

# Effects of Thimerosal on Lipid Bilayers and Human Erythrocytes: An In Vitro Study

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**Abstract** Thimerosal (THI, ethyl-mercury thiosalicylate) is added to vaccines as a preservative; as a consequence, infants may have been exposed to bolus doses of Hg that collectively added up to nominally 200 µg Hg during the first 6 months of life. While several studies report an association between THI-containing vaccines and neurological disorders, other studies do not support the causal relation between THI and autism. With the purpose to understand the molecular mechanisms of the toxic effect of THI it was assayed on human red cells and in bilayers built-up of dimyristoylphosphatidylcholine (DMPC) and dimyristoylphosphatidylethanolamine (DMPE), classes of phospholipids found in the outer and inner monolayers of the human erythrocyte membrane, respectively. The capacity of THI to interact with DMPC and DMPE was determined by X-ray diffraction and differential scanning calorimetry, whereas intact human erythrocytes were observed by optical, defocusing and scanning electron microscopy. The experimental findings of this study demonstrated that THI interacted in a concentration-dependent manner with DMPC and DMPE bilayers, and in vitro interacted with erythrocytes inducing

morphological changes. However, concentrations were considerable higher than those present in vaccines.

**Keywords** Thimerosal · Human erythrocyte membrane · Lipid bilayer

## Abbreviations

THI	Thimerosal
DMPC	Dimyristoylphosphatidylcholine
DMPE	Dimyristoylphosphatidylethanolamine
SEM	Scanning electron microscopy
DM	Defocusing microscopy
DSC	Scanning differential calorimetry

## Introduction

Thimerosal (THI, sodium ethyl-mercury thiosalicylate,  $C_9H_9HgNaO_2S$ , Fig. 1) is 49.55 % Hg in weight. It is currently used in pharmaceutical preparations and as a bactericidal and fungicidal additive to drugs that are injected (Geier et al. 2015). In water solutions, THI dissociates into thiosalicylic acid and ethylmercury cation (Trümpler et al. 2014). Its antimicrobial activity is due to the small amounts of ethylmercury. It has been reported that the in vitro toxicity of ethylmercury and THI is comparable to the toxicity of methylmercury (Dórea et al. 2013). Thimerosal is also used in vaccines as a preservative, at concentrations of 12.5–25 µg Hg per 0.5 mL vaccine dose. As a result, infants can be exposed to bolus doses of Hg in the range of 12.5–62.5 µg Hg that would amount up to 200 µg Hg during the first 6 months of life (Geier et al. 2013). Massive overdoses of products containing THI have resulted in toxic effects (Pichichero et al. 2002). Studies in humans have concluded that THI is

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