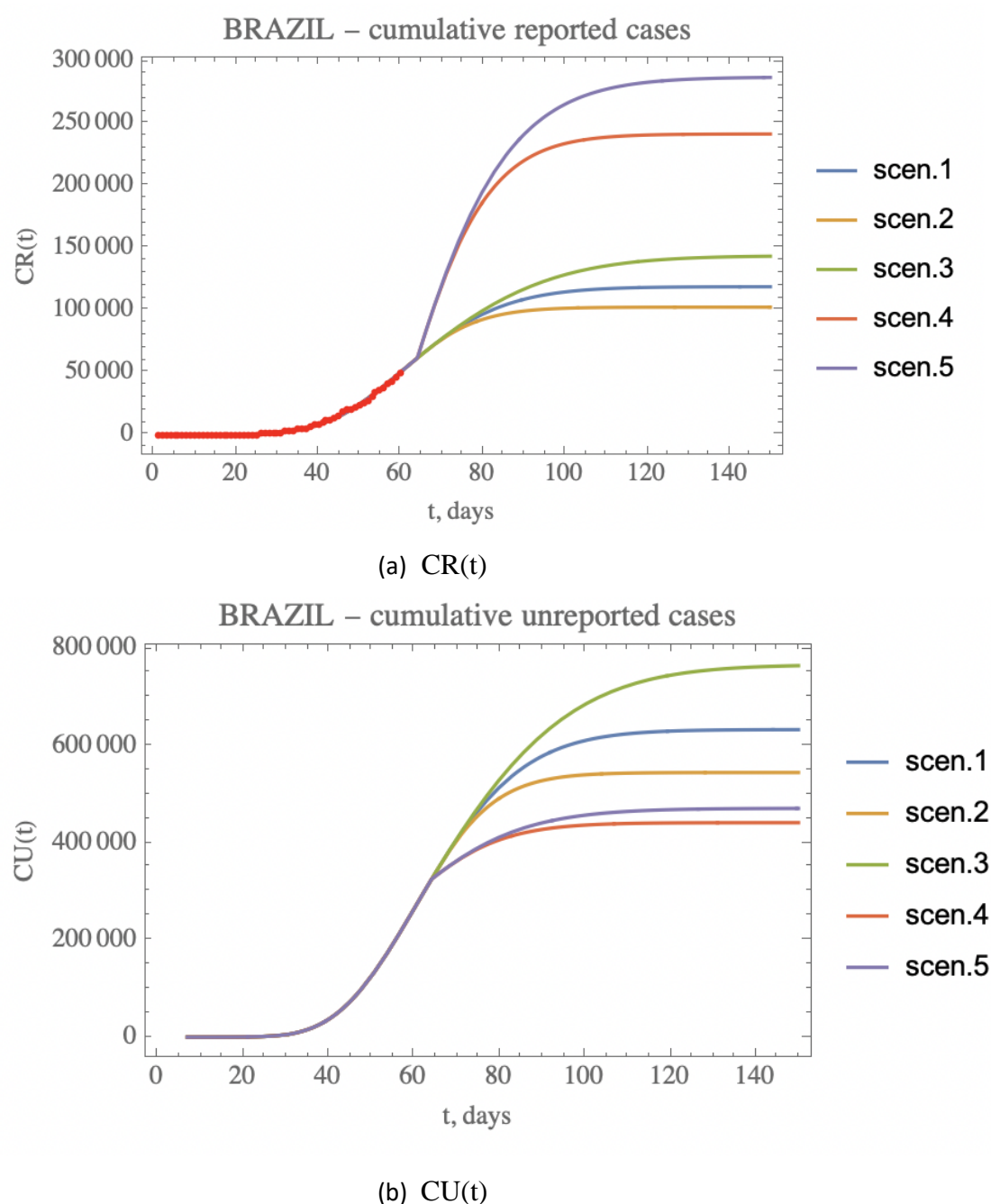
(a) CR(t)

(b) CU(t)

Figures 10.a,b – Comparative predictions for a) CR(t), and b) CU(t), for the five scenarios (i) to (v). (red dots in (a) show available data of CR(t) up to April 23rd).

CONCLUSIONS

The present work implements a mixed analytical-statistical inverse problem analysis to the prediction of epidemics evolution, with focus on the COVID-19 progression in Brazil. A SIRU-type model is implemented for the direct problem solution, while a mixture of an analytical parametric estimation for the early phase epidemic exponential behavior with a Bayesian inference approach for a wider period, that encompasses the initial public health interventions to control the epidemics, are considered for the inverse problem analysis. The evolution of the COVID-19 epidemy in China is considered for validation purposes, by taking the first part of the dataset of accumulated reported infectious individuals to estimate parameters, and retaining the rest of the evolution data for direct comparison with the predicted results, with excellent agreement. Then, the same approach is applied to the Brazilian case, this time employing an initial portion of the available time series so far for the parametric estimates, and then offering a validation of the evolution prediction through the remaining dataset up to the date available at conclusion of this study (April 23rd). Also, some public health intervention measures are critically examined through five different scenarios, in addition to those already implemented, permitting the inspection of their impact on the overall dynamics of the disease proliferation. It was observed that a combination of social distancing and sanitary habits with a more intensive testing for isolation of symptomatic cases, could lead to the same overall control of the disease than a more strict social distancing intervention. Further improvement on the modelling is envisioned by enriching the model with latency effects, age structure discrimination, spatial demographic distribution dependence, and recovery factor differentiation among isolated and non-isolated patients.

ACKNOWLEDGEMENTS

REFERENCES

[1] Tang, B.; Wang, X.; Li, Q.; Bragazzi, N.L.; Tang, S.; Xiao, Y.; Wu, J. Estimation of the Transmission Risk of 2019-nCov and Its Implication for Public Health Interventions. J. Clin. Med. 2020, 9, 462. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3525558
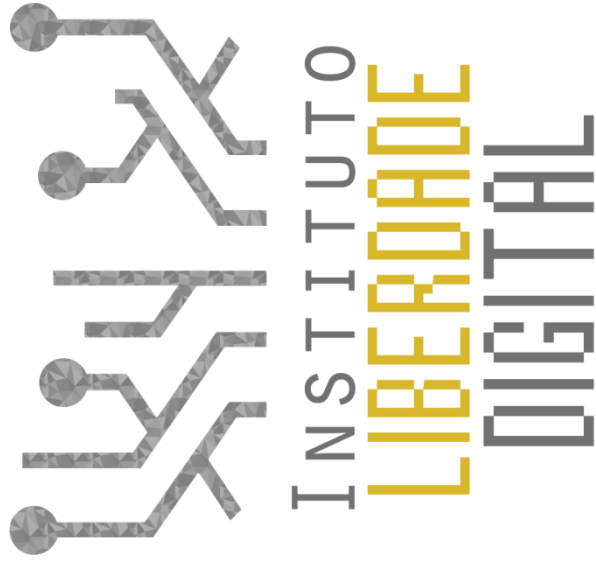
[2] Z.Liu, P.Magal, O.Seydi, and G.Webb, Understanding unreported cases in the 2019 - nCov epidemic outbreak in Wuhan, China, and the importance of major public health interventions, MPDI Biology 2020, 9 (3), 50.

[3] Magal, P.; Webb, G. The parameter identification problem for SIR epidemic models: Identifying Unreported Cases. J. Math. Biol. 2018, 77, 1629–1648.

[4] Ducrot, A.; Magal, P.; Nguyen, T.;Webb, G. Identifying the Number of Unreported Cases in SIR Epidemic Models. Math. Med. Biol. J. IMA 2019.

[5] Z.Liu, P.Magal, O.Seydi, and G.Webb, Predicting the cumulative number of cases for the COVID - 19 epidemic in China from early data, SSRN (2020)

[6] P.Magal and G.Webb, Predicting the number of reported and unreported cases for the COVID - 19 epidemic in South Korea, Italy, France and Germany, SSRN (2020)

[7] Z.Liu, P.Magal, O.Seydi, and G.Webb, A COVID - 19 epidemic model with latency period SSNR (2020)

[8] Kaipio, J., and E. Somersalo, Statistical and Computational Inverse Problems, Applied Mathematical Sciences, V. 160, Springer-Verlag, 2004.

[9] Gamerman, D., and H.F. Lopes, Markov Chain Monte Carlo: Stochastic Simulation for Bayesian Inference, 2nd ed., Chapman & Hall/CRC, Boca Raton, FL, USA, 2006.

[10] Orlande, H.R.B., O. Fudym, D. Maillet, R.M. Cotta, Thermal Measurements and Inverse Techniques, CRC Press, Boca Raton, FL, USA, 2011.

[11] Kruschke, J.K., Doing Bayesian Data Analysis: A Tutorial with R, JAGS and Stan, Academic Press, NY, 2015.

[12] Orlande, H.R.B., Inverse Problems in Heat Transfer: New Trends on Solution Methodologies and Applications, ASME J. Heat Transfer, V.134, pp.031011, 2012.

[13] https://www.worldometers.info/coronavirus/country/#countries

[14] S.A. Lauer, K.H. Grantz, Q. Bi, F.K. Jones, Q. Zheng, H.R. Meredith, A.S. Azman, N.G. Reich, and J. Lessler, The Incubation Period of Coronavirus Disease 2019 (COVID-19) From Publicly Reported Confirmed Cases: Estimation and Application, Annals of Internal Medicine, published at Annals.org on 10 March 2020. doi:10.7326/M20-0504

[15] Q. Li et al., Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus–Infected Pneumonia, The New England Journal of Medicine, published on January 29, 2020, and last updated on January 31, 2020, at NEJM.org. doi: 10.1056/NEJMoa2001316

[16] Neil M Ferguson et al., Impact of non-pharmaceutical interventions (NPIs) to reduce COVID19 mortality and healthcare demand, Imperial College COVID-19 Response Team, March 16th, 2020.

[17] B. Tang, X. Wang, Q. Li., N.L. Bragazzi, Sa.Tang, Y. Xiao, J Wu, Estimation of the transmission risk of 2019-nCov and its implication for public health interventions, SSRN, 20 Pages, Posted: 27 Jan 2020.

APPENDIX

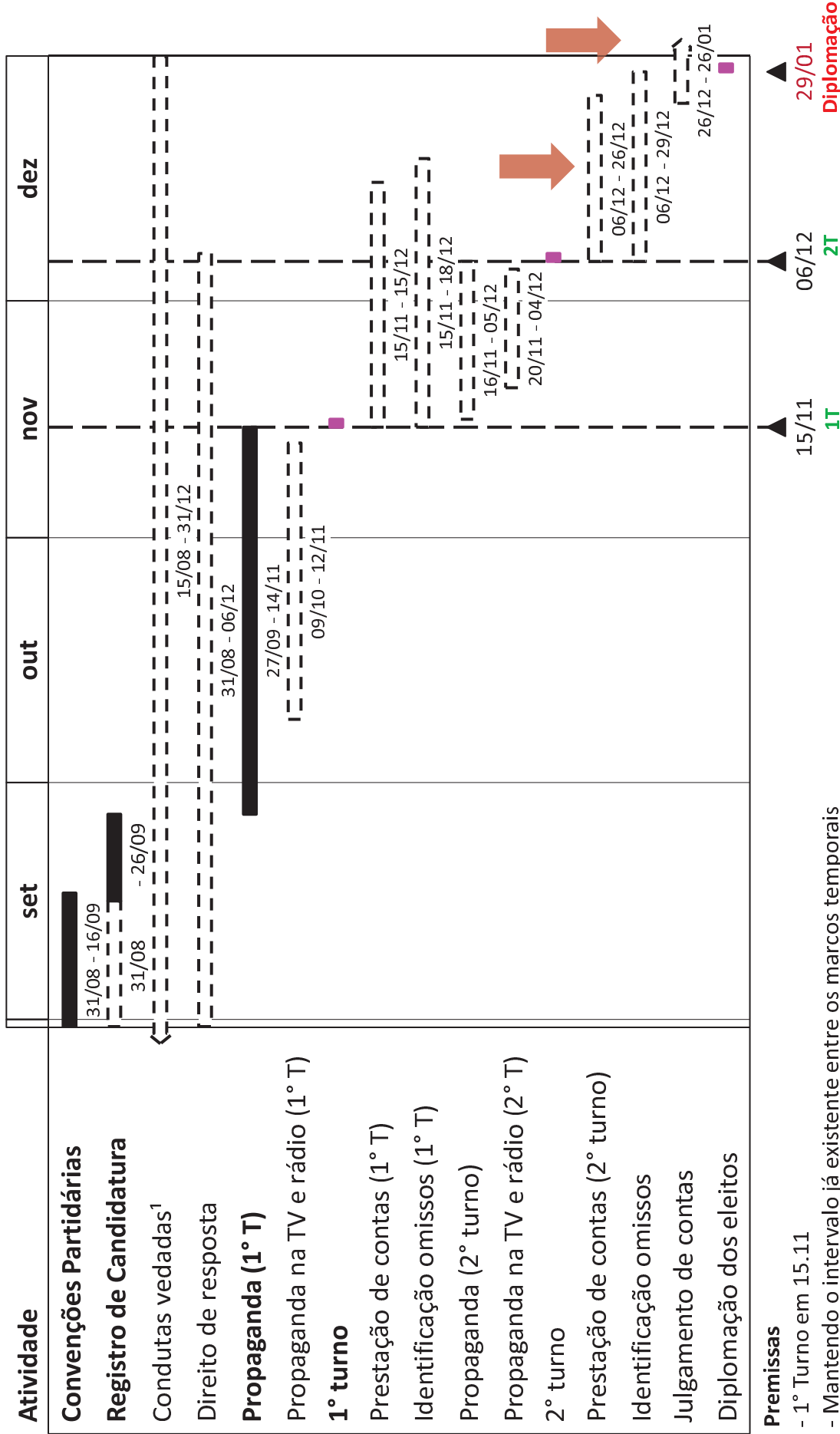**Table A.1 - Data for Brazil - accumulated reported cases, CR(t), and casualties.**

DATE	Day	Death	Infected	DATE	Day	Death	Infected
24/02/2020	1	0	0	30/03/2020	36	163	4630
25/02/2020	2	0	1	31/03/2020	37	201	5717
26/02/2020	3	0	1	01/04/2020	38	242	6880
27/02/2020	4	0	1	02/04/2020	39	324	8044
28/02/2020	5	0	1	03/04/2020	40	363	9194
29/02/2020	6	0	2	04/04/2020	41	445	10360
01/03/2020	7	0	2	05/04/2020	42	486	11254
02/03/2020	8	0	2	06/04/2020	43	564	12183
03/03/2020	9	0	2	07/04/2020	44	686	14034
04/03/2020	10	0	3	08/04/2020	45	820	16188
05/03/2020	11	0	8	09/04/2020	46	954	18145
06/03/2020	12	0	13	10/04/2020	47	1068	19789
07/03/2020	13	0	19	11/04/2020	48	1140	20962
08/03/2020	14	0	25	12/04/2020	49	1223	22192
09/03/2020	15	0	25	13/04/2020	50	1328	23430
10/03/2020	16	0	34	14/04/2020	51	1532	25262
11/03/2020	17	0	52	15/04/2020	52	1757	28610
12/03/2020	18	0	77	16/04/2020	53	1947	30683
13/03/2020	19	0	151	17/04/2020	54	2141	33682
14/03/2020	20	0	151	18/04/2020	55	2347	36599
15/03/2020	21	0	200	19/04/2020	56	2462	38654
16/03/2020	22	0	234	20/04/2020	57	2575	40581
17/03/2020	23	1	346	21/04/2020	58	2741	43079
18/03/2020	24	4	529	22/04/2020	59	2906	45757
19/03/2020	25	7	640	23/04/2020	60	3313	49492
20/03/2020	26	11	970				
21/03/2020	27	18	1178				
22/03/2020	28	25	1546				
23/03/2020	29	34	1924				
24/03/2020	30	46	2247				
25/03/2020	31	57	2433				
26/03/2020	32	77	2985				
27/03/2020	33	92	3417				
28/03/2020	34	111	3904				
29/03/2020	35	136	4256				

INSTITUTO LIBERDADE DIGITAL

SIMULAÇÕES ELEITORAIS

São Paulo, 20 de maio de 2020

CENÁRIO 1

Atividade

Convenções Partidárias — 31/08 - 16/09

Registro de Candidatura — 31/08 - 26/09

Condutas vedadas[1] — 31/08 - 31/12

Direito de resposta — 15/08 - 31/12

Propaganda (1° T) — 31/08 - 06/12

Propaganda na TV e rádio (1° T) — 27/09 - 14/11

1° turno — 09/10 - 12/11

Prestação de contas (1° T) — 15/11 - 15/12

Identificação omissos (1° T) — 15/11 - 18/12

Propaganda (2° turno) — 16/11 - 05/12

Propaganda na TV e rádio (2° T) — 20/11 - 04/12

2° turno

Prestação de contas (2° turno) — 06/12 - 26/12

Identificação omissos — 06/12 - 29/12

Julgamento de contas

Diplomação dos eleitos — 26/12 - 26/01

set | out | nov | dez

15/11 — **1T**

06/12 — **2T**

29/01 — **Diplomação**

Premissas
- 1° Turno em 15.11
- Mantendo o intervalo já existente entre os marcos temporais

Conclusões

Neste cenário, observe que diplomar os candidatos mantendo o intervalo temporal entre os marcos temporais não é viável. Uma alternativa seria reduzir o prazo de prestação de contas de 20 para 10 dias:

- Prestação contas do 2° turno: até 16.12
- Identificação dos omissos: 19.12
- Decisão sobre as contas: até 19.12
- Diplomação: 22.12

4

Somos uma Think Tank que atua por meio de pesquisas multidisciplinares em prol da Liberdade Digital e acredita no potencial das tecnologias digitais para a promoção da Democracia. Conciliamos a pesquisa aplicada aos dilemas sociais, a fim de gerar conhecimento, influenciar ideias e promover políticas públicas responsáveis.

INSTITUTO LIBERDADE DIGITAL