The Fiscal Consequences of Vaccination for Government: A Government Perspective Assessment of Tax Revenue and Transfers Associated to Changes in Population Health Status Attributed to Immunisation

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Background to study

In 2009 the WHO released the WHO Guide to Identify the Economic Consequences of Disease and Injury (WHO, 2009). Within the WHO guide the impact of population health on government was described. Specifically the report acknowledged that poor health can impact government fiscal accounts both in terms of lost tax revenue and increased transfers costs (WHO, 2009). Despite acknowledging that population health status will have fiscal consequences for governments, the report provided few examples of the ways in which population health does impact government revenues and transfers. The research described in this proposal aims at understanding, mapping out and quantifying the fiscal consequences for governments associated with population health changes – in particular those that relate to immunization programmes and policies in low and middle income countries.

Conceptual foundations

The fiscal consequences of population health have been evaluated in a limited number of studies in developed economies. The impact of ill health in working aged adults was described in a study conducted by the British government in 2009. The assessment of the economic consequences associated with ill health in working aged adults revealed that 89% of the costs of illness to the government was attributed to disability costs and lost tax revenue (Black, 2008). In contrast, government health costs on disease in this population which are typically considered in cost-effectiveness analysis represented only 11% of the total costs to government (see Table 1). This finding suggests that the typical health-service and societal perspectives applied to evaluate health programs would not encapsulate the broader economic effects of poor health to governments. Whilst these costs are often considered as transfers between individuals from the societal perspective, these fiscal transfers represent real costs for governments.

| Table 1 Fiscal consequences of poor health in working-aged populations United Kingdom (Black, 2008) |
|---------------------------------|---------------------------------|-----------------------------|
| Annual cost to government Billion £ (2007) | Percentage of government cost |
| Workless benefits | Cost | £29 | 43% |
| Healthcare | Cost | £5 – £11 | 11% |
| Foregone taxes | Revenue loss* | £28 – £36 | 46% |
| Total costs to government | | £62 - £76 |

* This may represent an underestimate of lost tax receipts because it does not account for lost consumption taxes associated with lower disability incomes.

The fiscal consequences at the disease specific level have also been assessed. For example, estimates from the United States indicate that lost tax revenue attributed to obesity will result in $60 billion in lost tax revenue in 2004 – 2050 (Goldman, 2010).

Applying a fiscal perspective to medical technologies highlights the limitations of the societal perspective typically applied in cost-effectiveness analysis. Because the societal perspective
excludes the economic consequences of health status changes for governments, the impact of health status changes on transfers and taxes would not be captured (Garrison, 2010). Whilst the societal perspective is useful for reflecting societal welfare, the actuarial and fiscal consequences of changes in health status represent real costs to governments (WHO, 2009; Black, 2008). Consequently, typical cost-effectiveness that ignores transfer and tax changes attributed to health gains is divorced from the budgetary reality that exists in all countries and within which funding decisions, for example, vaccination programs are often made on. With the above in mind, the analytic framework described here departs from welfare economics and focuses in tangible fiscal accounting and budgeting principles applied by governments. Whilst achieving welfare maximisation is a worthwhile goal to pursue, for many countries, fiscal constraints, especially in developing economies are equally important and need to be considered with respect to funding decisions to achieve sustainable financing, reduce future deficits and public debts.

Health and taxes
The fiscal consequences of health status changes are reliant on estimating productivity changes and how these changes translate into increased earnings and consequently increased tax revenue for government. Deriving estimates from health gains is an unconventional approach for valuing health gains and is seldom considered in the health economics literature. In contrast, valuing human lives in future tax revenue is fundamental to analytic approaches used by Treasury departments and international organisations such as the World Bank and IMF which often apply a generational accounting framework to analyse policy decisions (Auerbach, 1999). Inherent in these methodologies is the value of health human capital translated into future tax revenue for government. Because of this, the generational accounting methodology is increasingly applied in public finances as a means of forecasting fiscal sustainability (Bonin, 2004).

At the core of generational accounting is population age-structure (i.e. demography), the proportions of people of working-aged populations, future workers in the case of children, and productivity. These core measures are intricately linked to population health status and investments within the health sector. Consequently, it is possible to measure using the generational accounting framework how investments in health programs that influence the population age-structure and productivity will influence current and future government taxes and transfers. Furthermore, as implied by the name, the generational accounting framework assesses the fiscal dynamics of population health over very long time periods. Therefore, the methodology is well placed to evaluate vaccination programs because benefits from vaccination also accrue over very long time horizons.

Application in low and middle income countries
In low and middle income countries the fiscal consequences of poor health are poorly understood. This is mostly attributed to limited availability of data in these countries and the limited number of government transfers available to citizens.

There are two fundamental economic relationships that underpin the analytic approach described here. Firstly, the established relationship between health and economic growth that is applicable to both low and middle income countries (WHO, 2002). Secondly, the known economic relationship between increasing economic growth and increases in
government tax revenue (Sancak, 2010). The following figure depicts the two theoretical foundations on which the fiscal model described will be based:

![Diagram showing Population Health → Economic Growth → Tax Revenue → Decreased morbidity → Labor force participation]

**Research proposal**

In this study we propose developing a government perspective fiscal accounting model that demonstrates the economic consequences for government associated with changes in population health status attributed to immunisation programs. The economic metrics considered in the model will be discounted net tax revenue and gross tax receipts attributed to changes in population health status and labour force participation attributed to immunization. Labour force participation will be defined mainly in terms of survival and labour supplied by the immunized subjects. In addition, the corresponding labour loss for families that will care for the not-immunized and thus sick subjects will also be factored in the analysis.

**Methodological approach**

Changes in population dynamics attributed to changes in health status have the capacity to influence economic growth and numerous other macroeconomic parameters. The fiscal consequences of vaccination and associated changes in morbidity and mortality can influence government both positively and negatively.

One of the aims of this project is to develop a modelling framework based on the generational accounting approach used by Treasury and other international organisations for modelling the fiscal consequences of population change and associated transfers and taxes (Auerbach, 1999; Bonin, 2004).

The following descriptions are helpful for understanding the fiscal effects of vaccination captured using the generational accounting framework.

**Positive fiscal effects:**

- Increased survival influences the number of working-aged adults able to supply labour to the market and influence government tax receipts.
- Many parents are unable to participate in the labour force because they need to care for a sick child. Therefore, decreased morbidity from vaccination can influence the work force participation rate for adults. From the ‘government perspective’ this has positive fiscal consequences for government from increased tax receipts and possibly reduced transfers.
- Changes in health status can impact cognition in learning and will have positive labour effects (Lucas, 2005).
- Improved earning capacity can increase tax transfers to government from increased taxes
- Cognitive skills may influence educational attainment which, in human capital economics is known to have an impact on wages and labour participation rates
- Education may alter health seeking behaviours thus, result in effective disease prevention generating health and economic benefits
- Increased survival leads to increased consumption and consequently value added taxes paid to government
- Increased survival leads to higher earnings thus, higher savings and capital formation which impacts on tax receipts

Negative fiscal effects:

- Decreased child mortality leads to increased numbers of children attending school. This effect would be applicable over the short term, however over the long-term adjustments in total fertility may arise from reduced child mortality.
- Increased survival could increase costs for other government transfers in the form of education and health, but could also increase unemployment.
- Decreased child mortality from one condition could lead to increased mortality from another condition for which vaccination may or may not be available
Benefits of vaccination for government

The model will follow the health benefit framework described by Bärnighausen (2010), with the exception that benefits attributed to vaccination will be considered applying a government fiscal perspective. An example of the core components of the proposed model framework aligned with the Bärnighausen framework are described below.

<table>
<thead>
<tr>
<th>Benefit category</th>
<th>Description of benefit (Bärnighausen, 2011)</th>
<th>‘Government perspective’ benefit interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health gains</td>
<td>Reduction in mortality through vaccination</td>
<td>Increased labour supply and persons paying taxes; including consumption taxes</td>
</tr>
<tr>
<td>Health-care cost savings</td>
<td>Savings of medical expenditures because vaccination prevents illness episodes</td>
<td>Reduce public expenditure on health for vaccine treatable conditions</td>
</tr>
<tr>
<td>Care-related productivity gains</td>
<td>Savings of parents’ productive time because vaccination avoids the need for taking care of a sick child</td>
<td>Increased labour supply and persons paying taxes</td>
</tr>
<tr>
<td>Outcome-related productivity gains</td>
<td>Increased productivity because vaccination improves cognition, physical strength, and school attainment</td>
<td>Wage growth is linked to productivity growth; this would result in increased tax revenue for government. Improve cognitive skills and education attainment translates into higher wages which benefits government</td>
</tr>
<tr>
<td>Broad</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Behaviour-related productivity gains</td>
<td>Benefits accruing because vaccination improves child health and survival and thereby changes household behaviour</td>
<td>Changes in behaviour either through improved education, total fertility or work force participation will have fiscal consequences for government. These changes could positively and negatively influence government accounts.</td>
</tr>
<tr>
<td>Community externalities</td>
<td>Benefits accruing because vaccination improves outcomes in unvaccinated community members</td>
<td>The community externality would also be reflected in government accounts.</td>
</tr>
</tbody>
</table>

Building on the Bärnighausen framework the modelling framework will capture how both the narrow and broad benefits of vaccination will influence government accounts applying the “government perspective” framework.

Depending on the individual country identified for the case study and data inputs, all six domains described by Bärnighausen may not be incorporated in the model. This is dependent on the extent to which they influence government fiscal accounts.
Application of generational accounts to health investments

Previous examples are available applying the generational accounting framework to evaluate the fiscal consequences of investments in medical technologies. The analysis described by Connolly et al. reported that investments in assisted reproduction represent an 8-10 fold return on investments in assisted reproduction based on discounted net tax revenue attributed to resulting live births (Connolly, 2009a; Connolly, 2008). The underlying premise of the approach is that assisted reproduction, namely in-vitro fertilisation, contributes live births which influence population dynamics. As these children age and enter the work force they represent future tax payers for government.

A similar framework has also been applied to evaluate vaccination programs. In a similar manner, vaccination programs that influence morbidity and mortality will change the life course and population age structures. Consequently investments in immunisation can be assessed using the generational accounting framework. Two prior examples of applying the generational framework to rotavirus and malaria vaccination have been evaluated (Connolly 2012; Connolly 2009b).

In the proposed case study only those benefits that have fiscal consequences will be considered in the case study. From this perspective the approach likely undervalues vaccination investments because only those health benefits with tangible fiscal consequences for government either in the form of increased transfers and tax revenue are considered. The intangible benefits of good health that are normally reflected using quality-adjusted life years and disability-adjusted life years will more adequately reflect the health benefits from the patient perspective.

Generational accounting is based on intertemporal fiscal accounting principles. In practice, one of the reasons for developing GA was to assess fiscal sustainability in light of ageing populations in developed countries and for ensuring equitable intertemporal tax burden across generations. When applied in low and middle income countries the approach can be used to translate vaccination costs to government into future “tax receipts” associated with gains in population health status. The methodology also highlights the benefits of a functional tax system.

Analytic Perspective

The perspective applied for evaluating health programs is an important analytical consideration as this will dictate the costs and outcomes considered in the analysis. To date, the two dominant factors considered have been the societal and health service perspectives. However, both of these perspectives are limited as they fail to take into consideration the fiscal consequences that changes in population health can have on government accounts. This points was previously mentioned in the WHO report on the costs of illness, however few supporting studies are available to highlight the fiscal consequences (WHO, 2009).

Population health status is an important determinant of productivity which has been shown to be a determinant of economic growth. The relationship between health and economic growth is one of the cornerstones of development economics use to influence funding decisions in low and middle income countries. Because of the relationship between health and economic growth and the relationship between economic growth and government tax revenue, a rationale can be put forward for exploring the ‘government perspective’ associated with
investments in health. The underlying premise of such analyses is that changes in health status in current and future working populations will have fiscal implications for government. Therefore, health status changes can be shown to influence government tax revenue in those countries with functioning tax collection agencies.

**Model inputs**

In order to construct the government perspective model for the case study, it will be necessary to develop a government balance sheet for transfers and taxes at different stages of life. The table below depicts some of the potential costs that will be included in the government perspective fiscal health model.

<table>
<thead>
<tr>
<th>Government transfer costs</th>
<th>Tax transfers to government</th>
</tr>
</thead>
<tbody>
<tr>
<td>★ Health costs non-communicable disease related</td>
<td>★ Income taxes</td>
</tr>
<tr>
<td>★ <strong>Vaccine program(s)</strong></td>
<td>★ Excise taxes</td>
</tr>
<tr>
<td>★ Education</td>
<td>★ Property taxes</td>
</tr>
<tr>
<td>★ Allowances</td>
<td>★ Sales taxes</td>
</tr>
<tr>
<td>★ Unemployment benefits</td>
<td>★ Corporate taxes</td>
</tr>
<tr>
<td>★ Pensions</td>
<td></td>
</tr>
</tbody>
</table>

Depending on the country identified for the case study not all transfers and taxes will be relevant.

**Disease and economic modelling**

The focal point of the model will be the quantification of fiscal benefits deriving from population immunizations against a group of preventable diseases. Thus, emphasis will be put on modelling the long-term effects of vaccination on earnings and taxes rather than the long-term and short-term modelling of the disease. Given the macro nature of the analysis, it is expected that treatment costs for not immunised subjects will be a small proportion of the total cost. In addition, whilst the natural course of the modelled diseases will be reflected in the model, crude assumptions on the patient journey and the vaccine efficacy will be used.

**Project Proposal Specifics**

A two stage approach is proposed that will result in two peer review manuscripts. Stage 1 of the project is to define the fiscal consequences of vaccination in two case study countries. Stage 2 of the framework will be a methodological overview/operational guide for how to analyse the fiscal consequences of changes in health status attributed to vaccination.

**Stage 1 country case studies**

The modelling framework described here will be applied to two country examples. We propose to conduct the analysis applied to rotavirus and the fiscal consequences of vaccinating against rotavirus. After further consideration amongst the investigators it was felt that case examples applied to a specific vaccine would be more appropriate to analyse as the specific immunisation effect could be isolated.
The analysis for the two country case studies will then be used to compare and contrast findings

*Choice of case study countries*

Several factors will need to be taken into consideration with respect to identifying the case study country. Developing fiscal consequences for government associated with changes in health status is data intensive and requires numerous inputs for reflecting the value of vaccination back to government. The case study will be developed in one low or middle income country. The following caveats will be applied in selecting the target country.

- Access to national accounts data and national household surveys
- Functional tax collection agency available within the case example country
- Information on health service delivery and costs of care

Furthermore, the choice of country for the case study will be made in conjunction with WHO QUIVER members.

*Stage 2 Methodological Overview / Operational Guide*

The “government perspective” fiscal accounting approach applied to changes in health status changes has been applied in a limited number of health related publications. However, the government perspective approach discussed here is widely applied in actuarial sciences for assessing fiscal consequences. In addition, human capital economics have addressed several of the issues that the proposed framework encapsulates particularly, the estimation of lifetime earnings, taxes and government costs.

To bridge the gap between fiscal accounting principles and changes in health status we propose to develop a peer review paper that provides an overview of the method and theoretical foundations. It is envisaged that the second peer review paper can serve as an operational overview/guide for future researchers that are interested to apply the methodology. Furthermore, the paper will encompass a review of the methods used to quantify the inputs that the proposed framework encapsulates.

*Application of Research*

Modelling the fiscal consequences of changes in health status attributed to vaccination can inform local decision-making regarding vaccine funding. Because the model translates health status changes to productivity benefits and to fiscal benefits, the methodology should be highly relevant to funding decisions in these countries. Especially as vaccine funding decisions are often made outside of the health service. The methodology highlights the sustainability of health funding and the long-term benefits from vaccination. Since the analysis applies an analytical framework familiar to Treasury departments, the health gains from vaccination are expected to be communicated in a language familiar to governments.

*Research limitations*

One limitation of the approach described here is that not all countries in need of vaccination have reliable and functional taxation systems. Applying the generational accounting approach to population health changes requires that productivity, labour force participation
and wage changes can be translated into fiscal revenue for government. This suggests that the choice of country for the case study be critical for applying the analysis.

Despite the lack of functional tax system in some countries the methodology can be useful convey benefits to countries without domestic taxation services. Firstly, the benefits are translated into metrics which would be familiar to government in terms of productivity and labour force participation. Secondly, taxation and development has been a cornerstone of much of the development economics literature (IMF, 2011). Therefore, the methodology would simultaneously convey the benefits of taxation to governments without functional domestic tax systems. Additionally, when communicated to countries with domestic tax structures, it can be used to enforce the benefits of improved tax compliance.

**Project Deliverables**

A peer review manuscript will be developed that describes the following:

1. Excel model for calculating the fiscal consequences of changes in health status attributed to rotavirus vaccination
2. Peer review manuscript defining the fiscal consequences of vaccination in two case study countries
3. Peer review paper defining the methodological framework, theoretical foundations for constructing a government perspective fiscal accounting model applied to vaccination and operational overview.
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Curriculum vitae

Prof Maarten J Postma (29/01/1960) holds the chair in Pharmacoeconomics at the University of Groningen (Netherlands). Also, he holds an honorary chair in Health Economics at the University Medical Center Groningen. He did his MSc in econometrics and his PhD in health economics. Next to being head of the Unit PharmacoEpidemiology & PharmacoEconomics (30 employees) of the Department of Pharmacy and being in the board of directors of the Department, he specifically leads a team of 15 PhD and post-doc researchers in health- and pharmacoeconomics, contributing to many international research networks (co-operations with the University of London, Mario Negri in Italy, University of Ghent, the University of Munich, University la Rioja) and scientific communications. He serves (served) on various committees advising the Dutch government on reimbursement of drugs (“Commissie Farmaceutische Hulp”) and vaccines (Health Council). Also, he is advisor to various health-economics consultancy companies worldwide, member of editorial boards of scientific journals, on advisory boards for pharmaceutical companies and consultant for WHO. He has approximately 160 MEDLINE-publications and an H-factor of 20.
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PROFESSIONAL EXPERIENCE

January 2008 - present  Managing Director and Owner, Global Market Access Solutions Sàrl (www.gmasoln.com), Switzerland
- Established market access consultancy providing range of pricing, reimbursement, and health economic services to a broad range of pharmaceutical, medical device and not-for-profit organisations with offices in Geneva and London.
- Perform economic evaluations (eg, CUA, CEA), health technology appraisals, and pharmaceutical policy analyses
- Performed health economic analyses to support pricing and reimbursement applications in several European and International markets
- Develop and execute health investment strategy and economic models to support market access activities and stakeholder involvement
- Provide full range of medical writing services including pricing & reimbursement applications, publication strategy development, product value dossiers, peer reviewed publications, medical symposia, press materials, on-line publications

January 2009 – Present  Guest Researcher and Guest Lecturer, University of Groningen. Unit of PharmacoEconomics and PharmacoEpidemiology, Netherlands
- Research the fiscal consequences of assisted reproduction for doctoral thesis
- Lecturer on health economics and role of productivity and taxation in health

May 2005 – January 2008  Director (Global) Market Access & Pricing, Ferring Pharmaceuticals, Global Marketing, Switzerland
- Lead and develop global market access and pricing strategies in conjunction with R&D and local marketing organisations across four therapeutic areas
- Developed health economic tools to support market access activities and facilitate local implementation. Successfully published pharmacoeconomic results in recognised medical journals and at international conferences
- Health policy analysis and development of policy response to drive commercial strategy
- Responsibility for development of junior health economist and encourage development of local market access capabilities for Ferring
- Developed and launched media activities in conjunction with corporate communications to shape policy environment, influence government, and support product launches
Jun 2003 – Apr 2005  
Health Outcomes Manager, GlaxoSmithKline, United Kingdom  
- Delivery of reimbursement strategy and health outcome/economic tools to support successful reimbursement and market access in US, Europe and International markets  
- Provide strategic health economic and outcome input into R&D clinical trial development to support future reimbursement  
- Provide health economic/outcome perspective to drug target selection for products in early stage clinical development

Nov 2000 - May 2003  
Health Economics Manager, Aventis Pharma, Australia  
- Accountable for development and delivery of all aspects of pharmaceutical reimbursement and pricing in Australia  
- Coordinate key activities with medico-marketing and commercial groups to ensure effective product launches  
- Appointed member to Australian pharmaceutical industry association, Medicines Australia, for 2 years  
- Provide assessment of government health policies and free trade agreements to senior management

Health Economics Associate, Department of Health Economics, Covance, Australia (Held 2 different positions)  
- Perform economic evaluations and technology appraisals to support pricing and reimbursement submissions to Australian Pharmaceutical Benefits Advisory Committee (PBAC)  
- Conduct market forecasts and drug utilisation assessments  
- Design and validate clinical trial questionnaires  
- Develop sociodemographic recruitment model to determine impact on generalisability of trial results

Dec 1996 - Mar 1998  
Research Officer, Cardiopulmonary Transplant Unit, St Vincent's Hospital, Australia  
- Conduct and manage phase III-IV clinical trials for the treatment of heart disease  
- Data management and statistical analysis of local trial results, and presentation of clinical trial results to hospital staff and at scientific meetings

Dec 1994 - Dec 1996  
Senior Research Assistant, Victor Chang Cardiac Research Institute, Australia  
- Investigated cardiac receptor stimulation and intracellular activation

TERTIARY EDUCATION  
- Doctorate in Health Economics (2010), University of Groningen, Netherlands  
- Management Development Certificate (2007), Université de Genève, Switzerland  
- Masters in Health Economics by treatise (2003), Curtin University of Technology, Australia
- **Graduate Diploma Health Economics** (2001), Sydney University, Australia
- **Master of Science in Pharmacology** (1994), University of Michigan, USA
- **Bachelor of Arts in Biology** (Honours; 1992), University of Toledo, USA

**PROFESSIONAL AFFILIATIONS**

- Member of the European Society for Human Reproduction and Embryology (ESHRE) Task Force on demography, epidemiology, and health economics
- Occasional reviewer of fertility policy documents for RAND Corporation, Cambridge, UK

**PUBLICATIONS**


Connolly MP, Simoens S. Kiovig for primary immunodeficiency: Reduced infusion and cost per infusion. *Int Immunopharmacol* 2011 11(9):1358-61.


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Professional experience

Apr 2011 - present: Global Market Access Solutions, Sarl, Switzerland
Principal Health Economist: Producing market access and health economic deliverables for global pharmaceuticals and medical devices companies.

Dec-Mar 2009 - 2011: PRMA consulting ltd. Fleet, United Kingdom
Consultant: Delivered EU, US and Japan payers’ and pricing research, global access strategies and due diligence for top pharmaceutical and biotechnology companies; produced and managed the delivery of value dossiers, syndicated reports and systematic literature researches, across several therapeutic areas (oncology, CNS, dermatology and diabetes).

May-Nov 2006 - 2009: GlaxoSmithKline Pharmaceuticals, Athens, Greece
Government Affairs & Access Manager: In charge of local pricing and reimbursement negotiations; devised and implemented local government and corporate affairs plans and campaigns; regional (SE Europe) market access co-ordinator for the oncology portfolio; key account manager for vaccines.

Global Health Outcomes Manager: Designed and delivered EU, US and international market access and evidence generation strategies for the infectious diseases portfolio (HIV, HBV, HSV, HPV, antibiotics and sepsis); responsible for internal training and new methodologies; developed health economic models; designed and implemented multinational clinical and health economic protocols.

May-Sept 2002: University Hospital, Patras, Greece
Advisor to the Managing Director in operational research and management.

 Analyst: Conducted business plans, market research and cost-benefit analyses for public and private investment plans.

Education

2001 - 2002: City University, London
MSc Health Economics (Awarded with distinction)

1995 - 2000: University of Athens
Degree in Economics (Awarded with merit)

Spoken languages:
Greek, native. English, fluent (Cambridge Certificate of Proficiency). German, good knowledge (Zertifikat Deutsch als Fremdsprache). Italian, good knowledge.
Publications’ record

In peer reviewed journals:


Podium presentations:


Scalone L, Watson V, Ryan M, Patel R, Kotsopoulos N. Evaluation of Patients’ Preferences in Genital Herpes using a Discrete Choice Experiment. ISPOR 8th Annual European congress, Florence, Italy 6-8 November 2005

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