International Journal of Infectious Diseases 47 (2016) 29–37

Contents lists available at ScienceDirect

International Journal of Infectious Diseases

journal homepage: www.elsevier.com/locate/ijid

Hajj vaccinations—facts, challenges, and hope

Moataz Abd El Ghany [a,b,*], Hazem Sharaf [c], Grant A. Hill-Cawthorne [b,d,*]

[a] The Westmead Institute for Medical Research, The University of Sydney, Sydney, Australia
[b] The Marie Bashir Institute for Infectious Diseases and Biosecurity, The University of Sydney, Sydney, Australia
[c] Independent Researcher, Cairo, Egypt
[d] School of Public Health, The University of Sydney, Australia

ARTICLE INFO

Article history:
Received 17 February 2016
Received in revised form 19 May 2016
Accepted 23 May 2016

Corresponding Editor: Eskild Petersen, Aarhus, Denmark.

Keywords:
Mass gathering
Hajj
Vaccination
Vaccines
Preventive measures

SUMMARY

Vaccination is an effective preventive measure that has been used in the unique Hajj pilgrimage setting to control the transmission of infectious diseases. The current vaccination policy applied during Hajj is reviewed herein, highlighting the effectiveness of the approaches applied and identifying research gaps that need to be filled in order to improve the development and dissemination of Hajj vaccination strategies.

1. Introduction

Hajj is a unique mass gathering event associated with increased risks to public health within the host country (Kingdom of Saudi Arabia, KSA) and globally. The associated infectious disease hazards include the dissemination of airborne infections, food-borne disease, blood-borne diseases, and zoonotic infections.[1]

Vaccination is one of the major preventive measures used to prevent infections and control the transmission of infectious diseases. Vaccination has reduced the overall global morbidity and mortality associated with many infectious diseases, with the World Health Organization (WHO) estimating that 2.5 million lives a year are protected from infections.[2] Moreover, some vaccines confer protection not only to the vaccinated individuals but also to unvaccinated contacts, contributing to the development of community protection or herd immunity.[3] In addition, there is increasing evidence that bacterial and viral vaccines may have an impact on controlling the emergence and dissemination of antimicrobial resistance.[4–6]

Currently, licensed vaccines can be categorized into five main types: inactivated, live attenuated, subunit, toxoid, and conjugate vaccines (Table 1). The type of vaccine determines its mode of action, including the prevention of pathogen transmission, inhibition of pathogen persistence and multiplication, or a reduction in disease progression and severity.[7]

The current Hajj vaccination policy includes mandatory vaccination for all pilgrims against meningococcal disease.[8,9] This is in addition to mandatory vaccination against yellow fever and polio for pilgrims coming from endemic regions.[10] The Saudi Ministry of Health strongly recommends seasonal influenza vaccination for all pilgrims, particularly those at high risk of infection complications.[8,9]

The impact of the current vaccination policy on the control of infectious disease transmission in this unique setting of the Hajj pilgrimage is reviewed herein. Furthermore, how research can determine the elements of future Hajj vaccination strategies is discussed, and the research gaps in current knowledge required to improve the development and dissemination of vaccine strategies are identified.

2. Features of the preferred Hajj vaccines

A number of issues need to be addressed carefully before the introduction of a new vaccine for use during Hajj. Key aspects include the type of immune response induced by the vaccine, the efficacy of the vaccine among extremely varied populations (including different age groups, prior exposure to infectious

* Corresponding authors.
E-mail addresses: Moataz.mohamed@sydney.edu.au (M. Abd El Ghany), grant.hill-cawthorne@sydney.edu.au (G.A. Hill-Cawthorne).

http://dx.doi.org/10.1016/j.ijid.2016.05.024

Table 1
Vaccine availability for Hajj-associated diseases (FDA-approved only)

Health hazards at Hajj	Infectious agent	Vaccine	Manufacturer	Vaccine type	Administration	Approved for persons aged:
1. Airborne	*Neisseria meningitidis*	Menomune	Sanofi	Inactivated (A/C/Y/W135, polysaccharide)	SC	≥2 years
		Menactra	Sanofi	Inactivated (A/C/Y/W135, conjugate diphtheria toxoid)	IM	9 months–55 years
		Menveo	GlaxoSmithKline	Inactivated (A/C/Y/W135) conjugate (diphtheria CRM197)	IM	2 months–55 years
		Bexsero	GlaxoSmithKline	Recombinant	IM	10–25 years
		Trumenba	Pfizer	Recombinant	IM	10–25 years
	Streptococcus pneumoniae	Pneumovax 23	Merck	Inactivated (23-valent polysaccharide)	IM or SC	2 years at high risk and adults >50 years
		Prevnar 13	Pfizer	Inactivated (13-valent) conjugate (diphtheria CRM197)	IM	6–17 years and adults >50 years
	Influenza virus	Fluarix	GlaxoSmithKline	Inactivated (A and B serotypes)	IM	≥3 years
		FluLaval	GlaxoSmithKline	Inactivated (A and B serotypes)	IM	≥3 years
		Fluvirin	Novartis	Inactivated (A and B serotypes)	IM	≥4 years
		Agriflu	Novartis	Inactivated (A and B serotypes)	IM	≥18 years
		Flucelvax	Novartis	Inactivated (A and B serotypes)	IM	≥18 years
		Fluzone	Sanofi	Inactivated (A and B serotypes)	IM	≥6 months
		Fluzone (intradermal)	Sanofi	Inactivated (A and B serotypes)	ID	18–64 years
		Fluzone (high-dose)	Sanofi	Inactivated (A and B serotypes)	IM	≥65 years
		Afluria	bioCSL	Inactivated (A and B serotypes)	IM	≥5 years
		Flublok	Protein Science Corporation	Recombinant	IM	≥18 years
		FluMist	Medimmune	Live attenuated	IN (spray)	2–49 years
2. Food-borne and enteric	Poliovirus	Sabin OPV[a]		Live attenuated	Oral	
		IPOL	Sanofi	Inactivated	SC or IM	≥6 weeks
	Hepatitis A virus	Havrix	GlaxoSmithKline	Inactivated	IM	≥1 year
		Vaqta	Merck	Inactivated	IM	≥1 year
	Rotavirus	Rotateq	Merck	Live (pentavalent)	Oral	6–12 weeks
		Rotarix	GlaxoSmithKline	Live (pentavalent)	Oral	6–24 weeks
	Vibrio cholerae[a]	Dukoral	Valneva	Inactivated with recombinant CTB	Oral	≥2 years
		Shanchol	Shantha	Inactivated bivalent O1/O139	Oral	≥1 year
	Salmonella Typhi	Vivotif	Crucell	Live attenuated Ty2	Oral	≥6 years
		Typhim Vi	Sanofi	Inactivated	IM	≥2 years
	Diarrhoeagenic *Escherichia coli*	NA				
	Shigella spp	NA				
3. Blood-borne	Hepatitis B virus	Engerix-B	GlaxoSmithKline	Recombinant (all HepB serotypes)	IM	All ages
		Recombivax-HB	Merck	Recombinant (all HepB serotypes)	IM	All ages
		Twinrix	GlaxoSmithKline	Inactivated/recombinant (HepA–HepB)	IM	≥18 years
	Hepatitis C virus	NA				
	HIV	NA				
4. Vector-borne	Yellow fever virus	YF-Vax	Sanofi	Live attenuated	SC	≥9 months

FDA, US Food and Drug Administration; NA, no commercial vaccine is available; SC, subcutaneous; IM, intramuscular; ID, intradermal; IN, intranasal; CTB, Cholera Toxin B subunit.
[a] Not currently FDA-approved, but included for completeness.

agents, and ethnic origin), the ability of the vaccine to block the transmission of disease, the impact of vaccine types on circulating microbial genomes (risk of emergence of vaccine escape variants), and any indirect effects on the circulation of antimicrobial-resistant elements. Vaccination strategies in the Hajj setting should carefully address these aspects and emphasize the potential impacts from the immunological (e.g., efficacy and safety among different age groups), epidemiological (e.g., changes in transmission patterns), and evolutionary (e.g., changes in pathogen population structure) perspectives.

Importantly, the innate and acquired immune responses are weaker at younger ages and also decline with age, leading to the impaired persistence of antibody responses and the development of lower levels of serum antibodies to both protein and polysaccharide vaccines.[7] Therefore, age-associated changes in the immune response impact the efficacy of these particular types