Australian Government
Australian Research Council

EI 2018 ENGAGEMENT AND IMPACT

Engagement and Impact 2018

The University of Melbourne

MEL07 (HLS) - Impact

Overview

Title

(Title of the impact study)

Reducing epilepsy in developing countries: Development of practical vaccines to break the life-cycles of parasites

Unit of Assessment

07 - Agricultural and Veterinary Sciences

Additional FoR codes

(Identify up to two additional two-digit FoRs that relate to the overall content of the impact study.)

06 - Biological Sciences

11 - Medical and Health Sciences

Socio-Economic Objective (SEO) Codes

(Choose from the list of two-digit SEO codes that are relevant to the impact study.)

92 - Health

Australian and New Zealand Standard Industrial Classification (ANZSIC) Codes

(Choose from the list of two-digit ANZSIC codes that are relevant to the impact study.)

18 - Basic Chemical and Chemical Product Manufacturing

Keywords

(List up to 10 keywords related to the impact described in Part A.)

Parasite

Vaccine

Echinococcosis

Cysticercosis

Sensitivities

Commercially sensitive

No

Culturally sensitive

No

Sensitivities description

(Please describe any sensitivities in relation to the impact study that need to be considered, including any particular instructions for ARC staff or assessors, or for the impact study to be made publicly available after EI 2018.)

Aboriginal and Torres Strait Islander research flag

(Is this impact study associated with Aboriginal and Torres Strait Islander content?
NOTE - institutions may identify impact studies where the impact, associated research and/or approach to impact relates to Aboriginal and Torres Strait Islander peoples, nations, communities, language, place, culture and knowledges and/or is undertaken with Aboriginal and Torres Strait Islander peoples, nations, and/or communities.)

No

Science and Research Priorities

(Does this impact study fall within one or more of the Science and Research Priorities?)

Yes

Science and Research Priority	Practical Research Challenge
Health	Better models of health care and services that improve outcomes, reduce disparities for disadvantaged and vulnerable groups, increase efficiency and provide greater value for a given expenditure.

Impact

Summary of the impact

(Briefly describe the specific impact in simple, clear English. This will enable the general community to understand the impact of the research.)

A world-first vaccine developed by University researchers has become the first licensed vaccine for prevention of cysticercosis, a World Health Organisation prioritized neglected tropical disease. Cysticercosis is a potentially fatal form of brain disease, and a major cause of epilepsy, found mainly in developing countries. It is caused by infection with the larval stage of the tapeworm Taenia solium, and is spread through domestic pigs. The vaccine, applied to pigs, has been found to totally eliminate the spread of the disease, thereby significantly reducing the incidence of epilepsy in the developing world.

Beneficiaries

(List up to 10 beneficiaries related to the impact study)

Governments in developing countries through economic and health benefits

Community through improved health outcomes

Industry partners by developing new drugs, benefiting from world-first research

Countries in which the impact occurred

(Search the list of countries and add as many as relate to the location of the impact)

Australia
South America, nec
Peru
Cameroon

Details of the impact

(Provide a narrative that clearly outlines the research impact. The narrative should explain the relationship between the associated research and the impact. It should also identify the contribution the research has made beyond academia, including:
- who or what has benefitted from the results of the research (this should identify relevant research end-users, or beneficiaries from industry, the community, government, wider public etc.)
- the nature or type of impact and how the research made a social, economic, cultural, and/or environmental impact
- the extent of the impact (with specific references to appropriate evidence, such as cost-benefit-analysis, quantity of those affected, reported benefits etc.)
- the dates and time period in which the impact occurred.

NOTE - the narrative must describe only impact that has occurred within the reference period, and must not make aspirational claims.)

Professor Marshall Lightowlers and colleagues have developed a cysticercosis vaccine, the first in the world to fight a parasitic infection of humans that is transmitted by pigs. The vaccine is reducing the incidence of epilepsy in humans in developing countries.

NEUROCYSTICERCOSIS

Around 50 million people in the developing world are infected with cysticercosis, caused by the larval stage of the tapeworm Taenia solium, a parasite that is transmitted between humans and pigs and that causes neurocysticercosis, or brain cysts, in human hosts.

Neurocysticercosis is a serious public health and agricultural problem. It causes an estimated 50,000 deaths each year, and is most prevalent in subsistence farming communities in developing countries across Latin America, Southeast Asia and Africa. While the parasite has been virtually eliminated in developed countries, even in the US there are around 1,000 cases each year, mainly among immigrants. In 2015, the World Health Organisation Foodborne Disease Burden Epidemiology Reference Group identified Taenia solium as a leading cause of death from food-borne diseases, resulting in a total loss of 2.8 million disability-adjusted life-years.

Neurocysticercosis is one of the major causes of epilepsy in developing countries, responsible for approximately 30% of epilepsy in humans in Taenia solium prevalent regions. The total number of people suffering from neurocysticercosis, including symptomatic and asymptomatic cases, is estimated to be between 2.56–8.30 million, based on available epilepsy prevalence data.

In countries without proper sanitation, and where pigs and human beings live in close quarters, there is a constant cycle of disease transmission. Pigs become infected by consuming human faeces containing tapeworm eggs. In turn, humans acquire taeniasis by consuming pork contaminated with larval cysts, or acquire neurocysticercosis through incidental ingestion of tapeworm eggs.

The symptoms of neurocysticercosis vary. Heavy infections can be fatal, often as a result of inflammation after the parasites die. Other symptoms include: epileptic seizures; blindness; balance issues; and confusion. The disease also has a major economic impact on the affected farming communities, making pork unsafe to eat, and reducing the market value of pigs.

TSOL18 Vaccine (Cysvax®)
The TSOL18 Vaccine, developed by Professor Lightowlers and his colleagues, disrupts the infection cycle from pigs to humans by immunising pigs against cysticercosis. The vaccine is the first in the world to fight this parasitic disease in pigs.

During the reference period, the TSOL18 vaccine was trialled in a region of Cameroon that is highly endemic for the parasite. It achieved complete elimination of the parasite’s transmission. This demonstrated the vital role the vaccine plays in controlling the parasite and reducing the incidence of human neurocysticercosis.

A further study on the vaccine in the New England Journal of Medicine (2016), examined the effects of the TSOL18 vaccine and other disease control measures in one highly endemic region in Peru. It determined that the vaccine, used in conjunction with antiparasitic treatments, helped to prevent the transmission of the disease. The TSOL18 vaccine was found to be critical to achieving the highest level of disease control resulting in more than 99 per cent protection.

The TSOL18 vaccine is now commercially available, and has been recommended by the World Health Organization. The University of Melbourne, alongside industry partners, has collaborated in a public-private partnership for more than six years to make the vaccine available to those in the developing world where the Taenia solium infection is prevalent. As the TSOL18 vaccine technology is transferred from field assessments into more general use, it is expected to significantly reduce the incidence of epilepsy in the developing world.

The University has licensed the vaccine and facilitated its development at no cost. This approach has been taken to minimize the cost of the vaccine because it is needed exclusively by poor communities living in the developing world.

Internationally, the impact of Professor Lightowlers’ research has been demonstrated in his involvement in World Health Organisation Working Groups on neglected tropical diseases. These Groups, comprised of international experts in the field of Medical Parasitology, meet regularly to identify mechanisms to improve tools for diagnosis including pharmacologic approaches as well as socioeconomic and political ones.

Nationally, in 2012 the work of Lightowlers was featured as one of National Health and Medical Research Council's ‘Ten of the Best Research Projects 2012’. This identified his pig vaccine research as being one of the top ten research projects, chosen from among the thousands of NHMRC funded medical research projects underway in Australia.

Significance of the research has been further recognised though the award of substantial funding--from the Bill and Melinda Gates Foundation, the Department for International Development in the UK through the Global

Alliance for Livestock Vaccines and Medicines, as well as from the UK's Wellcome Trust--for the industrial scale-up and registration of the TSOL18 vaccine. Registration of the vaccine will soon start in other countries including Uganda, Tanzania, Kenya, Nepal, Philippines, Thailand and Sri Lanka.

The vaccine is an outstanding example of how a single veterinary public health intervention can reap several advantages simultaneously. Vaccination has the potential to break the infection cycle, thereby preventing epilepsy through neurocysticercosis in humans. The vaccine also promises to contribute to economic wellbeing by improving market outcomes for farmers in affected regions. The work of Lightowlers and colleagues has resulted in a world-first vaccine that is preventing a disease that causes substantial human morbidity and mortality worldwide.

Associated research

(Briefly describe the research that led to the impact presented for the UoA. The research must meet the definition of research in Section 1.9 of the EI 2018 Submission Guidelines. The description should include details of:
- what was researched
- when the research occurred
- who conducted the research and what is the association with the institution)

Professor Lightowlers has been part of a team which developed the first recombinant vaccine against a parasitic disease. Between 2002 to 2016 he developed a highly effective vaccine against tissue infection in pigs caused by the pork tapeworm, Taenia solium. This was done by extracting a gene from the parasite that encodes a specific protein, and from there produced that protein for use in making the TSOL18 vaccine (Cysvax®). Having achieved this breakthrough, the team went on to conduct field trials in many countries including northern Cameroon and Peru where the vaccine was shown to be highly effective in eliminating the disease.

In developing the vaccine to combat this problem, Professor Lightowlers opted to target the livestock rather than the people who are affected as animal vaccines are significantly cheaper to develop and to license. The vaccine is now commercially available and has since been adopted by the Global Alliance for Livestock Vaccines and Medicines. The University of Melbourne, alongside industry partners, has collaborated to make the vaccine available to those in the developing world where the Taenia solium infection has a tremendous effect on human health and the economy.

FoR of associated research

(Up to three two-digit FoRs that best describe the associated research)

07 - Agricultural and Veterinary Sciences
06 - Biological Sciences
11 - Medical and Health Sciences

References (up to 10 references, 350 characters per reference)

(This section should include a list of up to 10 of the most relevant research outputs associated with the impact)

Assana, E., Kyngdon, C., Gauci, C., Geerts, S., Dorny, P., De Deken, R., . . . Lightowlers, M. (2010). Elimination of Taenia solium transmission to pigs in a field trial of the TSOL18 vaccine in Cameroon. International Journal for Parasitology, 40(5), 515-519. doi:10.1016/j.ijpara.2010.01.006

Flisser, A., Gauci, C., Zoli, A., Martinez-Ocana, J., Garza-Rodriguez, A., Dominguez-Alpizar, L. L., . . . Lightowlers, M. (2004). Induction of protection against porcine cysticercosis by vaccination with recombinant oncosphere antigens. Infection and Immunity, 72(9), 5292-5297. doi:10.1128/IAI.72.9.5292-5297.2004

Gauci, C., Verastegui, M., Gilman, R., & Lightowlers, M. (2006). Taenia solium and Taenia ovis: Stage-specific expression of the vaccine antigen genes, TSOL18, TSOL16, and homologues, in oncospheres. Experimental Parasitology, 113, 272-275. doi:10.1016/j.exppara.2006.01.006

Gauci, C., Jayashi Flores, C., Gonzalez, A. E., Lackenby, J., & Lightowlers, M. W. (2012). Protection of pigs against Taenia solium cysticercosis by immunization with novel recombinant antigens. Vaccine, 30(26), 3824-3828. doi:10.1016/j.vaccine.2012.04.019

Garcia, H. H., Gonzalez, A. E., Tsang, V. C. W., O'Neal, S. E., Llanos-Zavalaga, F., Gonzalvez, G., . . . Gilman, R. H. (2016). Elimination of Taenia solium Transmission in Northern Peru. New England Journal of Medicine, 374(24), 2335-2344. doi:10.1056/NEJMoa1515520

Heath, D., Lightowlers, M., Qiu, J., Yang, W., Zhang, L. H., & Mcmanus, D. P. (2004). Vaccination against hydatidosis and the significance of parasite strain variation in designing a control program. In P. R. Torgerson, & B. Shaikenov (Eds.), Echinococcosis in Central Asia: problems and solutions (1 ed., pp. 9). KZ (Almaty): Dauir.

Lightowlers, M. (2010). Eradication of Taenia solium cysticercosis: A role for vaccination of pigs. International Journal for Parasitology, 40(10), 1183-1192. doi:10.1016/j.ijpara.2010.05.001

Lightowlers, M. W., Assana, E., Jayashi, C. M., Gauci, C. G., & Donadeu, M. (2015). Sensitivity of partial carcass dissection for assessment of porcine cysticercosis at necropsy. International Journal for Parasitology, 45(13), 815-818. doi:10.1016/j.ijpara.2015.08.004

Lightowlers, M. W., Donadeu, M., Elaiyaraja, M., Maithal, K., Kumar, K. A., Gauci, C. G., . . . Rowan, T. G. (2016). Anamnestic responses in pigs to the Taenia solium TSOL18 vaccine and implications for control strategies. Parasitology, 143(4), 416-420. doi:10.1017/S0031182016000202

Lightowlers, M. W., Garcia, H. H., Gauci, C. G., Donadeu, M., & Abela-Ridder, B. (2016). Monitoring the outcomes of interventions against Taenia solium: options and suggestions. Parasite Immunology, 38(3), 158-169. doi:10.1111/pim.12291

Additional impact indicator information

Additional impact indicator information

(Provide information about any indicators not captured above that are relevant to the impact study, for example return on investment, jobs created, improvements in quality of life years (QALYs). Additional indicators should be quantitative in nature and include:
- name of indicator (100 characters)
- data for indicator (200 characters)
- brief description of indicator and how it is calculated (300 characters).)