Iodine prophylaxis in Guernsey for thyroid protection in the event of nuclear radiation exposure

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Abstract

This document attempts to extrapolate the implications, for the island of Guernsey, of the guidelines for iodine prophylaxis following nuclear accidents compiled by the World Health Organisation. Addressed specifically here is the issue of costs and potential benefits as well as the logistical implications of distribution and storage of the appropriate prophylaxis. The authors aim to provide an external perspective on this issue.

Keywords: iodine prophylaxis, nuclear disaster planning, Channel Islands

1. Introduction

Whilst increasingly stringent safety procedures and the redundant failsafe mechanisms utilised by the nuclear power industry make significant nuclear accidents a vanishing rarity, the recent events at the Fukushima nuclear plant in Japan have emphasised the fact that large nuclear radiation leaks are still a possibility. Whilst the unfortunate combination of events at Fukushima are unlikely to occur at sites around the English Channel this accident should still serve as a reminder that even the most rigorous safety systems are not infallible. In spite of the severity of damage to the local infrastructure and the relative paucity of emergency services available, distribution of prophylactic iodine and a large scale evacuation of nearly 185,000 people from the towns closest to the Fukushima nuclear accident was still possible [1]. In a similar situation in the Channel Islands it is likely that an emergency evacuation would be less rapid as a result of geographical difficulties. A large scale evacuation of the population of the islands is likely to take a considerable length of time during which time the population would suffer a degree of radiation exposure. In these circumstances the importance of reducing the impact of radiation exposure to the local population is even more critical. A principle danger of radiation leaks is the release of radioactive isotopes of iodine (namely ^{131}I, ^{132}I, and ^{133}I) which give rise to both external and internal radiation exposure. Internal radiation exposure poses the largest health risk and is primarily caused by inhalation and in part by ingestion of these radioactive isotopes. Once in the body iodine is preferentially taken up the the thyroid gland. The thyroid gland is subsequently exposed to the radiation released by these isotopes as they undergo radioactive decay. This increases the risk of a number of thyroid pathologies including hypothyroidism (reduced thyroid function), transient thyroiditis (inflammation of the thyroid), benign thyroid tumors and thyroid malignancies (cancer). Consumption of high dose, stable iodine (^{127}I) before and during radiation exposure has been demonstrated to reduce the risk of these conditions effectively [2]. This prophylactic dose of stable iodine prevents the uptake of the radioactive isotopes by saturating the thyroid gland with stable iodine. Effective prophylaxis involves provision of a once daily dose of stable iodine during the period of radiation exposure. One of the key factors in maximising the effectiveness of this treatment is instigating the first dose of iodine as early as possible.

The greatest risk of radiation related disease occurs in those under the age of 18. The relative risk of developing malignancy within the under 18 population shows a negative correlation with age, i.e. the youngest children have the highest subsequent lifetime risk [3, 4].

The World Health Organisation (WHO) have compiled a set of guidelines for the implementation of a strategy to provide iodine prophylaxis following nuclear accidents [2]. These guidelines include the recommendation that a supply of stable iodine tablets should readily available for distribution to populations within a short distance of a nuclear power plant. This document attempts to highlight the implications of these guidelines for the island of Guernsey and the impact of implementing a effective strategy of storage and distribution of prophylactic tablets.

2. Radiation risks posed to Guernsey

The nearest nuclear power plant to Guernsey is located at Flamanville, France and operated by Électricité de France (EDF) and has recently been earmarked for significant ongoing investment [5]. The distance between Guernsey and this power plant is just under 30 miles (48 km). The deterministic effects of the radiation exposure are estimated to be significant only out

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Age group	Mass of Iodine (mg)	Mass of KI (mg)	Fraction of 100 mg tablet
Adults and adolescents over 12	100	130	1
Children 3 to 12 years	50	65	1/2
Infants 1 month to 3 years	25	32	1/4
Neonates birth to 1 month	12.5	16	1/8

Table 1: Recommended single dose of stable iodine to be taken promptly in the case of significant radiation exposure and repeated daily in prolonged exposure. Table excerpted from the World Health Organisation Guidelines for Iodine Prophylaxis following Nuclear Accidents [2].

to a radius of approximately 5 km [2]. This includes permanent damage to the thyroid resulting in hypothyroidism. As Guernsey is significantly far outside this radius it is unlikely that radiation exposure in the Channel Islands would result in any significant risk of these deterministic effects. In contrast, the stochastic effects of radiation exposure (including the development of thyroid malignancy) have been reported up to 500 km from the site of the Chernobyl accident [2]. Guernsey is within this 500 km distance of a number of nuclear power plants including Hinkley Point B, Berkeley, Dungeness, Sizewell B, Wylfa, and Heysham in the United Kingdom; and Paluel, Penly, Saint-Laurent, Chinon, Civaux, Belleville, Dampierre, and Nogent in France. Whilst it is very unlikely that any significant health risk could be posed by a radiation leak at any of the more distant of these reactors, the proximity of Guernsey to the Flamanville site may qualify as a significant danger to justify the stockpiling of iodine prophylaxis according the WHO guidelines. In addition, the difficultes of rapid evacuation from the Channel Islands in the event of a nuclear accident make it more important that effective methods of immediate prevention of radiation damage are available. Furthermore the efficacy of the iodine prophylaxis falls rapidly after the first three hours post exposure [2]. This effectively rules out the possibility of emergency importation from the UK, or elsewhere, of sufficient iodine supplies as the total time taken for dispatch, transit, and distribution would greatly restrict the effectiveness of such a programme.

The lifetime risk of developing a thyroid malignancy subsequent to significant radiation exposure is estimated to be as high as 1% for those exposed younger than 15 [2, 3]. Based on interpretations of the 2010 Guernsey census data [6] this would equate to around 100 thyroid cancers in the under 15s alone with additional malignancies in the older population group. Whilst the mortality from these malignancies is low, the associated morbidity and ongoing healthcare costs (including lifetime screening for additional malignancies) is high. A reduced risk of malignancy is also present in adults under 40. The WHO analysis concludes that no significant risk is posed to individuals over 40 [2].

3. Iodine prophylaxis

The efficacy and proposed treatment doses are discussed fully within the WHO guidelines and will not be fully elaborated upon here. However the treatment doses recommended are replicated in table 1.

The treatment referred to by the WHO is potassium iodide (KI). This basic salt can be purchased at minimal cost. Based on current population data, to provide adequate prophylaxis for the entire population under 40 in Guernsey for one week of radiation exposure, a total number 190,000 130 mg doses are required. The estimated expense of providing this quantity of KI is £2371.20 based on the British National Formularly price for the liquid preparation. The shelf life of these salts is widely regarded to be 5 years making the the annual cost of maintaining these supplies under £500.00.

4. Proposed programmes

The most effective method of distribution of prophylactic iodine in the event of a nuclear emergency is widely considered to be from schools and hospitals. Multiple distribution points minimise traffic congestion and transit time in the event of a an emergency. In addition, the transport infrastructure around schools is generally sufficient to cope with the large volumes of traffic. The regional demarcation of Guernsey's parishes provides an excellent and natural mechanism for determining which population areas should report to which distribution centre.

The most basic provision plan for a nuclear accident is to have the necessary iodine supplies available at a single location in Guernsey with subsequent division of these supplies between the local distribution centres when required. In addition a broadcast explanation of the procedure and reporting instructions could be aired. A more advanced system would consist of the iodine being divided between the smaller centres in anticipation of the emergency with basic written guidance as to the planned distribution process. This could be instigated at minimal extra cost.

A considerably more advanced and more expensive system would provide additional training for staff members at the distribution centres although the benefit of this increased level of preparation is unclear and unlikely to be cost effective.

5. A comparison with other European countries

There are very few European countries have without provisions for Iodine prophylaxsis. The governments of Malta and Estonia have made an active descision not provide stable iodine prophylaxis arrangements [7]. Malta has no nuclear power plants in its vicinity and the closest nuclear power plant to the Estonian border is Leningrad, at a distance of 80 km. Croatia is the only other country without a stratergy implemented, however a discussion about nuclear emergency planning is currently underway [7]. Ireland has decided to discontinue provision for iodine prophylaxis following the closure of the two most vulnerable nuclear reactors in the UK (Calder Hall and Chapleross) [7]. The closest reactor remaining to the Repulic of Ireland is the Wylfa reactor in North Wales, at a distance of 114 km.

The majority of the remaining European contries , namely Belgium, the Czech Republic, Denmark, Finland, Germany, Hungary, Italy, Lithuania, Luxembourg, Norway, Romania, Slovakia, Slovenia, Sweden, Switzerland, Turkey, and the United Kingdom have chosen to adopt the provision of the doses recommended by the WHO. Bulgaria, France, the Netherlands, and Poland have adopted the stratergy with minor variations to the suggested doses [7]. The median frequency of replacement of KI stores is every 60 months, however a number of countries (Belgium, Germany, Spain, and Switzerland) have adopted a period of 120 months. The selected radiation dose for immediate intervention with KI tablets is variously selected to be between 10-100 mSv [7].

6. Conclusions

Considering the proximity of the nuclear power plant at Flamanville, serious consideration is needed as to whether or not to implement a prophylactic iodine distribution programme. The financial cost of implementing the most basic programme of stock piling and distribution of potassium iodide is minimal. It would be considerably more costly to develop a more extensive programme involving the production of detailed emergency plans and provision of training for relevant individuals on distribution procedures. However, this more extensive programme could be considered to be an unnecessary expense. Written emergency procedures together with iodine stock piles could be rapidly distributed in the unlikely event of such an emergency.

In the event of a significant local nuclear accident, such a programme would prevent an estimated 100 thyroid cancers in the under 15s as well as an additional number of cancers amongst older children and young adults. It would also limit the associated morbidity and large healthcare costs that these malignancies would cause. It is impossible to accurately quantify the chance of a significant nuclear accident. However this risk is considered to be very small. Therefore the question that needs answering is: How much should be spent on the prevention of a significant number of thyroid cancers when these cancers will only occur in the unquantifiably unlikely event of a nuclear accident?

7. Declaration of interests and acknowledgements

This work has not been produced in affiliation with any commercial or government organisation and solely reflects the opinions of the authors. Many thanks to Dr Lucilla Butler, Dr Katie Platts, and Mr Peter McGovern for their suggested revisions and additions to this work.

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