# Adding Lithium to Drinking Water for Suicide Prevention—The Ethics

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Recent observations associate naturally occurring trace levels of Lithium in ground water with significantly lower suicide rates. It has been suggested that adding trace Lithium to drinking water could be a safe and effective way to reduce suicide. This article discusses the many ethical implications of such population-wide Lithium medication. It compares this policy to more targeted solutions that introduce trace amounts of Lithium to groups at higher risk of suicide or lower risk of adverse effects. The question of mass treatment with Lithium recalls other choices in public health between population-wide and more targeted interventions. The framework we propose could be relevant to some of these other dilemmas.

## Water Fortification with Lithium for Suicide Prevention—Background

900,000 people die from suicide every year globally, with low and middle-income countries accounting for more than 80% of that burden. Suicide is also one of the three leading causes of death among those in the most economically productive period of their lives (World Health Organization, 2012).

Global efforts to prevent suicide are intensifying, and different strategies are being proposed (World Health Organization, 2010; Scott *et al.*, 2012; Usborne, 2017). Evidence on how to effectively prevent suicide remains limited however. The most effective method appears to be restriction of access to means of suicide, e.g. firearms (du Roscoat and Beck, 2013; Pirkis *et al.*, 2013) but a combination of several strategies is probably necessary for substantial reductions (World Health Organization, 2012).

Over 90% of those who complete suicide have psychiatric diagnoses at the time of death, most commonly mood, psychotic and/or substance-use disorders (Bertolote and Fleischmann, 2002). A treated or untreated mental disorder interacts with social, physical, or environmental risk factors (e.g. availability of means for suicide, low socioeconomic status, substance abuse and frequent media reporting of suicide) to increase suicide rates—in ways that are understood only in part.

While the prevalence of risk factors is high in the general population, suicides are rare events (Schwartz-Lifshitz *et al.*, 2012). Most people who commit suicide will have no recent contact with psychiatric services (Ahmedani *et al.*, 2014) including those with psychiatric illnesses, most of whom are undiagnozed (Bertolote and Fleischmann, 2002), and there is no way to reliably predict suicide at the individual level. Levels of both false positives and false negatives remain high (Large and Ryan, 2014; Bolton *et al.*, 2015). Hence, to reduce suicide in the population, most suicide prevention measures would need to target a significant portion of the population, including those with very low suicide risk.

Ecological studies have suggested that rates of suicide are significantly lower in areas where trace amounts of Lithium naturally occur in groundwater. Some scholars have therefore argued that adding trace amounts of Lithium to drinking water could be a safe and a cheap intervention that would greatly reduce suicide rates

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(Vita *et al.*, 2015). And the vision of fortification of drinking water or basic food items like salt with trace amounts of Lithium has captured the imagination of mainstream media (2009; Appel, 2010; Bates, 2011; Boseley, 2011; Fels, 2014; Ghaemi, 2017).

Studies have also associated trace amounts of Lithium in groundwater on the one hand and lower rates of violence and Alzheimer's disease on the other (Schrauzer and Shrestha, 1990; Young, 2011, Mauer *et al.*, 2014). However, the present article focuses primarily on Lithium's potential suicide-prevention effects.

The argument for mass fortification with trace amounts of Lithium, that is, for adding small amounts of Lithium to drinking water, goes:

(1) Trace doses of Lithium to the population will generate large public health benefits, namely, reduced rates of suicide (and possibly homicide and dementia (Kessing *et al.*, 2017)),
(2) Because the individual's risk of committing suicide is hard to gauge in advance, and most suicidal individuals are not in contact with mental healthcare, the efficacy of low dose Lithium is likely to be greatest under the least selective intervention, which happens to be adding trace Lithium to drinking water.
(3) Trace amounts of Lithium are likely to have few if any (serious) adverse effects,
(4) The practice of food and water fortification is already well-established and successful (e.g. iodine in table salt, fluoride in tap water), and
(5) Adding Lithium to drinking water is in principle no different than fortification practices already in place.

Hence, the argument concludes, if further studies confirm that trace amounts of Lithium are sufficiently safe and effective, mass fortification (e.g. adding Lithium to drinking water) should be initiated. As bioethicist Jacob Appel concludes: 'If we are willing to ingest fluoride to prevent tooth decay, surely we can tolerate a trace of Lithium to prevent suicides' (Appel, 2010).

However, adding Lithium to the public's drinking water raises initial ethical concerns, several of which this paper explores. After deliberation, we reject some of the concerns, but others cut deeper. Our conclusion is that adding Lithium to drinking water is preferable to adding it to commonly used food items and to more targeted prescription in some respects only. In addition, additional empirical evidence is necessary on several aspects of Lithium fortification.

The structure of the article is as follows. First, we informally review what is known about the efficacy and effectiveness, safety and cost effectiveness of water fortification with trace amounts of Lithium. We then discuss two clusters of ethical objections—about preventing harm, and about individual and communal consent. The article then builds upon these ethical discussions and compares introducing trace amounts of Lithium to tap water to three alternatives: adding Lithium to certain food items, e.g. particular type of table salt; selective population medication and specifically adding it to medications prescribed to groups with higher risk of suicide such as psychiatric patients; and indicated medication, namely, prescription (including financial coverage) only to individuals who are deemed to be at high risk by their clinicians. Finally, we lay out open empirical and normative questions on which the preferable Lithium medication policy partly depends.

Although the question of how to deliver the benefits of Lithium is new, choices between targeted interventions and 'one-size-fits-all' arise in many areas of public health. Should anti-smoking campaigns primarily take the form of population-wide ads and zoning laws for smoking prevention, or, at the other extreme, of primarily quit campaigns and cessation services (Bitton and Eyal, 2011)? Should everyone pay a 'fat tax', or only overweight and obese individuals? Should HIV countermeasures in resource strapped countries where HIV is endemic focus on prevention of infection or on targeting those already infected for treatment (Brock and Wikler, 2009; Frick, 2015)?

While typically in public health, mass primary prevention is more cost effective than targeting higher-risk populations (Rose, 1985), targeted interventions are sometimes preferable. That can happen when risk is not homogenously spread and less selective interventions would reduce efficacy per patient and multiply adverse effects and delivery cost enough to make population impact or cost effectiveness worse. For instance, in the case of obesity reduction, directing the same full set of interventions at everyone may exacerbate stigma and trigger weight-gain (Green *et al.*, 2015). In South Africa, while the most cost effective interventions against HIV remain preventative, offering treatment to all HIV-infected patients turns out to be less cost effective than offering it only to ones whose disease advanced to the '500 CD4 count' threshold (Chiu *et al.*, 2017). We hope that our discussion of Lithium fortification will illuminate these complexities in general.

## Efficacy and Effectiveness

Lithium, an element found naturally on earth, is one of the most effective psychopharmacological treatments

available for certain indications. Since the late 1940s, Lithium has been effectively used in both the treatment of bipolar disorder (Young and Newham, 2006; Kessing *et al.*, 2011; Curran and Ravindran, 2014), and major depressive disorder (Bschor, 2014).

In high doses, Lithium can cause serious adverse effects. In toxic doses it can lead to death (Terao, 1993). The Lithium dosages used in psychiatric treatment typically range between 300 mg (milligram) and 1800 mg per day, with blood levels monitored regularly to maintain effectiveness and safety. Long-term treatment with Lithium does carry some risk of adverse effects such as hypothyroidism, weight gain and renal disease (Oruch *et al.*, 2014). However, when adequately monitored and titrated, Lithium is a safe and highly effective treatment for serious mood disorders (Severus *et al.*, 2014).

Some opponents of water fortification with Lithium misleadingly point to the potential adverse effects of Lithium in high doses as proof that it is unsafe in trace doses (Breggin, 2017). In very low doses, Lithium is actually essential for optimal human growth and development (Schrauzer, 2002), and, as one proponent pointed out, 'a person would have to "swallow several Olympic swimming pools" of water a day to get a similar dosage to a prescription pill' (Bates, 2011).

Several studies confirm that Lithium significantly reduces the risk of suicide and death when used for treatment of mood disorders (Cipriani *et al.*, 2005; Cipriani *et al.*, 2013). One likely pathway for this effect is through treatment and relapse prevention of mood disorders. Moreover, the anti-suicide effect of Lithium is probably larger than its effects on mood, indicating potential additional pathways (Ernst and Goldberg, 2004). One postulation is that high-dosage Lithium reduces excitatory neurotransmission and increases inhibitory neurotransmission (Malhi *et al.*, 2013), which helps to reduce aggression and possibly impulsivity, two contributors to suicide. There is also evidence of neuroprotective effects. Structural imaging studies have suggested that patients treated with high-dosage Lithium develop increased gray matter volumes in the prefrontal cortex, a brain part implicated in planning and execution of complex decisions and social moderation (Sassi *et al.*, 2002; Bearden *et al.*, 2007).

The evidence is more mixed about the efficacy of trace amounts of Lithium for suicide reduction. Some observations associate trace amounts of Lithium in groundwater and reduced suicide rates. One study comparing different counties in Texas showed that the suicide rate was 14.2 per 100,000 of the population in the low Lithium areas and 8.7 per 100,000 in the (relatively) high Lithium areas (Schrauzer and Shrestha, 1990). In further studies, conducted in Japan, Greece and Austria, suicide rates were also inversely correlated with Lithium content in the local water supply. These associations remained significant after sensitivity analyses and adjustment for socioeconomic factors (Ohgami *et al.*, 2009; Kapusta *et al.*, 2011; Sugawara *et al.*, 2013; Giotakos *et al.*, 2015). But the studies are ecological and thus potentially confounded. One recent Danish study (Knudsen *et al.*, 2017) of areas with up to 31 micrograms/litre did not find evidence of a suicide protective effect of Lithium in the drinking water. However, the communities in the Danish study had lower levels of Lithium, compared to the areas with higher levels in e.g. Texas where Lithium levels ranged from 70 to 170 micrograms/litre.

If we assume that Lithium is responsible for the anti-suicide effect, we still lack information regarding the exact quantity or duration of trace Lithium exposure that is necessary to achieve its effect. Based on the level of Lithium in the studies conducted, assuming that individuals drink no more than 2 liters of water a day, an intake of Lithium through drinking water would result in a daily dose of 13.8 mg Lithium carbonate by mouth—about 1% of what psychiatric patients typically receive.

It also matters that the patients most assisted by adding trace amounts of Lithium to drinking water are at higher risk of suicide than the general population. Suicide disproportionally afflicts disadvantaged groups in society, such as people who are victims of discrimination, the mentally ill, unemployed, and sufferers of chronic illnesses (Page *et al.*, 2014; Rane and Nadkarni, 2014; Sundquist *et al.*, 2014; Kang *et al.*, 2015). One could therefore argue that mass treatment is urgent in order to benefit those populations who are vulnerable or disadvantaged, socioeconomically or health-wise. A further argument for 'one-size-fits-all' policies is that they tend less to stigmatize and shame beneficiaries (Wolff, 1998).

## Safety

In high doses, Lithium can cause serious adverse effects. In toxic doses it can lead to death (Terao, 1993). The Lithium dosages used in psychiatric treatment typically range between 300 mg (milligram) and 1800 mg per day, with blood levels monitored regularly to maintain effectiveness and safety. Long-term treatment with high-dosage Lithium does carry some risk of adverse effects such as hypothyroidism, weight gain and renal disease (Oruch *et al.*, 2014). However, when adequately

monitored and titrated, even high-dosage Lithium is a safe and highly effective treatment for serious mood disorders (Severus *et al.*, 2014).

However, because adding low-dose Lithium to tap water would medicate nearly everyone, a fair worry concerns widespread adverse effects. First, a few studies showed side effects of trace Lithium. Studies in the Andes Mountains associated high doses of Lithium in the drinking water with hypothyroidism as well as some reduction in fetal size (Broberg *et al.*, 2011; Concha *et al.*, 2010; Harari *et al.*, 2015). The level of Lithium in the drinking water in some of the Andes communities, was, however, considerably higher (up to 1000 microg/litre) (Broberg *et al.*, 2011), that is about 10 times the levels found in the Texas study (Schrauzer and Shrestha, 1990).

Second, if the suicide prevention effect of Lithium is achieved through effects on behavior, e.g. reducing aggression and impulsivity, its effect may also manifest in other behavioral traits, at least for some individuals (Wingo et al., 2009; Ko *et al.*, 2014). Some of these changes may be negative or at least unwanted for individuals or for society.

Thus far, interventional studies of behavioral and personality change related to Lithium had always been conducted using clinical dosages (Judd *et al.*, 1977; Barton *et al.*, 1993). This leaves important empirical questions unanswered, both regarding positive effects and risks of adverse effects.

### Costs

Population-level interventions can potentially be very expensive, because a substantial financial cost is multiplied over the entire population. Other times, it is the selective intervention that is more expensive, say, because diagnosing high-risk sub-populations would cost a lot or they can only be identified too late for cheap preventative measures. Given the high costs of suicide, suicide prevention interventions are likely to be very cost effective even with a modest 1% reduction in the suicide rate (McDaid *et al.*, 2010).

While cost is not the only consideration in health policy, it is clearly one relevant consideration (Norheim *et al.*, 2014; Brock *et al.*, 2016). Everything else equal, lower costs are preferable. Although we are not aware of any studies about the costs of adding Lithium to drinking water, Lithium is inexpensive and, like fluoride, can be added to the water supply. Doing so is likely to be cheaper than much more targeted interventions that require finding out who is at high risk for suicide and offering them individual therapy.

This generalization may hold, although adding any amount of Lithium to tap water requires special infrastructure, experts, and other advance financial investments. That being said, costs may vary a lot in different areas and given different circumstances.

### A Scenario

Given the mixed or lack in evidence, observations that apply new methodologies in settings with greater differences in natural levels of Lithium, as well as intervention studies, are needed. Meanwhile, we propose to proceed by assuming one particular scenario and discussing the ethics on that assumption.

This article will assume that adding trace Lithium to the degree that populations reach the daily recommended allowance as stated by Schrauzer has a real and substantial suicide prevention effect that its other health effects are moderate, and that it is cost effective compared to more targeted alternatives. Specifically, we shall assume that it increases only by a little the hazard of hypothyroidism in the population (and we shall assume that the intervention is considered in a country with the means to manage hypothyroidism). In fact, many side effects of hypothyroidism ceases and is reversible the moment Lithium is stopped. The risk of kidney impairment is also elevated in patients on Lithium therapy but, given the low dosage, we will assume this hazard to be very low. We will also assume that trace Lithium water fortification carries also a small probability, though across the entire population in a fair number of individuals, for changes (not for better or worse) to personal behavior or character.

The rest of this article assesses objections to the addition of Lithium to drinking water on that scenario, which may or may not be true.

The advantage of assessing the ethics on a descriptive scenario that is not implausible but may or may not be true is that the ethical recommendations do depend on the fact and a determinate scenario provides concreteness. Occasionally we assess robustness by discussing variations on this scenario.

## Harm and Consent: Two Challenges to Water Fortification with Lithium

Let us examine two clusters of objections to adding Lithium to drinking water, on the above scenario. One

clusters surrounds the notion of harm and the other, that of consent.

## Preventing Harm

A harm-based objection to adding Lithium to drinking water on this scenario will come in four variants respectively, based on the intervention's (1) aggregate individual effects, (2) collective effects, (3) active nature or (4) effect distribution.

First, even though the hazard and degree of harmful side effects from water fortification with trace Lithium may very well remain small for the average individual (and the scenario above assumes as much), the aggregate individual harm may be substantial given that a great many people are exposed. Our scenario above does not strictly rule out this possibility, and it depends in part on complex priority weights for, e.g. the individual and familial harm from suicide. Ethical approaches that assign prevention of large harms priority over prevention of much smaller ones regardless of aggregative benefits (Scanlon, 1998) would tend to support water fortification with trace Lithium. Under the scenario we are assuming (which ruled out even kidney damage), death from suicide is clearly far worse than the worst side effects envisaged.

Second, some may speculate about a collective harm that is separate from the harms directly done to individuals. For example, some may oppose mass fortification with Lithium on the ground that it could be used as a substitute for addressing the underlying social causes of suicide in e.g. underprivileged communities. However, if this argument worked it would also undermine other interventions that focus on preventing acts of suicide rather than address the underlying causes, including means restriction and other broadly accepted interventions. Considering the costs and emotional burden of suicide, it seems cynical not to implement measures that would effectively prevent suicide just because they do not address one important set of causes.

A third variant of a harm-based objection against adding Lithium to drinking water is based on *Primum non Nocere*, namely, the alleged priority of refraining from active harm, as compared to either provision of benefits or prevention of natural harms, e.g. natural disease and its effects. Indeed, the side effects of artificially adding Lithium to drinking water would clearly be the results of state *action*; advocates were too quick to dismiss the opposition by saying: 'People who oppose adding lithium to the drinking water in trace amounts don't go around advocating to strain the lithium from the drinking water from areas where it does exist. Why not give everyone the same benefit?' (quoted in Bates, 2011). Harm from naturally occurring Lithium might be considered less weighty than ones introduced by the state.

However, even assuming that *Primum non Nocere* so interpreted is valid, note that in our case, the worst danger from the active addition of Lithium to drinking water is low-level morbidity, not at all commensurate with the tragedy of suicide. Therefore, to argue against drinking water fortification with Lithium on the basis of opposition to active harm would require a nontrivial argument that it is worse to expose people actively to low risks of (moderate) adverse effects than to provide benefits such as suicide-prevention.

It could also be argued that enhancement is less important than treatment, and that therefore treatment-requiring harms from sheer water-fortification enhancement are unacceptable. However, Lithium fortification is not 'enhancement' in the sense of e.g. generating superhuman capabilities. Its attraction is as a prophylactic against a major source of human mortality.

Finally, the matter of the distribution of harm and the separateness of individuals. For some individuals, adding Lithium to the drinking water does not improve their prospects and would only pose risks—mild or significant. For instance, young children, while having a lower risk of suicide than the overall population may be at higher risk of adverse effects, as their developing nervous and renal systems create increased vulnerability to any drugs that affect these systems (Tueth *et al.*, 1998). If observations further show that on average, the benefits for the population at large from Lithium greatly surpass these offsets, this would create ethical dilemmas. From a certain philosophical viewpoint, one could argue that it is never justified to sacrifice the net interests or rights of one individual for the sakes of others, for the sakes of those likelier to benefit from the intervention. On a certain philosophical approach, unless all recipients consent to the intervention, distributing Lithium for the benefit of some would mean using others, or perhaps all, as mere means, and that is usually wrong (Nozick, 1986; Kamm, 1996; Otsuka, 2005).

We lack the space to discuss this philosophical approach in full. However, let us make three rejoinders. First, the argument about sacrifice loses much of its force in cases where the alternative of opting out exists. If no one is coerced or manipulated into taking Lithium, it is harder to argue that they are sacrificed. We will return to this question in the following section. Importantly, central proponents of this philosophical approach are strict libertarians, for whom the possibility

to opt out, e.g. by purchasing or receiving bottled water without Lithium, is sufficient by way of consent. Such philosophers would find no problem in adding Lithium to tap water.

Second, some of the proponents of this philosophical approach concede that to impose mild harms on a nonconsenting innocent so that others are free from major harm can be permissible. To shove a nonconsenting innocent person causing them to fall on the ground is permissible as a way to save another from death is permissible (Otsuka, 2005). If all the harm caused by Lithium in tap water turns out to be mild, they may agree that causing it is permissible for effective suicide prevention.

Third, public health practice is somewhat interventionist and may already assume away these philosophers' libertarian approach. Some practices in public health regularly expose persons to interventions not for their own sakes, but primarily for the sakes of others, sometimes without full consent. An example is influenza immunization policies, where adults are immunized against influenza largely to protect the elderly, children, and people with reduced immune systems; for the latter, contracting seasonal flu is likelier to be fatal, and immunization, likelier to be burdensome (Reichert *et al.*, 2001). Another example is rubella vaccination of children, primarily for the sake of pregnant women and their fetuses (Miller *et al.*, 1997). There is, however, one potentially important difference between these policies and the case of mass Lithium treatment. In the case of these vaccinations the motive is to protect others from being harmed by the intervention recipients (getting infected by them), which is widely recognized as a legitimate cause for liberty-restricting measures (Nozick, 1986; Mill, 2003; Emhoff *et al.*, 2016). Lithium fortification for suicide prevention, however, aims to prevent harm to self, which typically is seen as a more controversial ground for interference (Feinberg, 1986; Mill, 2003, but see Conly, 2012).

That said, even if we must reject the philosophical viewpoint that any sacrifice of some people's interests for others' interests' sakes is wrong, there initially remains a question about adding Lithium to drinking water. It is not trivially right. Albeit important causes of death in certain age groups, suicides are rare events. The global suicide rate in 2012 was about 11.4/100,000 (WHO, 2014). This means that even if adding Lithium to tap water halved the suicide rate, in a standard population more than 17,000 individuals would have to be exposed to Lithium in drinking water in order to save a single person from suicide. In this regard, adding Lithium to drinking water to prevent suicide would differ from, say, adding fluoride to prevent cavities. Many people are at high risk of dental caries, which is endemic. By contrast, most people are at a very low risk of suicide (Joiner, 2011). There are at least two responses to this worry. First, suicide is a far more severe harm than caries. Second, everyone or nearly everyone is at some objective hazard of moderate harmful externalities from suicide, such as the mental health effects of suicide on family and the economic losses to workplaces (Institute of Medicine (US) Committee on Health and Behavior: Research, 2001; Taylor *et al.*, 2005; Li *et al.*, 2011).

We tentatively conclude that, depending on whether further studies confirm the scenario assumed above, objections clustered around harm-prevention fail to show that adding trace Lithium to drinking water would be wrong.

## Personal and Communal Consent

Libertarians and liberals agree that administering a medical drug can usually be justifiable only with the advance consent of all individuals being medicated. That pertains not only to harmful drugs, but to any drug. But individual consent to mass medication is unattainable in practice—certainly consent ascertained to be informed, voluntary, and competent. Indeed, in 1989, when the first paper demonstrating the inverse relationship between trace amounts of Lithium in water and suicide was published, critics wrote that the lead researcher was trying to impose 'mass mind control' (quoted in Bates, 2011).

For many libertarians, a potentially satisfactory response should be that people can always opt out of being medicated with Lithium, for example, by buying bottled water instead. If they cannot afford the latter then they have only their own poverty to blame.

For many liberals, however, this answer is not enough. Bottled water is expensive and, even with financial compensation, far less ubiquitous than taps. A similarly strained 'opt-out' would not be acceptable for invasive medical interventions and liberals may object that mass treatment is inappropriately paternalistic.[1] Paternalistic interventions with autonomous decisions (so-called 'hard paternalism') are controversial and according to some never acceptable. Few public health measures are openly justified purely on beneficence grounds and regardless of impact on autonomy (Faden and Sirine, 2010).

Nonetheless, interventions for the benefit of individuals who are unable to make autonomous decisions about the matter ('soft paternalism') are far less

controversial. While surely some individuals in the entire population are perfectly capable of making an autonomous, rational decision on whether to add Lithium to their drinking water and/or commit suicide, a potential response would motivate paternalistic population intervention by referring to the interests of a subset of individuals who, at least temporarily, predictably would not or could not make autonomous decisions about the matter. This kind of paternalism has been called 'group soft paternalism' (Miller and Wertheimer, 2007). This would be analogous to the argument in support of fluoridation of everyone's water to prevent cavities in children, who cannot make autonomous decisions about dental hygiene, and despite the capacity of many adults to decide on their own.

In our setting, many (perhaps most) suicides are not results of autonomous and rational decision-making processes, especially in individuals with serious psychiatric disorders (Cholbi, 2004/2012; Okai *et al.*, 2007). Decisions to attempt suicide are often made on very short notice (Joiner, 2011); in acute suicidal crises, problem-solving abilities are altered (Jollant *et al.*, 2011). Absent means of telling which individuals will commit suicide non-autonomously and when, the fact that many suicides are not autonomous acts may justify group soft paternalistic interventions across the population as necessary to prevent substantially non-autonomous suicide.

But a group soft paternalistic response to the consent challenge is insufficient given that Lithium is not beneficial to all—it is neutral or even somewhat detrimental to some. It is here that another response to the consent challenge may help. That response focuses on the potential for democratic consent. In a word, if those affected by the program are able to influence decision-making, e.g. through political processes, then consent may be obtained on a group basis. Even if on matters concerning medication with powerful drugs and other high-stakes or invasive interventions in the body, individual refusal would trump democratic majority rule, it can remain the case that when even individual losers from a public health measure stand to lose only a bit, majority rule suffices by way of consent. In this vein, we usually think that laws requiring seat belts, smoking zoning laws, and others are within the authority of the democratic legislature. Arguably, in the scenario assumed in this article, the addition of Lithium to tap water is relatively benign and non-invasive, and in the rare exceptions that a person knows or fears a special sensitivity he or she could rely on bottled water, so the addition of Lithium to tap water could be justified by democratic majority rule.

In our view, this pretty much resolves the direct challenge about nonconsensual medication. Still, while Lithium in tap water would not violate rights to consent or to autonomous authorization, chequered public support resulting from perceived violations of consent and autonomy may pose at least two practical challenges.

First, if as a result trust in health authorities erodes, distrust could thwart the implementation of health measures more urgent for population health. In many places around the world, there is already considerable distrust of public health authorities. Take water fluoridation. Despite its patent success in reducing caries, vocal opposition remains. Some opponents refuse to risk even remote possibilities of side effects, not even to greatly assist a minority (Cross and Carton, 2003; Shickle, 2006). Adding a psychotropic substance to the population's drinking water or basic food items is likely to be even more controversial, especially if it sets back some people's net prospects, or they perceive it to do so. Another problem is the possibility of harmful opt-outs, that individuals turn to options with adverse consequences, just to avoid that measure. For instance, if Lithium were added to tap water, some might unnecessarily drink more bottled 'Lithium-free' water, wasting money with negative environmental effects due to preparation, transportation and disposal of bottled water. Or they might drink more bottled sugary drinks, with negative effects on population health. Since anyone frustrated that Lithium is not being added to drinking water is free to seek medical help and individual prescription or therapy, their political standing to impose mass administration on others is likely to be undermined. And, as argued in the next section, subgroups that may benefit the most may be disadvantaged and relatively disenfranchized. However, the question of political support is difficult to speculate about and may be affected by non-related political issues and status quo biases, either in advance of the intervention or following its implementation (Bostrom and Ord, 2006).

## Alternative Methods of Lithium Distribution

How do relatively targeted delivery methods for Lithium delivery ethically compete with adding trace Lithium to tap water? Let us review three such methods: the addition of trace Lithium to table salt, Lithium addition it to selected general medications and, most selectively, to individual prescriptions of Lithium to those at risk of suicide.

## Table Salt

One way to make opting out easier while reaching a large population will be through Lithium fortification of certain types of food products, such as some types of table salt. Iodine is regularly added to table salt, and fluoridated salt is used in some parts of Europe and South America. One advantage of adding Lithium to designated types of salt instead of all tap water is lower risk of overexposure for children.

However, in countries where fluoridated salt is provided on sale along with unfluoridated salt, its effectiveness on a population basis has been shown to be limited. In our own case, choosing Lithium-enriched salt might be perceived as admission of mental health problems and incur stigma. Additional reasons, including ignorance, may dissuade some from buying unfortified products. Hence, the measure is likely to reach fewer people, nor will those who avoid Lithium necessarily be those who stand to benefit. Hence, all in all, the benefit of trace Lithium in salt would likely be lower than under a policy of adding it to tap water.

## Selected General Medications

A somewhat more targeted approach abandons the idea that the preventive measures should potentially reach all or most in the population. It shifts focus to individuals with known increased risk, such as patients diagnosed with psychiatric disorders or with other medical conditions linked to higher risk of suicide. If these patients are already taking medication, this may make the risk-benefit ratio more favorable than under less selective approaches. Addition of trace Lithium could be offered as primary prophylaxis to all psychiatric patients (an opt-in model), to all patients with suicidal ideations, or to other patients with conditions that are known risk factors for suicide (e.g. chronic pain). Trace amounts of Lithium could be added to medications such as antidepressants, anxiolytics, and antipsychotics.

One advantage of such selection is that individual informed consent becomes possible. If Lithium were added to all psychiatric medications, then opting out is (burdensome but) practicable—especially if versions of the same medications without Lithium could be procured. Another advantage would be that the risk of adverse effects of trace amounts of Lithium, if any, is more justified for patients at high risk, who may also have a healthcare contact to monitor their health status. However, this intervention would not reach persons at risk without ongoing contact with healthcare—perhaps the group that would benefit the most from not needing individualized prescription of Lithium. In addition, unless combined with increased access to health services, the impact of making psychiatric patients eligible to medications containing Lithium is usually limited. However, although this option is attractive from some perspectives, it is important to note that we do not have data to support that it would actually be effective. More research would help draw conclusions about (trace) Lithium's anti-suicide effect.

## Individual Prescription

The least selective alternative is to treat low or high-dose Lithium like any other prescribed medication—to offer it only after specific clinical assessment. If studies show that certain levels of Lithium are effective in preventing impulsive suicide, then it could be prescribed to individuals at particular risk, e.g. to people with a history of impulsive self-harm or attempted suicide, or to patients with serious psychiatric disorder. It could be argued that, just as aspirin is routinely offered to patients with a history of cardiovascular events, low dose Lithium should be offered to patients at elevated risk for suicide. This measure will be most conducive to individual autonomy since fully informed consent would be highly practicable. The risk-benefit ratio per patient medicated would be better than for the less selective approaches. However, this policy's effect on total suicide rates would remain relatively low, certainly if it is not paired with significantly greater access to psychiatric care and greater willingness to seek psychiatric help. Also, research would be needed to demonstrate clinical effectiveness of low-dose Lithium to prevent suicide when used as a targeted intervention in high-risk groups.

## Future Research

To gather more evidence, prospective cluster-randomized controlled trials specifically investigating efficacy and toxicity of trace doses of Lithium would be ideal. However, given how rare suicides are, the study would require an unrealistically large number of participants followed up over decades, with high potential for inter-arm 'pollution'. One possibility would be introducing large-scale administration with trace Lithium temporarily or in circumscribed geographical zones, and taking stock and potentially removing or expanding the policy once some of these good and bad effects materialize. However, even setting aside the financial investment necessary for first introduction, given the factors mentioned above, a large-scale population-wide experiment

may only exacerbate fears and encounter additional opposition. It seems inevitable to continue to rely on observations, and comparing cohorts with differences in natural levels of Lithium. If and when Lithium is introduced on a population level, the measure should be designed for scientific evaluation, which should be conducted in parallel with implementation For targeted measures, such as individual prescription, intervention studies would be easier to conduct, e.g. through randomized controlled trials. However, also here a large number of participants would need to be included in order to evaluate the effects given that suicides are rare also among typical high-risk groups. However, individual consent would be possible to acquire and the active treatment component is cheap and well-known as a psychiatric medication. However, there is no big financial incentive for any pharmaceutical company to expand the use of Lithium in psychiatry.

## Conclusion

Whether and how we should administer trace amounts of Lithium depends in part on what future empirical evidence reveals. In order to justify mass administration (e.g. adding Lithium to drinking water), the intervention must be demonstrably efficacious and effective enough, and benign enough to expose a very large number of people to it.

If future empirical evidence reveals that trace Lithium is highly efficacious and effective in preventing suicide, that its toxicity is entirely rare and mild, and that there is no relevant impact on behavior or personality, then the case for water fortification will be very strong. Now assume instead that trace amounts of Lithium are somewhat efficacious and effective for suicide prevention, as well as fairly safe, along the lines described in the scenario above. If that is case, adding trace Lithium to drinking water does stand the highest potential to reduce the total number of suicides, compared to more selective approaches of delivery. It is true that adding trace Lithium to drinking water is also the option with the highest risk of causing harm through adverse effects, and of transgressing individual autonomy. We thought that, notwithstanding these objections, on the scenario above, adding it remains the best option on balance. However, if trace Lithium turns out to have serious toxicity and profound effects on behavior and personality then, given how rare suicides are in the general population, normally the measure should not be introduced.

## Notes

1. By 'paternalism' we refer to the interference of an agent (including a state) with another person, without the person's consent, when motivated by a belief that the person interfered with will be better off or protected from harm Dworkin, G. (2017).

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## Conflict of interest

All authors declare that they have no conflict of interests.

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