ecdc
EUROPEAN CENTRE FOR DISEASE PREVENTION AND CONTROL

TECHNICAL REPORT

Measles and rubella elimination: communicating the importance of vaccination

www.ecdc.europa.eu

ECDC TECHNICAL REPORT

Measles and rubella elimination: communicating the importance of vaccination

This report was commissioned by the European Centre for Disease Prevention and Control (ECDC), coordinated by Svetla Tsolova, and produced by Cornelia Betsch.

Author

Dr Cornelia Betsch, University of Erfurt, Germany

Acknowledgements

Reliable and high-quality support by Cindy Holtmann, Philipp Schmidt and Lars Korn (University of Erfurt) is gratefully acknowledged. The author would also like to thank the ECDC coordination team: Svetla Tsolova, Tarik Derrough, Pier Luigi Lopalco, Niklas Danielsson, Emma Huitric, Ülla-Karin Nurm, Paoloma Carrillo-Santisteve and Andrea Würz for fruitful discussions, valuable feedback and their trust.
The author gratefully appreciates peer review by Madelene Danielsson, Christina Ebbersten, and Ingrid Uhnoo.

Final thanks go to the entire team of ECDC's Vaccine-Preventable Disease Programme for their comments and feedback during the development of these materials.

Suggested citation: European Centre for Disease Prevention and Control. Measles and rubella elimination: communicating the importance of vaccination. Stockholm: ECDC; 2014.

Stockholm, August 2014

ISBN 978-92-9193-586-4

doi 10.2900/31986

Catalogue number TQ-01-14-694-EN-N

Contents

Figures

Tables

Abbreviations

CRS	Congenital rubella syndrome
EEA	European Economic Area
EU	European Union
MMR	Measles, mumps and rubella
MMRV	Measles, mumps, rubella and varicella
Q&As	Questions and answers
WHO	World Health Organization

Goals of the project

The goal of this project is to support EU Member States in their fight against measles and rubella. More specifically, this project aims to:

- dispel the myths about measles vaccination;
- offer scientific, evidence-based corrections of misperceptions on measles
- inform about rubella infections in pregnancy; and
- discuss the risks and benefits of vaccination against rubella for women of childbearing age.

This report should enable Member States to engage in effective, evidence-based risk communication. Information on measles and rubella is presented in a modular fashion, so it can be easily used in customised leaflets, flyers, or web pages. The facts presented in this report are intended to lower the barriers to measles and rubella vaccination and raise awareness for congenital rubella syndrome (CRS), including awareness for ante-natal screenings and post-partum vaccination.

Methodology

We reviewed recent scientific literature on measles and rubella vaccination. We also conducted a global search of internet sites on measles and rubella published in English, German, Dutch, or Spanish.

Specific internet searches (internet discussion forums, websites of anti-vaccination activists, anti-vaccine websites, and social media) were conducted to find:

- flyers which could serve as examples on how to inform the public or health professionals on measles, measles vaccination, or debunking vaccination myths;
- information on common 'measles myths';
- information on EU vaccine policies (rubella) with respect to women of childbearing age; and
- information about recent rubella outbreaks, with a focus on CRS.

Scientific literature was analysed in order to obtain information

- on recent rubella outbreaks, with a focus on CRS;
- on the risks of rubella infection and the benefits of vaccination with regard to pregnancy and protection of the foetus/newborn;
- on common myths about measles and measles vaccination; and
- on evidence-based corrections in order to reduce misperceptions on measles and measles vaccination.

There is increasing awareness that communicated facts should be evidence-based and that it is necessary to employ evidence-based communication to make health communication effective [3]. Especially when myths are debunked, certain techniques should be applied [4] to ensure effective correction of misperceptions [5].

Review of online flyers

We conducted a global online search in four languages (German, English, Spanish, and Dutch). As search terms we used 'leaflet', 'brochure', 'flyer', 'measles', 'vaccine/vaccination', 'herd immunity' combined with country names (Great Britain, Switzerland/Schweiz, Netherlands/Nederland, Österreich, United States, Canada, South Africa) and/or with names of public health authorities both at the national and county level (NHS, CDC, Bundeszentrale für gesundheitliche Aufklärung, Bundesamt für Gesundheit, Eidgenössisches Departement des Innern, Health Service Executive Public Health Division, Rijksinstituut voor Volksgezondheid en Milieu, Department of Health of the Republic of South Africa).

A detailed list of obtained flyers along with an evaluation grid can be found in Annex A.

The first flyer we analysed (filename: PL-dis-measles-color-office.pdf) was produced at the US CDC and directed at parents. It meets most of the criteria for comprehensive information. It is well structured; text is presented in short paragraphs. Core information can be easily extracted. Furthermore, the use of tables and natural numbers helps understanding.

The second flyer (filename: Measles_infographic.pdf) by Public Health Wales uses a visual approach. Literature has repeatedly shown that health literacy strongly depends on literacy as well as numeracy [8]. The Public Health Wales infographic should be understandable to a much wider audience, although there are no empirical data available; as an added benefit, healthcare workers can use the illustrations when talking to their patients.

A review of all leaflets showed that none of them discloses any conflicts of interest or makes mention of scientific or medical uncertainties, i.e. points to issues where science may lack evidence or where studies contradict each

other. The leaflets only occasionally use graphs and figures, and only few leaflets point out that there is no effective alternative to vaccination. These shortcomings are addressed in the fact sheets/key messages presented later in this report.

We also conducted an online search for flyers on rubella, albeit in a less systematic fashion. Two commendable examples were developed the US CDC: one on rubella (PL-dis-rubella-color-office.pdf) and one on 'Immunization and pregnancy' (CDC, f_preg.pdf).

Common myths and evidence-based counterarguments

We collected common myths on measles and measles vaccination by searching internet forums, websites of anti-vaccination activists, vaccine-sceptic websites and social media. In a more specific search, we selected websites where common myths were collected and partially refuted (Table 1a) as well as websites from anti-vaccination movements (Table 1b).

In an unspecific search, Google and Google Scholar were used to identify the most common myths as mentioned in scientific papers [16-18] and newspaper/magazine articles [19]. Facebook and Twitter were searched to assess the popularity of these myths in social media. The number of followers of the websites was used as a proxy for popularity (see Table 1c for most popular sites).

Table 1a. Public health websites

Title	Source
Some common misconceptions about vaccination and how to respond to them	http://www.cdc.gov/vaccines/vac-gen/6mishome.htm
Top 20 questions about vaccination	http://www.historyofvaccines.org/content/articles/top-20-questions-about-vaccination
Schutzimpfungen: 20 Einwände und Antworten des Robert-Koch Instituts und des Paul-Ehrlich Instituts	http://www.rki.de/DE/Content/Infekt/Impfen/Bedeutung/Schutzimpfungen_20_Einwaende.html
What are some of the myths – and facts – about vaccination?	http://www.who.int/features/qa/84/en/

Table 1b. Anti-vaccination websites

Title	Source
Vaccination causes autism – Here's what they know…	http://vactruth.com/2013/07/04/vaccination-causes-autism/
Case reports to NVIC of diabetes following MMR shots	http://www.nvic.org/vaccines-and-diseases/Diabetes/diabetesmmrshots.aspx
The great thimerosal cover-up: Mercury, vaccines, autism and your child's health	http://www.naturalnews.com/011764_thimerosal_mercury.html
Datenbank Impfschadensmeldungen	http://www.impfschaden.info/impfsch%C3%A4den/impfschadensdatenbank.html

Table 1c. Facebook accounts

Page/group name	
Vaccine resistance movement	601 like this page on Facebook (as of 6 February 2014)
Dr. Tenpenny on vaccines	73 279 like this page on Facebook (as of 6 February 2014)
Impfen … Nein danke!	245 like this page on Facebook (as of 6 February 2014)
Vaccine Information Network (VINE)	96 512 like this page on Facebook (as of 6 February 2014)
Gegen Zwangsimpfung und Impfhysterie	37 Facebook group members (as of 6 February 2014)

We selected the following six myths to be debunked:

- Measles is a harmless disease. The healthcare system in developed countries provides enough resources when someone has measles.
- It is better to get immunity through disease exposure than through the vaccine.
- Homeopathy can be used as an alternative to protect children against measles.
- Giving a child the MMR vaccine increases the risk of harmful side effects and can overload the immune system.
- MMR vaccination may cause autism.
- Measles is eliminated in Europe, so there is no reason to get vaccinated.

Literature searches were conducted to collect information regarding the myths to be refuted. The actual debunking process followed rules proposed in the literature [4,5,9].

Defining 'myth'

Myths and misperceptions about vaccination are as old as vaccination itself. Research has identified common myths [10-12], and the literature on the topic discusses potential reasons of how these vaccination myths developed [13]. In general, risks are less tolerated and perceived as higher when they result from human actions, are hidden, cause irreversible damage, or are poorly understood by science [13,14]. Myths often link diseases or chronic conditions to vaccination. It was found that the diseases or chronic conditions linked to vaccination are usually of idiopathic origin; that they are characterised by an apparent rise in incidence; that there is face-value biological plausibility of a link to vaccines; that the outcomes are dreaded, and that disease onset is in close proximity to immunisation [13]. We consider misinformation as a myth when sufficient scientific evidence refutes the claim.

Defining 'evidence-based'

According to Sackett et al., 'evidence-based' is defined as follows: 'Evidence-based medicine is the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence-based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research' [15].

Fact sheets and key messages: design and concept

Criteria and definitions

We used a standard set of criteria elaborated by Bodemer et al. as criteria to evaluate flyers and develop our own fact sheets and key messages [7]. These criteria include: explaining the goal, defining the target population, explaining aetiology, providing epidemiological data, comparing figures, elaborating on cost estimates, communicating treatment effects (including visual references), explaining alternative treatments and their limitations, and disclosing conflicts of interest.

Criteria for collecting facts, based on Bodemer et al. [7]:

- How is the disease transmitted?
- What are the consequences of the infection?
- How prevalent is the disease?
- Is there any specific treatment?
- What is the aim of the vaccination?
- For whom is the vaccine recommended?
- How long does vaccine protection last?
- Are there other preventive methods?
- What is the vaccine's effectiveness?
- What are the side effects of the vaccines?

Communicating vaccination information

Ever since vaccination has been practiced, myths and misinformation about vaccination abound. Psychological research has shown that debunking myths is difficult: the mere reading about a myth, even about a myth's refutation, can strengthen the myth – rather than weaken its influence [35]. Likewise, an explicit and strong negation of a risk can paradoxically increase the perception of risk in the reader [5].

Building blocks for debunking vaccination myths

- Core facts. A refutation should emphasise the facts, not the myth. The introduction should start with the facts to aid retention. Present only key facts. Avoid that complicated debunking is harder to process than a simple myth.
- Explicit warnings. Before any mention of a myth, text or visual cues should warn that the upcoming information is false.
- Alternative explanation. Any gaps in the mental model left by the debunking need to be filled. This may be achieved by providing an alternative causal explanation for why the myth is wrong and, optionally, why the misinformers promoted the myth in the first place.
- Graphics. Core facts should be displayed graphically if possible.
- Language. Avoid strong language when you say that there is no risk. Making strong claims denying the possibility of risk associated with vaccinations may backfire.

Adapted from [4,5,9]

Fact sheets and questions and answers (Q&As)

We identified a total of six key messages for measles and another five for rubella and expanded them into full-fledged fact sheets, offering detailed and evidence-based corrections of measles myths [6].

Preceding the fact sheets and their key messages are two short sections with questions and answers ('Q&A: measles', 'Q&A: rubella') which address basic questions on transmission, prevalence and prevention.

The fact sheets aim at providing Member States with the necessary building blocks to design their own evidence-based information materials or campaigns. Information is presented in a modular way, which lets public health official use either a complete or partial set of modules when designing information campaigns.

Target groups

The fact sheets/key messages presented in this report are directed at health professionals and communication experts who are in charge of communication and information activities. Consequently, the level of scientific explanations is geared toward supplying public health personnel with arguments designed to effectively communicate with the general public.

As the fact sheets on measles intend to support health professionals in communicating with un- or undervaccinated adults and parents of unvaccinated children, their language is less complex than in scientific literature.

The fact sheets/key messages on rubella are targeted at women of childbearing age, women planning to become pregnant, and parents of unvaccinated children. Therefore, this information is especially suitable for designing catch-up campaigns.

Structure of the fact sheets

All fact sheets on measles first introduce a key message, which is followed by a brief introductory paragraph. We then present a misperception ('a myth'), immediately followed by its scientific correction and the corresponding scientific evidence. For the presentation and correction of the myth we follow techniques proposed by Lewandowsky et al. [4]. For details, please refer to the text box above.

At the end of each fact sheet, a conclusion repeats the key message to make it more memorable [8].

It is important to note that our key messages do not directly reiterate a myth because research has shown that referring to misinformation in headlines and key messages can actually reinforce misperceptions [4].

With regard to rubella, we also summarised vaccination policies in Member States and included information on recent outbreaks and CRS cases in order to raise awareness and provide convincing examples of the seriousness of the disease (Annex B).

A separate Q&A (questions and answers) section for both measles and rubella provides the basic scientific facts on immunisation and serves as a general introduction into the topic.

Note: In the Q&A sections, references to the literature are in parentheses/round brackets and listed as endnotes immediately following the text. All other references appear in square brackets, with a full list of references at the end of this report.

Q&A – measles

How are measles transmitted?

Measles is transmitted from person-to-person via droplets. Measles can be transmitted in closed areas (e.g. office, examination room) for up to two hours after a person with measles left the area.

Measles is highly communicable. The probability of infection when a susceptible person had contact with an infected person or source is 90% (1).

Measles is a human disease; there is no known animal reservoir.

What are the consequences of the infection?

Symptoms usually appear after 10 to 12 days of infection, initially resembling a cold with a runny nose, cough and a slight fever. The eyes become red and sensitive to light. As the illness progresses, and usually on the third to seventh day, the temperature may reach up to 39–41 °C, and a red rash lasting four to seven days appears. The rash begins on the face and then spreads over the entire body. Small white spots (Koplik's spots) may also appear on the gums and inside of the cheeks (2).

Approximately 30% of reported measles cases have one or more complications (1), with more complications among children younger than five years of age and adults 20 years of age and older. The following complications can be expected (1, 3-5):

- Diarrhoea: 80 in 1000 measles cases
- Otitis media: 70 to 90 in 1000 measles cases
- Pneumonia: 10 to 60 in 1000 measles cases
- Encephalitis: 1 in 1000 measles cases
- Convulsions: 5 in 1000 measles cases
- Death: 0.7 to 2 in 1000 measles cases
- SSPE: 1 in 1700 to 1 in 3300 measles cases

SSPE (subacute sclerosing panencephalitis) is a degenerative central nervous system disease which starts usually between 4 and 10 years after the measles infection. A recent German study (4) suggests that the risk for SSPE in children infected with measles below five years of age is 1:1 700 to 1:3 300. In Europe, 38 cases were complicated by acute measles encephalitis between 2007 and 2011 (6-10). Between 2005 and 2013 there were 24 deaths from measles in Bulgaria; 17 in Romania; 10 in France; 3 in Albania, the United Kingdom and Germany; 2 in Georgia and the Netherlands; and one in Spain. After the disease, a person has life-long immunity against measles.

How prevalent is measles?

2013/2014 data

Reported rates of measles in EU/EEA countries, June 2013 to May 2014 (11)

Country	2013	2013	2013	2013	2013	2013	2013	2014	2014	2014	2014	2014	Total cases	Cases per million	Total lab-positive cases
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May			
Austria	5	0	6	5	9	3	5	33	11	8	5	8	98	11.6	64.0
Belgium	5	2	1	4	3	2	1	2	8	7	29	26	90	8.1	54.0
Bulgaria	7	1	0	0	0	0	0	0	0	0	0	0	8	1.1	7.0
Croatia	0	0	1	0	0	0	0	0	1	0	1	0	3	0.7	1.0
Cyprus	0	0	0	0	0	0	0	0	0	4	6	0	10	11.6	8.0
Czech Republic	1	0	0	0	0	0	1	0	2	34	57	25	120	11.4	119.0
Denmark	0	0	0	0	0	0	0	0	5	8	6	1	20	3.6	10.0
Estonia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Finland	0	0	0	0	0	0	0	2	0	0	0	0	2	0.4	0.0
France	34	25	13	13	15	11	7	41	38	27	35	44	303	4.6	133.0
Germany	391	306	127	108	76	47	20	22	26	37	45	25	1230	15.1	645.0
Greece	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Hungary	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Iceland	0	0	0	0	0	0	0	0	0	1	0	0	1	3.1	1.0
Ireland	6	2	3	0	16	6	1	2	6	15	11	1	69	15.1	42.0
Italy	383	200	74	42	35	178	264	316	203	304	258	187	2444	40.2	1208.0
Latvia	0	0	0	0	0	0	0	0	0	0	25	9	34	16.7	33.0
Lithuania	7	0	0	1	0	0	0	0	0	2	0	2	12	4	2.0
Luxembourg	0	0	0	0	0	0	0	1	0	0	0	1	2	3.8	1.0
Malta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Netherlands	295	700	407	444	473	177	106	45	23	41	18	0	2729	163.1	949.0
Norway	7	0	0	0	0	0	0	0	0	0	2	0	9	1.8	9.0
Poland	17	10	3	1	1	1	1	15	27	27	19	8	130	3.4	94.0
Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Romania	127	83	27	11	23	22	12	25	17	5	1	5	358	16.8	281.0
Slovakia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Slovenia	0	1	0	0	0	0	0	0	0	0	0	1	2	1	2.0
Spain	18	31	8	4	4	0	3	11	26	78	27	7	217	4.7	195.0
Sweden	15	6	0	0	0	0	0	2	7	0	0	3	33	3.5	33.0
United Kingdom	124	81	22	15	28	13	4	39	27	26	12	2	393	6.4	390.0
Total	1442	1448	692	648	683	460	425	556	427	624	557	355	8317	16.3	4281

Monthly updates can be found in ECDC's publication 'Measles and rubella monitoring' (12).

Is there any specific treatment for measles?	There is no specific treatment for measles. Only symptoms can be treated. The symptoms usually disappear within 7 to 10 days if no complications occur (13). Supportive care that ensures good nutrition, adequate fluid intake, and treatment of dehydration may prevent severe complications. Antibiotics should be used to treat eye and ear infections, and pneumonia (14).
What is the aim of the vaccination?	Vaccination against measles – usually combined with vaccines against mumps and rubella (MMR) – elicits specific responses in the immune system, similar to infection with an actual pathogen. This way, the immune system produces antibodies against the disease. The vaccinated individual is protected against the disease and will not develop severe symptoms, complications or sequelae. If 95% of the population were vaccinated, elimination of the measles would be possible; this had been achieved in the Americas. Thus, vaccination against measles has a direct effect by providing protection for the vaccinated individual and an indirect effect by stopping transmission, which helps to control morbidity and mortality on a societal level.
For whom is the vaccine recommended?	All Member States of the European Union embark on a two-dose measles vaccination strategy (15). The specific schedules differ between countries. In general, the first dose is given around the first 12 months of life. The online ECDC immunisation scheduler offers access to the immunisation schedules of all EU/EEA countries (15).
How long does the vaccine last?	One dose of MMR vaccine delivers livelong immunity to most people (1, 16). A second dose protects those who did not respond to the first dose and increases the immune response in those whose response was low from the first dose. Thus, a second dose leads to a protective level of antibodies and is therefore necessary to ensure protection (17).
Are there other preventive methods?	Immunisation is the only effective preventive measure against measles (18).
What is the vaccine's effectiveness?	The measles vaccine is usually combined with rubella and mumps vaccines in one product (MMR vaccine). It is equally effective in the single or combined form (14). Measles vaccine is at least 95% (range 90%–98%) effective. Vaccine failure of the first dose at 12 months of age or older occurs in up to 5% of people who receive vaccination, but a second vaccine dose gives immunity to 95% of first-dose failures (18). In Europe in 2012/2013, 3.5% of the measles cases occurred in individuals who were vaccinated with two doses (19). Eliminating measles is a cost-effective strategy. This was examined by comparing elimination against the status quo in 2010 (20). Elimination can only be achieved by increasing coverage in Europe to 95%, with two doses of measles-containing vaccine.
What are the side effects of the vaccine?	A vaccine, like any pharmaceutical substance, is capable of causing adverse events. MMR vaccine has been used since 1963 and has an excellent safety record. As MMR vaccine is a live-attenuated vaccine it can cause mild and non-communicable symptoms of measles (rash, fever) in three to five of 100 vaccinated individuals. It commonly causes minor reactions and rarely more serious reactions (21, 22): Common adverse events (1 in 10 to 1 in 100 vaccinated individuals): • Fever (usually day 5–12 post-vaccination) • Local swelling at injection site • Rash commonly between day 5–12 post-vaccination • Irritability • Arthralgia (transient; mainly in adults, e.g. post-partum vaccination) Less common adverse events (1 in 1000 to 1 in 10 000 vaccinated individuals) • Lymphadenopathy • Swelling of parotid gland • Diarrhoea • Vomiting • Febrile convulsions Rare adverse events (< 1 in 10 000 vaccinated individuals) • Urticaria • Thrombocytopenia (transient; up to 1 per 30 000) • Meningitis/encephalitis (up to 1 per 100 000) • Deafness • Anaphylaxis, anaphylactoid reactions (1.5 per 1 000 000)

Q&A measles: references

(1) Atkinson W, Hamborsky J, Wolfe S, editors. Centers for Disease Control and Prevention. Epidemiology and prevention of vaccine-preventable diseases. 12th ed. Washington DC: Public Health Foundation; 2012.

(2) European Centre for Disease Prevention and Control. Factsheet for the general public [internet]. Stockholm: ECDC; 2014. Available from: http://www.ecdc.europa.eu/en/healthtopics/measles/Pages/factsheet-general-public.aspx

(3) Salisbury D, Ramsay M, editors. Immunisation against infectious disease. London: Public Health England; 2013. Available from: https://www.gov.uk/government/collections/immunisation-against-infectious-disease-the-green-book

(4) Muscat M, Bang H, Wohlfahrt J, Glismann S, Mølbak K. Measles in Europe: an epidemiological assessment. Lancet. 2009 Jan 31;373(9661):383-9.

(5) Schönberger K, Ludwig MS, Wildner M, Weissbrich B. Epidemiology of subacute sclerosing panencephalitis (SSPE) in Germany from 2003 to 2009: a risk estimation. PLoS One. 2013 Jul 9;8(7):e68909. Available from: http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0068909

(6) European Centre for Disease Prevention and Control. Annual epidemiological report 2013. Reporting on 2011 surveillance data and 2012 epidemic intelligence data. Stockholm: ECDC; 2013. Available from: http://ecdc.europa.eu/en/publications/Publications/annual-epidemiological-report-2013.pdf

(7) European Centre for Disease Prevention and Control. Annual epidemiological report 2012. Reporting on 2010 surveillance data and 2011 epidemic intelligence data. Stockholm: ECDC; 2013. Available from: http://ecdc.europa.eu/en/publications/Publications/Annual-Epidemiological-Report-2012.pdf

(8) European Centre for Disease Prevention and Control. Annual epidemiological report 2011. Reporting on 2009 surveillance data and 2010 epidemic intelligence data. Stockholm: ECDC; 2011. Available from: http://www.ecdc.europa.eu/en/publications/Publications/1111_SUR_Annual_Epidemiological_Report_on_Communicable_Diseases_in_Europe.pdf

(9) European Centre for Disease Prevention and Control [internet]. Annual epidemiological report on communicable diseases in Europe 2010. Stockholm: ECDC; 2010. Available from: http://ecdc.europa.eu/en/publications/publications/1011_sur_annual_epidemiological_report_on_communicable_diseases_in_europe.pdf

(10) European Centre for Disease Prevention and Control. Annual epidemiological report on communicable diseases in Europe 2009. Stockholm: ECDC; 2009. Available from: http://www.ecdc.europa.eu/en/publications/Publications/0910_SUR_Annual_Epidemiological_Report_on_Communicable_Diseases_in_Europe.pdf

(11) European Centre for Disease Prevention and Control. Maps [internet]. Stockholm: ECDC; 2014. Available from: http://ecdc.europa.eu/en/healthtopics/measles/epidemiological_data/pages/annual_epidemiological_reports.aspx

(12) European Centre for Disease Prevention and Control. Measles and rubella monitoring. Available from: http://www.ecdc.europa.eu/en/publications/surveillance_reports/vpd/pages/emmo.aspx

(13) National Health Service. Measles – treatment [internet]. London: NHS; 2014. Available from: http://www.nhs.uk/Conditions/Measles/Pages/Treatment.aspx

(14) World Health Organization. Measles [internet]. Geneva: WHO; 2013. Available from: http://www.who.int/mediacentre/factsheets/fs286/en/

(15) European Centre for Disease Prevention and Control. Vaccine schedule. Stockholm: ECDC; 2014. Available from: http://vaccine-schedule.ecdc.europa.eu/Pages/Scheduler.aspx

(16) Markowitz LE, Preblud SR, Fine PE, Orenstein WA. Duration of live measles vaccine-induced immunity. Pediatr Infect Dis J. 1990; 9 :101–10.

(17) Christenson B, Böttiger M. Measles antibody: comparison of long-term vaccination titres, early vaccination titres and naturally acquired immunity to and booster effects on the measles virus. Vaccine. 1994 Feb; 12(2): 129-133

(18) European Centre for Disease Prevention and Control. Factsheet for health professionals [internet]. Stockholm: ECDC; 2011. Available from: http://ecdc.europa.eu/en/healthtopics/measles/Pages/health_professionals.aspx

(19) European Centre for Disease Prevention and Control. Measles and rubella monitoring – May 2013. Stockholm: ECDC [accessed 2014 July 12]. Available from: http://ecdc.europa.eu/en/publications/publications/measles-rubella-monitoring-may-2013.pdf

(20) Bishai D, Johns B, Lefevre A, Nair D. Cost effectiveness of measles eradication. Final report. Geneva: WHO; 2010. Available from: http://www.who.int/immunization/sage/1_Bishai_Economic_analysis.pdf

(21) European Centre for Disease Prevention and Control. MMR vaccine safety – technical notes. Stockholm: ECDC; 2012.

(22) Bohlke K, Davis RL, Marcy SM, Braun MM, DeStefano F, Black SB, et al. Risk of anaphylaxis after vaccination of children and adolescents. Pediatrics. 2003; 112(4): 815-820.

Communicating the importance of measles immunisation – key messages

Key message: Measles is a serious disease

Introduction

In 1980, before measles vaccination became widely available, 2.6 million deaths worldwide were caused by measles [1][1]. In 2012, this number has been reduced to 122 000 people, mostly children.

Myth

It is a common misperception that measles is a harmless disease. Some people also believe that the healthcare system in developed countries has sufficient resources for good care when someone is infected with measles.

Correction of the myth

This misperception probably occurs due to the vaccination's success: many people have never seen a person with measles infection and consider measles a relatively harmless disease. In fact, measles can be a very severe infection, which cannot be directly treated with antivirals. Once infected, only the symptoms (e.g. high fever) can be mitigated.

Complications occur in about 30% of all measles cases and affect almost every organ [2]. Complications range from ear infections, diarrhoea and related dehydration, to severe respiratory infections such as pneumonia and involve sequelae such as blindness or encephalitis [1,2].

Most measles-related deaths occur due to the complications associated with measles. Supportive care may only lower the probability of severe complications [2]. Globally, more than 95% of measles deaths occur in low-income countries with weak health infrastructures. However, measles-related deaths also occur in developed and industrialised European countries: between 2005 and 2013, there were 24 deaths in Bulgaria, 17 in Romania, 10 in France, four in Italy, and three each in the United Kingdom and Germany [3].

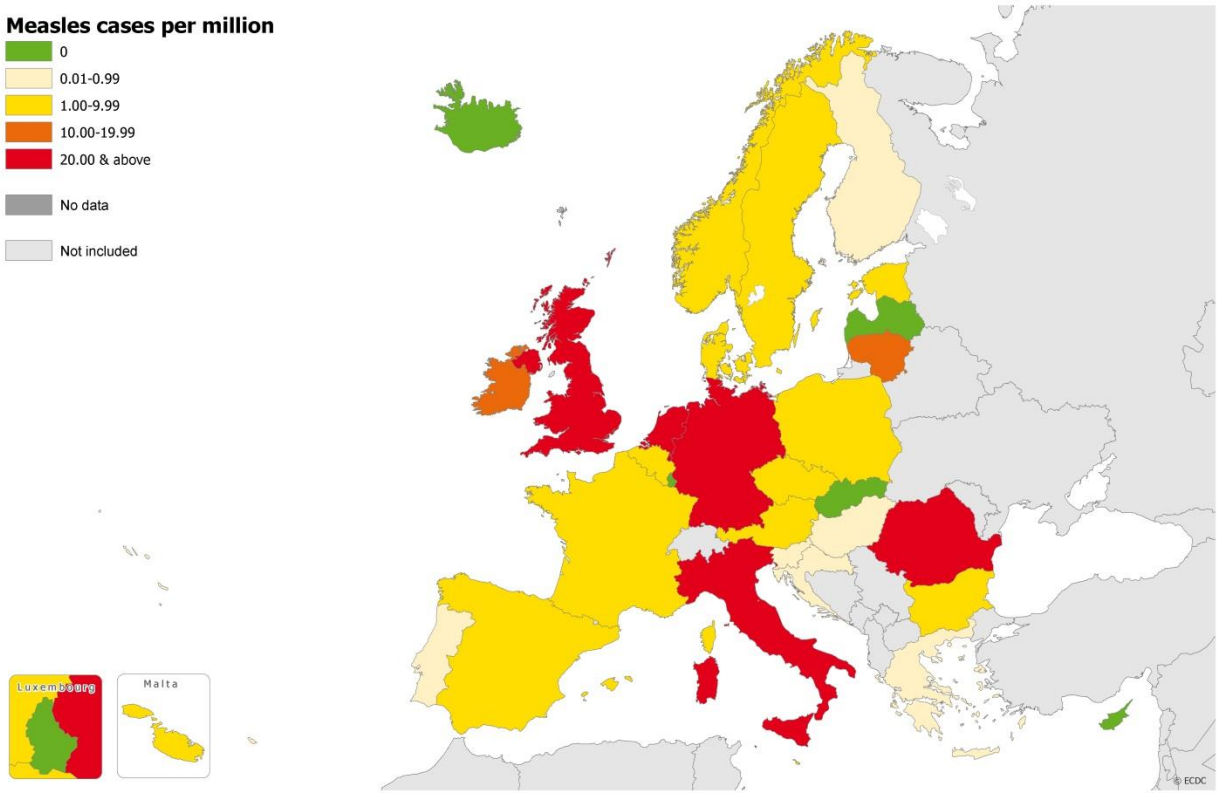
The number of hospitalisations due to measles is considerable: between 2005 and 2013, there were around 20 000 hospitalisations in Ukraine, Romania and Bulgaria, 5 239 hospitalisations in France, 1 607 in the United Kingdom, and 1 216 in Spain [3].

Conclusion

Although good healthcare can lower the probability of severe complications, measles-related deaths and hospitalisations due to complications occur even in developed and industrialised European countries. Vaccination is the only effective way to protect against it.

[1] All key messages have a dedicated reference section (see p. 10).

Figure 1. Incidence of measles in the EU, 2013 (cases per 1 000 000 population)



Source: European Centre for Disease Prevention and Control. Measles Atlas [internet]. Stockholm: ECDC; 2014. Available from: http://ecdc.europa.eu/en/healthtopics/measles/epidemiological_data/Pages/measles_maps.aspx

References: Measles is a serious disease

1. World Health Organization. Measles fact sheet [internet]. Geneva: WHO; [no year] [cited 12 Dec 2013]. Available from: www.who.int/mediacentre/factsheets/fs286/en/

2. World Health Organization. Centralized information system for infectious diseases [internet]. Geneva: WHO; [no year] [cited 12 Dec 2013]. Available from: http://data.euro.who.int/cisid/?TabID=326447

3. Orenstein WA, Perry RT, Halsey NA. The clinical significance of measles: a review. J Infect Dis. 2004; 189(1): 4-16.

Key message: Vaccination is the best way to get immunity against measles

Introduction

The MMR vaccine provides protection against measles, mumps and rubella without causing severe symptoms, complications, or sequelae that are associated with the diseases. Mild symptoms such as rash or fever may occur after vaccination in three to five of 100 individuals, as MMR is a live-attenuated vaccine.

Measles is a severe infection, which cannot be treated with antivirals. Once infected, only the symptoms can be treated. Complications of measles occur in 30% of the infections, can affect almost every organ [1], and involve sequelae such as blindness, encephalitis, severe diarrhoea and related dehydration, ear infections, or severe respiratory infections such as pneumonia [1,2]. Most measles-related deaths occur following complications.

Myth

It is a common myth that it is better to get immunity from the disease than from the vaccine.

Correction of the myth

This misperception seems to be based on the false assumption that vaccination does not give life-long immunity [3]. It is a fact, however, that a second dose of the vaccine leads to a protective level of antibodies and thus to the same degree of immunity one would acquire through natural infection.

Vaccinations elicit specific immune responses from the immune system (i.e. the production of specific antibodies against the disease), similar to the way an infection would. Vaccination protects against the disease with minimal consequences, as opposed to measles infection and its potentially severe symptoms, complications, and sequelae.

Further, immunity through vaccination will protect others. Vaccination immunises the individual so he or she cannot transmit the virus. Acquiring immunity through the disease, on the other hand, exposes others to the risk of infection. Measles is communicable four days before the first symptoms appear. During this time, non-immune individuals may be infected and measles can spread.

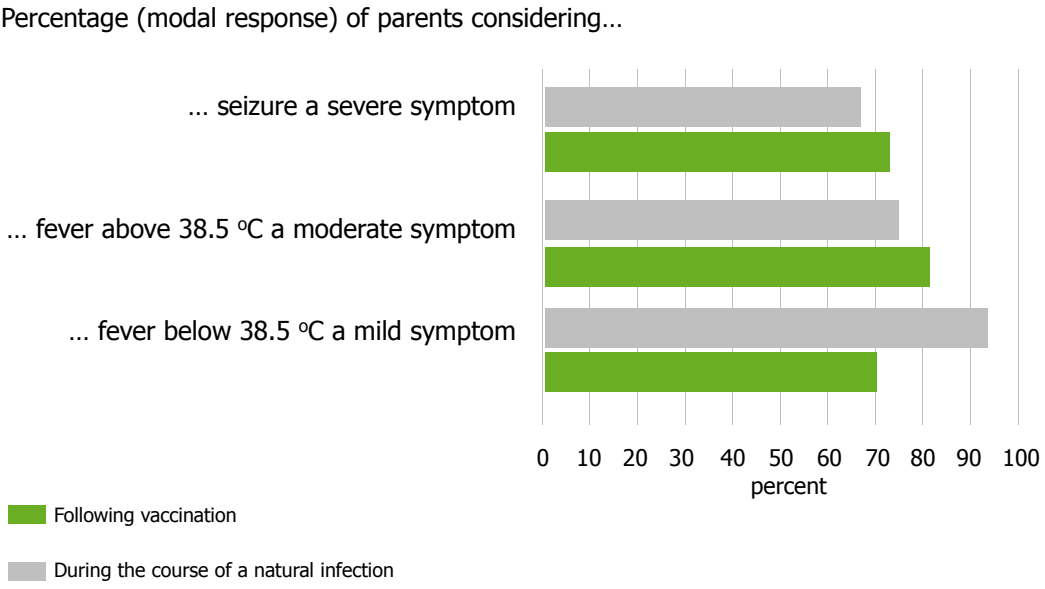
Another factor may be the fear of potential side effects from vaccination. A vaccine, like any pharmaceutical substance, entails a certain probability of side effects [4], for example fever in 5–15 of 100 first doses or seizures in 1 of 3 000 first doses [5]. More severe reactions occur only rarely, with incidences below 1 in 10 000. MMR vaccination thus has an excellent safety record and is recommended in all EU countries.

The way humans perceive risk may also contribute to a preference for natural infection. A study showed that parents rated the symptoms following vaccination as more severe than the same symptoms during an actual infection [6] (see Figure below). This bias occurs because humans tend to regret negative outcomes that result from their own actions more than identical outcomes caused by others or inaction: while own actions and their negative outcomes lead to guilt, the outcomes caused by outside factors are considered as ‘unavoidable fate’. Understanding this bias can help to take a more rational decision [7].

Conclusion

The MMR vaccine provides protection against measles while avoiding potentially severe symptoms, complications or sequelae. Severe adverse events following MMR vaccination are very rare. It is therefore safer to vaccinate than to contract the disease. Further, immunity through vaccination will protect others while immunity through the disease exposes others to the risk of the disease, both before and during the time of infection. Thus, vaccination offers better and safer protection against measles.

Figure 2. Biased perception of side effects



Source: Brown et al. [6]
All differences are statistically significant ($p<0.05$)

References: Vaccination is the best way to get immunity against measles

1. World Health Organization. Measles fact sheet [internet]. Geneva: WHO; [no year] [cited 2013 Nov 21]. Available from: http://www.who.int/mediacentre/factsheets/fs286/en/

2. Orenstein WA, Perry RT, Halsey NA. The clinical significance of measles: a review. J Infect Dis. 2004; 189(1):4-16.

3. Christenson B, Böttiger M. Measles antibody: comparison of long-term vaccination titres, early vaccination titres and naturally acquired immunity to and booster effects on the measles virus. Vaccine. 1994;12(2):129-133.

4. Edwards IR, Aronson JK. Adverse drug reactions: definitions, diagnosis, and management. Lancet. 2000; 356(9237):1255-1259.

5. World Health Organization. Mass measles immunization campaigns: reporting and investigating adverse events following immunization. Geneva: WHO; 2002. Available from: www.who.int/vaccine_safety/en/AEFI_measles_campaigns.pdf

6. Brown KF, Kroll JS, Hudson MJ, Ramsay M, Green J, Vincent CA, et al. Omission bias and vaccine rejection by parents of healthy children: implications for the influenza A/H1N1 vaccination programme. Vaccine. 2010 Jun;28:4181-4185.

7. Wroe AL, Turner N, Salkovskis PM. Understanding and predicting parental decisions about early childhood immunizations. Health Psychol. 2004;23(1):33.

Key message: Vaccination is the only effective way to protect against measles

Introduction

MMR vaccination elicits specific responses in the immune system, similar to the way an infection would, leading to the production of antibodies against measles, mumps and rubella, but without causing severe symptoms, complications, and sequelae.

Myth

It is a myth that homeopathy can be used as a vaccination alternative to protect children against measles. Despite the lack of evidence for alternative methods, a number of medical professionals are hesitant in recommending vaccination against measles and other childhood vaccinations [1] and offer, for example, homeopathic remedies as alternatives to vaccination.

Correction of the myth

A vaccine, like any pharmaceutical substance, entails a certain probability of side effects [2]. Even though the side effects are usually mild, and more severe adverse events are very rare, this may lead to the desire of avoiding these side effects by using seemingly harmless homeopathic products instead. Homeopathic products promise to strengthen the immune system and thereby protect against disease without side effects. However, homeopathy is not entirely devoid of risk [3]. Research has also shown that the proposed mechanisms of homeopathy are implausible [4] and that homeopathic substances are ineffective [3, 5, 6]. Ostensible effects of homeopathic substances are equal to placebo effects: effects occur because of mere expectations and not because of the substances themselves [7].

But even people with a strong immune system are susceptible to measles: individuals exposed to the virus will contract measles with a probability of 90%, regardless of the state of their immune system. Only vaccination can protect against measles.

Conclusion

Homeopathy has been shown to be ineffective; it is based on implausible mechanisms. Substances that claim to strengthen the immune system in general will not prevent a susceptible individual from contracting measles. Vaccination is the only effective way to protect against measles.

References: Vaccination is the only effective way to protect against measles

1. Lehrke P, Nuebling M, Hofmann F, Stoessel U. Attitudes of homoeopathic physicians towards vaccination. Vaccine. 2001;19: 4859-64.

2. Stratton K, Ford A, Rusch E, Clayton EW, editors. Adverse effects of vaccines: evidence and causality. Washington DC: The National Academies Press; 2012.

3. Ernst E. Is homeopathy a clinically valuable approach? Trends Pharmacol Sci. 2005; 26(11):547-548.

4. Grimes DR. Proposed mechanisms for homeopathy are physically impossible. Focus Altern Complement Ther. 2012;17(3):149-155 .

5. Ernst E. A systematic review of systematic reviews of homeopathy. Br J Clin Pharmacol. 2002;54 (6): 577–82.

6. House of Commons, Science and Technology Committee. Evidence check 2: Homeopathy: Fourth report of session 2009–2010. London: House of Commons; 2010. Available from: http://www.publications.parliament.uk/pa/cm200910/cmselect/cmsctech/45/45.pdf

7. Shang A, Huwiler-Müntener K, Nartey L, Jüni P, Dörig S, Sterne JAC, et al. Are the clinical effects of homoeopathy placebo effects? Comparative study of placebo-controlled trials of homoeopathy and allopathy. Lancet. 2005; 366(9487):726–732.

Key message: The MMR vaccine combines three vaccinations in one and has an excellent safety record

Introduction

Some combination vaccines contain multiple vaccines against different diseases, such as MMR vaccine, which contains vaccines against measles, mumps and rubella. This way, the organism is protected against different diseases with only one shot.

Myth

It is a common myth that giving a child the MMR combination vaccine increases the risk of harmful side effects and can overload the immune system.

Correction of the myth

This misperception is based on the idea that the more foreign substances enter the body, the more the immune system is stressed. However, the myth that combination vaccines overload the immune system underestimates the power of the human immune system [1], and overestimates the number of foreign substances in multivalent vaccines [2]. The neonatal immune system develops even before birth [2]. The immune system is capable of dealing with a very large number of antigens at the same time. In fact, foreign substances, e.g. in dust and dirt, continuously trigger a child's immune responses. A sore throat or a cold exposes a child to more antigens than a vaccine. Studies have shown that vaccines do not weaken the immune system because recently vaccinated children were equally likely to become infected by other pathogens as unvaccinated children [3–5].

Sometimes two or more injections with multivalent vaccines are administered during one visit (e.g. MMR and varicella, or MMR and diphtheria-tetanus-pertussis (DTP)). Several studies have shown that both MMR alone and MMR combined with certain other vaccines have an excellent safety record [2, 6–7]. If multiple vaccines would weaken the immune system, one would expect lower immune responses than with individual applications of the vaccines [8, 9]. However, similar immune responses have been found when MMR vaccine was combined on the same day with vaccination against a) varicella [10, 11], or b) DTP and oral poliovirus [12], or c) DTP-Hib (*Haemophilus influenzae* type b and varicella [13], or d) with Hib [14].

Conclusion

The myth that combination vaccines overload the immune system underestimates the power of the human immune system and overestimates the number of foreign substances in combination vaccines [1]. In sum, the MMR vaccine, either applied alone or simultaneously with certain other vaccines, provides protection against many diseases while reducing the number of injections. The combination formula has an excellent safety record.

References: The MMR vaccine combines three vaccinations in one and has an excellent safety record

1. Abbas AK, Lichtman AH, Pober JS. Cellular and molecular immunology. 2nd ed. Philadelphia: WB Saunders Co; 1994.

2. Offit PA, Quarles J, Gerber MA, Hackett CJ, Marcuse EK, Kollman TR, et al. Addressing parents' concerns: do multiple vaccines overwhelm or weaken the infant's immune system? Pediatrics. 2002; 109(1):124-129.

3. Black SB, Cherry J D, Shinefield HR, Fireman B, Christenson P, Lampert D. Apparent decreased risk of invasive bacterial disease after heterologous childhood immunization. Am J Dis Child. 1991;145:746–749.

4. Davidson M, Letson GW, Ward JI, Ball A, Bulkow L, Christenson P, et al. DTP immunization and susceptibility to infectious diseases. Is there a relationship? Am J Dis Child. 1991;145:750–754.

5. Storsaeter J, Olin P, Renemar B, Lagergard T, Norberg R, Romanus V, et al. Mortality and morbidity from invasive bacterial infections during a clinical trial of acellular pertussis vaccines in Sweden. Pediatr Infect Dis J. 1988;7:637–645.

6. Smith MJ, Woods CR. On-time vaccine receipt in the first year does not adversely affect neuropsychological outcomes. Pediatrics. 2010;125(6): 1134-1141.

7. Stratton KR, Wilson CB, McKormick MC. Immunization safety review: multiple immunizations and immune dysfunction. Washington DC: The National Academies Press; 2002.

8. King GE, Hadler SC. Simultaneous administration of childhood vaccines: an important public health policy that is safe and efficacious. Pediatr Infect Dis J. 1994;13:394–407.

9. American Academy of Pediatrics. Combination vaccines for childhood immunization: recommendations of the Advisory Committee on Immunization Practices, the American Academy of Pediatrics, and the American Academy of Family Physicians. Pediatrics. 1999;103:1064–1077.

10. Englund JA, Suarez C, Kelly J, et al. Placebo-controlled trial of varicella vaccine given with or after measles-mumps-rubella vaccine. J Pediatr. 1989;114:37–44.

11. Brunell PA, Novelli VM, Lipton SV, Pollock B. Combined vaccine against measles, mumps, rubella, and varicella. Pediatrics. 1988;81:779–784.

12. Deforest A, Long SS, Lischner HW, Girone JAC, Clark JL, Srinivasan R, et al. Simultaneous administration of measles-mumps-rubella vaccine with booster doses of diphtheria tetanus pertussis and poliovirus vaccines. Pediatrics. 1988;81:237–246.

13. Shinefield HR, Black SB, Staehle BO, Adelman T, Ensor K, Ngai A, et al. Safety, tolerability, and immunogenicity of concomitant infections in separate locations of MMRII, Varivax and Tetramune in healthy children vs concomitant infection of MMRII and Tetramune followed six weeks later by Varivax. Pediatr Infect Dis J. 1998;17:980–985.

14. Dashefsky B, Wald E, Guerra N, Byers C. Safety, tolerability, and immunogenicity of concurrent administration of Haemophilus influenza type b conjugate vaccine (meningococcal protein conjugate) with either measles-mumps-rubella vaccine or diphtheria-tetanus-pertussis and oral poliovirus vaccines in 14- to 23-month-old infants. Pediatrics. 1990;85:682–689.

Key message: MMR vaccination does not increase the risk of getting autism

Introduction

Since its introduction, around 575 million doses of MMR vaccine have been administered worldwide. It has an excellent safety record [1].

Myth

A common myth states that MMR vaccination may cause autism.

Correction of the myth

This myth was born in England in 1998. A journal article suggested a link between the MMR vaccine and autism and gastrointestinal disease. The author's call to stop distributing the MMR vaccine received considerable media attention. In 2004, it was revealed that the author had a pecuniary interest in linking the MMR vaccine to autism [2]. A lawyer who intended to sue vaccine manufacturers had hired him and also recruited the children for the study. Moreover, data were falsified: contrary to what was stated in the article, some of the children already showed signs of autism before they were even vaccinated. The original article was retracted by the journal [3]. The fears caused by this article and the media attention it received led to years of lowered vaccine uptake, especially in the United Kingdom, which in turn led to several severe measles outbreaks.

Several independent studies were conducted in many parts of the world to test the correlation between MMR vaccine and autism. All concluded that there is no such correlation [4-9].

One reason why this myth is so persistent is that autism is often diagnosed at a time in the life of a child when most countries administer MMR vaccination [10]; this might have given rise to a false sense of causality. Moreover, from 1976 to 1997 diagnoses of autism increased by a factor of almost 10 in the United States [11] – the same period when the MMR vaccine was introduced. This increase, however, does not mean autism is occurring more often; more likely, the increase may be related to 'the introduction of broader, more precise diagnostic criteria, increased availability of services, and increased awareness of autism' [11]. When two rare events become very noticeable (e.g. due to novelty or an increase in frequency), humans tend to perceive causality between the two events [12]. This so-called illusory correlation is a typical cognitive bias [12] and may have contributed to the persistence of the myth.

Conclusion

A flawed journal article caused fears that the MMR vaccine may lead to autism. Numerous scientific articles showing no such correlation have since refuted this claim. A general cognitive bias to perceive causality when two rare events randomly co-occur contributed to the stability of the myth. It can be concluded that MMR vaccination does not increase the risk of developing autism.

References: MMR vaccination does not increase the risk of getting autism

1. Lievano F, Galea SA, Thornton M, Wiedmann RT, Manoff S, Tran TN, Plotkin SA. Measles, mumps, and rubella virus vaccine (M–M–R II): A review of 32 years of clinical and postmarketing experience. Vaccine. 2012 Nov; 30(48):6918-26.

2. Deer B. Secrets of the MMR scare: How the vaccine crisis was meant to make money. BMJ. 2011; 342:c5258.

3. The Editors of the Lancet. Retraction – Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children. Lancet. 2010 Feb; 375(9713):445.

4. Fombonne E, Chakrabarti S. No evidence for a new variant of measles-mumps-rubella–induced autism. Pediatrics. 2001; 108(4): e58.

5. Taylor B, Miller E, Farrington CP, Petropoulos MC, Favot-Mayaud I, Li J, et al. Autism and measles, mumps, and rubella vaccine no epidemiological evidence for a causal association. Lancet. 1999;353.

6. Peltola H, Patja A, Leinikki P, Valle M, Davidkin I, Paunio M. No evidence for measles, mumps, and rubella vaccine-associated inflammatory bowel disease or autism in a 14-year prospective study. Lancet. 1998; 351:1327-1328.

7. Honda H, Shimizu Y, Rutter M. No effect of MMR withdrawal on the incidence of autism a total population study. J Child Psychol Psychiatry. 2005 Jun; 46(6):572-9.

8. Madsen KM, Hviid A, Vestergaard M, Schendel D, Wohlfahrt J, Thorsen P, Melbye, M. A population-based study of measles, mumps, and rubella vaccination and autism. N Engl J Med. 2002; 347(19): 1477-1482.

9. Hornig M, Briese T, Buie T, Bauman ML, Lauwers G, Siemetzki U, et al. Lack of association between measles virus vaccine and autism with enteropathy: a case-control study. PLoS One. 2008; 3(9):e3140.

10. Johnson CP, Myers SM. Identification and evaluation of children with autism spectrum disorders. Pediatrics. 2007; 120(5): 1183–215.

11. Barbaresi WJ, Katusic SK, Colligan RC, Weaver AL, Jacobsen SJ. The incidence of autism in Olmsted County, Minnesota, 1976-1997: results from a population-based study. Arch Pediatr Adolesc Med. 2005;159(1):37-44.

12. Hamilton DL, Gifford RK. Illusory correlation in interpersonal perception: A cognitive basis of stereotypic judgments. J Exp Soc Psychol. 1976; 12:392-407.

Key message: Measles is a serious threat to health; elimination of measles in Europe is endangered by non-vaccinated individuals

Introduction

In some regions of the world, for example the Americas, measles has been eliminated [1].

Myth

It is a misconception that measles has also been eliminated in Europe. There is still a need to get vaccinated.

Correction of the myth

Overall, measles is rare in Europe, and many people may have never seen a person infected with measles. This may explain the myth.

European countries have pledged to eliminate measles by 2015. Since 2005, outbreaks have occurred in Austria, Belgium, Bulgaria, Denmark, France, Italy, Spain, Romania, the United Kingdom and Switzerland [2-9, 10]. Outbreaks lead to hospitalisations and measles-related deaths. Between 2005 and 2013, measles caused 24 deaths in Bulgaria; 17 in Romania; 10 in France; three each in Albania, the United Kingdom, and Germany; two each in Georgia and the Netherlands; and one in Spain [11]. Outbreaks occur due to pockets of susceptible individuals who are not immune, either because they did not get vaccinated, their immune systems failed to respond to the vaccine (this is rare), or because they were too young or too ill to get vaccinated [1].

Measles occurs with even higher incidence rates in other parts of the world, e.g. Africa and Asia [10,12]. Global interconnectivity can distribute diseases across huge distances [13], and only high vaccination rates can mitigate the consistent introduction and reintroduction of measles. If at least 95% of the population are vaccinated with two doses of measles-containing vaccine, measles can be eliminated [14].

Stopping measles vaccination in a population can lead to dramatic increases in measles infections. This was seen, for example, in the United Kingdom following an unsubstantiated vaccine scare, which caused vaccine rates to drop and led to thousands of measles cases [15].

Vaccination against measles helps to protect the individual and at the same time protects others who may be not immune but benefit from so-called herd immunity: when a significant number of people are vaccinated, chains of infections are stopped sooner, which indirectly protects non-immune individuals. For measles, 95% vaccine coverage is needed for herd immunity to work. To quote Bauch et al.: 'Vaccine-generated herd immunity can reduce disease incidence to such low levels that real or imagined vaccine risks appear large in comparison, causing individuals to cease vaccinating. This implies a feedback loop between disease prevalence and strategic individual vaccinating behaviour.' [16].

Experts emphasise the importance of individual contributions to both health programmes and society at large: 'Successful vaccination programmes, like successful societies, depend on the cooperation of every individual to ensure the good of all' [17]. It is each individual's responsibility to contribute to a safe and healthy environment for everyone.

Conclusion

The planned elimination of measles in Europe is endangered by non-vaccinated individuals and high global mobility. Elimination can only be reached if 95% percent of Europe's population are vaccinated with two doses of measles-containing vaccine. Until then, measles remains a serious threat to health in Europe.

References: Measles is a serious threat to health; elimination of measles in Europe is endangered by non-vaccinated individuals

1. Istre GR, Mckee PA, West GR, O'Mara DJ, Rettig PJ, Stuemky J, et al. Measles spread in medical settings: an important focus of disease transmission?. Pediatrics. 1987;79(3):356-358.

2. Schmid D, Holzmann H, Schwarz K, Kasper S, Kuo HW, Aberle SW, et al. Measles outbreak linked to a minority group in Austria, 2008. Epidemiol Infect. 2010;138(3):415.

3. Lernout T, Kissling E, Hutse V, Schrijver KD, Top G. An outbreak of measles in orthodox Jewish communities in Antwerp, Belgium, 2007–2008: different reasons for accumulation of susceptibles. Euro Surveill. 2009;14(2).

4. Muscat M, Christiansen AH, Persson K, Plesner AM, Bottiger BE, Glismann S, et al. Measles outbreak in the Oresund region of Denmark and Sweden. Euro Surveill. 2006; 11(3):e060330.

5. Du Châtelet IP, Antona D, Freymuth F, Muscat M, Halftermeyer-Zhou F, Maine C, et al. Spotlight on measles 2010: Update on the ongoing measles outbreak in France, 2008–2010. Euro Surveill. 2010; 15(36):19656.

6. Van Treeck UV. Measles outbreak in Germany: over 1000 cases now reported in Nordrhein-Westfalen. Euro Surveill. 2006;11(5):e060511.

7. Filia A, Curtale F, Kreidl P, Morosetti G, Nicoletti L, Perrelli F, et al. Cluster of measles cases in the Roma/Sinti population, Italy, June-September 2006. Euro Surveill. 2006; 11(10):e061012.

8. Perucha M, Ramalle-Gómara E, Lezaun ME, Blanco A, Quiñones C, Blasco M. A measles outbreak in children under 15 months of age in La Rioja, Spain, 2005-2006. Euro Surveill. 2006; 11(10):267.

9. Richard JL, Masserey-Spicher V. Ongoing measles outbreak in Switzerland: results from November 2006 to July 2007. Euro Surveill, 2007; 12(7), e070726.

10. World Health Organization. Immunization surveillance, assessment and monitoring [internet]. Geneva: WHO; [cited 2013 Nov21]. Available from: http://apps.who.int/immunization_monitoring/en/

11. World Health Organization Europe [internet]. Centralized Information System For Infectious Diseases (CISID). Copenhagen: WHO Europe; 2014. Available from: http://data.euro.who.int/cisid

12. Marshall TM, Hlatswayo D, Schoub B. Nosocomial Outbreaks—A Potential Threat to the Elimination of Measles?. J Infect Dis. 2003; 187(1):97-101.

13. Brockmann D, Helbing D. The hidden geometry of complex, network-driven contagion phenomena. Science. 2013 Dec 13;342(6164):1337-42.

14. World Health Organization. Global measles and rubella strategic plan: 2012-2020. Available from: http://www.measlesrubellainitiative.org/wp-content/uploads/2013/06/Measles-Rubella-Strategic-Plan.pdf

15. Public Health Wales. Measles outbreak:data. [internet]. 2013 [cited 2014 Jul 30]. Available from: Public Health Wales, Web site: http://www.wales.nhs.uk/sitesplus/888/page/66389

16. Bauch CT, Bhattacharyya S. Evolutionary game theory and social learning can determine how vaccine scares unfold. PLoS Comput Biol. 2012;8(4):e1002452.

17. World Health Organization. What are some of the myths – and facts – about vaccination? [internet]. Geneva: WHO; 2013. Available from: http://www.who.int/features/qa/84/en/

Q&A – rubella

How is rubella transmitted?

Rubella is transmitted via droplets from person to person. It may be transmitted by persons with subclinical or asymptomatic infection, which occurs in up to 50% of all rubella infections (1).

What are the consequences of the infection?

Rubella is usually a mild disease (2).

Children usually have few or no constitutional symptoms but adults may experience 1–5 days of fever, malaise, headache and arthralgia.

The typical presentation of rubella is a red rash and swollen lymph glands around the ears and the back of the head and – occasionally in adults – pain and inflammation of the joints.

Complications of acute rubella are rare (with the exception of rubella infection during pregnancy, which is discussed below):

- Encephalitis: 1 out of 5000–6000 cases
- Thrombocytopenia: 1 out of 3000 cases
- Transient polyarthralgia and polyarthritis are common complications in adolescents and adults, but rare in children.

What are the consequences of rubella in a pregnant woman?

85 out of 100 babies born to mothers who had rubella before conception or in the first three months of pregnancy will have a birth defect, so-called congenital rubella syndrome (CRS) (3). This syndrome manifests itself in a number of ways: deafness, cataracts, heart defects, microcephaly, mental retardation, bone alterations, liver and spleen damage.

Symptoms appear after birth up to when the infected child is two to four years old. Other late-onset manifestations are diabetes mellitus, thyroid dysfunction, visual or neurological abnormalities.

In 20% of the cases, rubella infections can result in spontaneous abortion and stillbirth/foetal death (1,4,5).

How prevalent is rubella in the EU? 2013/14 data

Reported rates of rubella in EU/EEA countries, June 2013 to May 2014 (6)

Country	2013	2013	2013	2013	2013	2013	2013	2014	2014	2014	2014	2014	Total cases	Cases per million	Total lab-positive cases
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May			
Austria	0	1	0	0	0	0	1	1	1	0	0	1	5	0.6	4.0
Belgium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-	-
Bulgaria	0	0	0	2	0	1	0	1	5	0	0	0	9	1.2	2.0
Croatia	0	1	0	0	0	0	0	0	NR	NR	NR	NR	1	0.2	1.0
Cyprus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Czech Republic	0	0	0	0	0	0	0	1	0	0	0	0	1	0.1	1.0
Denmark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Estonia	2	0	0	0	0	0	0	0	0	0	0	0	2	1.5	2.0
Finland	1	0	0	0	0	0	0	0	0	0	0	0	1	0.2	0.0
France	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-	-
Germany	NR	NR	NR	NR	NR	NR	0	12	19	13	18	22	84	1	12.0
Greece	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Hungary	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Iceland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Ireland	0	0	0	0	0	0	0	0	0	0	0	1	1	0.2	0.0
Italy	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-	-
Latvia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Lithuania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Luxembourg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Malta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Netherlands	12	43	0	0	0	0	0	0	1	0	0	0	56	3.3	15.0
Norway	0	0	0	0	0	0	0	1	2	0	0	0	3	0.6	2.0
Poland	4114	1877	690	569	606	481	485	770	672	913	837	822	12836	333.1	0.0
Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Romania	17	7	17	9	2	1	3	0	0	0	0	13	69	3.2	59.0
Slovakia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Slovenia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Spain	0	0	0	0	0	0	0	0	0	1	NR	NR	1	0	0.0
Sweden	0	0	0	0	0	0	0	0	0	1	0	0	1	0.1	1.0
United Kingdom	2	1	1	1	1	2	0	0	0	0	0	0	8	0.1	8.0
Total	4148	1930	708	581	609	485	489	786	700	928	855	859	13078		107.0

NR=not reporting

Monthly updates can be found in ECDC's publication 'Measles and rubella monitoring' (7).

How prevalent is CRS?	Between 2008 and 2012, there were at least 77 CRS cases in Europe (8): two cases each occurred in the Czech Republic, Poland, and Portugal; four cases each were reported from Germany and Spain; Italy reported six cases; and 57 cases were reported by Romania.
Is there any specific treatment for rubella?	There is no specific treatment for rubella. Symptoms will normally pass within 7 to 10 days (9). Up to 50% of infections may be subclinical or unapparent (1).
What is the aim of the vaccination?	The aim of the vaccination is to reduce and eliminate rubella and congenital rubella syndrome (1). It is usually given as MMR vaccine, which is a combination vaccine against measles, mumps and rubella. MMR vaccination elicits specific responses in the immune system, similar to infection with an actual pathogen. This way, the immune system produces antibodies against measles, mumps and rubella without developing severe symptoms, complications and sequelae. The vaccinated individual is protected against the diseases. Elimination of rubella is possible and cost-effective (10), but it can only be achieved by increasing coverage in Europe to more than 80%, with at least one dose of rubella-containing vaccine. Since rubella vaccine is usually combined with vaccination against measles, elimination of rubella will benefit from the goal of 95% coverage for the MMR vaccine. As measles is more contagious than rubella, higher coverage is needed to reach elimination. Vaccination against rubella has a direct effect by providing protection for the vaccinated individual, especially during pregnancy, and an indirect effect by stopping transmission, which helps to control morbidity and mortality on a societal level.
For whom is the vaccine recommended?	As of December 2009, all European countries have introduced rubella-containing vaccine to their routine schedules (11). According to national schedules, every child should receive immunisation against rubella by means of the MMR vaccine. WHO recommends that in order to eliminate rubella within 10 years, high vaccination coverage must be achieved in young children, adolescents and adults (1–39 years) (11), which means that some countries must run catch-up campaigns for those who have not yet been vaccinated. Women who wish to be pregnant should be advised to check their immunity status. Women with unknown immunisation status or no specific IgG antibodies must be considered susceptible and should get vaccinated before pregnancy (12). After vaccination with MMR vaccine women should avoid getting pregnant for at least 28 days (11).
How long does the vaccine last?	One dose of MMR vaccine delivers livelong immunity to most people (1,13,14,15). After two doses, between 91% and 100% of the vaccinees had detectable antibodies 12 to 15 years after receiving the second dose (14,15). A recent study shows that natural infections lead to higher levels of antibodies. However, after two rather than one dose of MMR vaccine, the concentration of rubella-specific antibodies was above the protective level and declined slower (16).
Are there other preventive methods?	Only rubella vaccine (usually included in MMR vaccine) can prevent rubella and CRS.
What is the vaccine's effectiveness?	All licensed rubella vaccines induce seroconversion rates of approximately 95% or higher after a single dose. The high response rate to a single dose of rubella vaccine and the long-term persistence of protection in vaccinees do not support a routine requirement for a second dose of rubella vaccine, even though immunity wanes more slowly after two doses (16). However, as the combined MMR vaccine is 98% effective, a second dose of MMR is recommended to produce immunity to measles and mumps in those who failed to respond to the first dose. Data indicate that almost all persons who do not respond to the measles component of the first dose will respond to a second dose of MMR (1).

What are the side effects of the vaccines?	The live-attenuated measles, mumps and rubella combination vaccine has been used since 1963 and has an excellent safety record. However, some adverse events may be possible, as with any medicinal product. MMR vaccine commonly causes minor reactions, and rarely more serious reactions (17,18): Common adverse events (1 in 10 to 1 in 100 vaccinated individuals) • Fever commonly day 5–12 post-vaccination • Local swelling at injection site • Rash commonly between day 5–12 post-vaccination • Irritability • Arthralgia, transient (mainly in adults, e.g. post-partum vaccination) Less common adverse events (1 in 1000 to 1 in 10 000 vaccinated individuals) • Lymphadenopathy • Swelling of parotid gland • Diarrhoea • Vomiting • Febrile convulsions Rare adverse events (< 1 in 10 000 vaccinated individuals) • Urticaria • Thrombocytopenia, transient (up to 1 per 30 000) • Meningitis/encephalitis (up to 1 per 100 000) • Deafness • Anaphylaxis, anaphylactoid reactions (1.5 per 1.000 000) (19)

Q&A rubella: references

(1) Centers for Disease Control and Prevention. Rubella information for parents. Updated 2013 Feb. Atlanta: CDC; 2013. Available from: http://www.cdc.gov/vaccines/vpd-vac/rubella/downloads/PL-dis-rubella-color-office.pdf

(2) European Centre for Disease Prevention and Control. Rubella factsheet for health professionals [internet]. Stockholm: ECDC; [no year]. Available from: http://ecdc.europa.eu/en/healthtopics/rubella/Pages/professionals.aspx

(3) Atkinson W, Hamborsky J, Wolfe S, editors. Centers for Disease Control and Prevention. Epidemiology and prevention of vaccine-preventable diseases. 12th ed. Washington DC: Public Health Foundation; 2012.

(4) World Health Organization. Factsheet about rubella [internet]. Available from: http://www.who.int/mediacentre/factsheets/fs367/en/

(5) Siegel M, Fuerst HT, Guinee VF. Rubella epidemicity and embryopathy. Results of a long-term prospective study. Am J Dis Child. 1971 Jun;121(6):469-73. Available from: http://archpedi.jamanetwork.com/article.aspx?articleid=504042

(6) European Centre for Disease Prevention and Control. Measles and rubella monitoring – April 2014. Available from: http://ecdc.europa.eu/en/publications/Publications/measles-rubella-monitoring-april-2014.pdf

(7) European Centre for Disease Prevention and Control. Measles and rubella monitoring. Available from: http://www.ecdc.europa.eu/en/publications/surveillance_reports/vpd/pages/emmo.aspx

(8) World Health Organization. Immunization monitoring: rubella (CRS) reported cases [internet]. Geneva: WHO; 2013. Available from: http://apps.who.int/immunization_monitoring/globalsummary/timeseries/tsincidencecrs.html

(9) National Health Service. Rubella [internet]. London: NHS; 2013. Available from: http://www.nhs.uk/conditions/Rubella/Pages/Introduction.aspx

(10) Wichmann O, Ultsch B. Effektivität, Populationseffekte und Gesundheitsökonomie der Impfungen gegen Masern und Röteln. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz. 2013 Sep;56(9):1260-9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23990088

(11) World Health Organization. Rubella vaccines: WHO position paper. Wkly Epidemiol Rec. 2011 Jul 15;86(29):301-16. Available from: http://www.who.int/wer/2011/wer8629.pdf

(12) Pandolfi E, Chiaradia G, Moncada M, Rava L, Tozzi AE. Prevention of congenital rubella and congenital varicella in Europe . Euro Surveill. 2009;14(9):pii=19133. Available from: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19133

(13) Davidkin I, Jokinen S, Broman M, Leinikki P, Peltola H. Persistence of measles, mumps, and rubella antibodies in an MMR-vaccinated cohort: a 20-year follow-up. J Infect Dis 2008;197:950–6

(14) Markowitz LE, Preblud SR, Fine PE, Orenstein WA. Duration of live measles vaccine-induced immunity. Pediatr Infect Dis J. 1990;9:101–10

(15) LeBaron CW, Forghani B, Matter L, Reef SE, Beck C, Bi D, et al. Persistence of rubella antibodies after 2 doses of measles-mumps-rubella vaccine. J Infect Dis 2009;200:888–99

(16) Smits G, Mollema L, Hahné S, de Melker H, Tcherniaeva I, van der Klis F, et al. Seroprevalence of rubella antibodies in the Netherlands after 32 years of high vaccination coverage. Vaccine. 2014 Feb 7. pii: S0264-410X(14)00118-2.

(17) Centres for Disease Control and Prevention. Rubella disease in-short [internet]. Atlanta: CDC; 2009. Available from: http://www.cdc.gov/vaccines/vpd-vac/rubella/in-short-adult.htm

(18) European Centre for Disease Prevention and Control. MMR vaccine safety – technical notes. Stockholm: ECDC; 2012.

(19) Bohlke K, Davis RL, Marcy SM, Braun MM, DeStefano F, Black SB, et al. Risk of anaphylaxis after vaccination of children and adolescents. Pediatrics. 2003;112(4):815-820

Communicating the importance of rubella immunisation – key messages

Key message: Rubella infection during early pregnancy carries a high risk of harm to the foetus

Evidence

The symptoms of rubella are often mild, and up to 50% of infections may be subclinical or inapparent [1]. However, 85 out of 100 babies born to mothers who had rubella shortly before or during the first three months of pregnancy will have a birth defect, so-called congenital rubella syndrome (CRS) [2]. These include deafness, cataracts, heart defects, microcephaly, mental retardation, bone alterations, liver and spleen damage. Symptoms occur after birth up to when the infected child is two to four years old. Other late-onset manifestations are diabetes mellitus, thyroid dysfunction, and visual or neurological abnormalities. In 20% of the cases, rubella infections can result in spontaneous abortion and stillbirth/foetal death [1, 3, 4].

Worldwide, an estimated 110 000 babies are born with CRS every year [3]. EU countries reported 77 cases between 2008 and 2012 [5].

Pockets of unvaccinated individuals were repeatedly involved in large outbreaks of rubella, for example in Poland in 2013, with more than 30 000 cases of rubella infections. In the Netherlands in 2004/2005, 29 women were reported to have been infected with rubella virus during their pregnancy, none of whom had been vaccinated. The infections in the Netherlands, as known so far, resulted in two foetal deaths and 14 infants with congenital infection. Eleven children had clinical defects including deafness in all cases [6].

Conclusion

Rubella infections in healthy individuals usually have mild symptoms. However, rubella infection occurring just before conception and during early pregnancy is very likely to result in miscarriage, foetal death, or congenital defects known as congenital rubella syndrome (CRS). Vaccination well before getting pregnant protects from rubella and CRS.

References: Rubella infection during early pregnancy carries a high risk of harm to the foetus

1. Atkinson W, Hamborsky J, Wolfe S, editors. Centers for Disease Control and Prevention. Epidemiology and prevention of vaccine-preventable diseases. 12th ed. Washington DC: Public Health Foundation; 2012.

2. Centers for Disease Control and Prevention. Rubella information for parents [internet]. Updated 2013 Feb. Atlanta: CDC; 2013. Available from: http://www.cdc.gov/vaccines/vpd-vac/rubella/downloads/PL-dis-rubella-color-office.pdf

3. World Health Organization. Factsheet about rubella [internet]. Geneva: WHO; [no year]. Available from: http://www.who.int/mediacentre/factsheets/fs367/en/

4. Siegel M, Fuerst HT, Guinee VF. Rubella epidemicity and embryopathy. Results of a long-term prospective study. Am J Dis Child. 1971 Jun;121(6):469-73. Available from: http://archpedi.jamanetwork.com/article.aspx?articleid=504042

5. World Health Organization. Immunization monitoring: rubella (CRS) reported cases [internet]. Geneva: WHO; 2013. Available from: http://apps.who.int/immunization_monitoring/globalsummary/timeseries/tsincidencecrs.html

6. Hahné S, Macey J, van Binnendijk R, Kohl R, Dolman S, van der Veen Y, et al. Rubella outbreak in the Netherlands, 2004–2005: High burden of congenital infection and spread to Canada. Pediatr Infect Dis J. 2009 Sep;28(9):795-800. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19710586

Key message: Check your immunity against rubella before getting pregnant

Evidence

Before planning to get pregnant, women should confirm their rubella vaccination status [1]. Vaccination at least one month before pregnancy is the only way to effectively prevent congenital rubella syndrome (CRS). When a pregnant woman is infected with rubella shortly before or during the first trimester of her pregnancy, the virus is capable of infecting the foetus. It then stops cells from developing, or destroys them [2], which results in an 85–90% probability of the child being born with CRS [2].

In cases where it is not possible to verify the immunisation status (verification is usually done by checking vaccination cards or by testing for specific IgG antibodies), a woman must be considered susceptible. Screening is not a necessary condition for vaccination [3]. Vaccination against rubella and varicella should be offered to all women of childbearing age who do not have acceptable evidence of immunity [4].

Conclusion

If a woman wishes to be pregnant and is rubella antibody negative or of unknown immune status, she should receive at least one dose of MMR or MMRV vaccine. She should avoid becoming pregnant for 28 days after receipt of MMR vaccine because MMR is a live-attenuated vaccine [3].

References: Check your immunity against rubella before getting pregnant

1. Akkerman D, Cleland L, Croft G, Eskuchen K, Heim C, Levine A, et al. Health Care Guideline: Routine Prenatal Care. Fourteenth Edition. Institute for Clinical Improvement .Updated July 2012. Available from: https://www.icsi.org/_asset/13n9y4/Prenatal.pdf

2. Edlich RF, Winters KL, Long WB, Gubler KD. Rubella and congenital rubella (German measles). J Long Term Eff Med Implants .2005;15(3):319–28. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16022642/DOI:10.1615/JLongTermEffMedImplants.v15.i3.8

3. World Health Organization. Weekly epidemiological record. 2011 July 27. 2011;29(86):301–316. Available from: http://www.who.int/wer/2011/wer8629.pdf

4. Pandolfi E, Chiaradia G, Moncada M, Rava L, Tozzi AE. Prevention of congenital rubella and congenital varicella in Europe. Euro Surveill. 2009;14(9):pii=19133. Available from: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19133

Key message: Susceptible pregnant women should receive immunisation against rubella immediately after delivery

Evidence

In most EU countries, rubella screening is offered during regular antenatal care. Screening does not detect rubella infection in pregnancy but it identifies susceptible women, who can then get vaccinated in the post-partum period, which reduces the risk of infection in future pregnancies [1].

Susceptibility to rubella during pregnancy has several consequences. For example, pregnant women who were screened as non-immune should avoid contact with potentially infected individuals.

Rubella is contagious about one week before the individual develops the characteristic rash and about one week thereafter [2]. Up to 50% of all infections disappear without any symptoms. Thus, pregnant women may encounter individuals with rubella who may not know (yet) that they are infected.

Any woman presenting with a rash or who is exposed to others with a rash should be investigated.

Conclusion

Women who are found to be susceptible for rubella during their pregnancy should avoid contact with potentially infected individuals. Infections during early pregnancy can lead to severe consequences for the unborn child [3]. In order to protect the foetus in any subsequent pregnancies, susceptible women should receive at least one dose of rubella-containing vaccine immediately after delivery [4]. The same strategy applies to women after abortions [3].

References: Susceptible pregnant women should receive immunisation against rubella immediately after delivery

1. Akkerman D, Cleland L, Croft G, Eskuchen K, Heim C, Levine A, et al. Health care guideline: Routine prenatal care. Fourteenth edition. Institute for Clinical Improvement .Updated July 2012. Available from: https://www.icsi.org/_asset/13n9y4/Prenatal.pdf

2. Richardson M, Elliman D, Maguire H, Simpson J, Nicoll A. Evidence base of incubation periods, periods of infectiousness and exclusion policies for the control of communicable diseases in schools and preschools. Pediatr Infect Dis J. 2001 Apr;20(4):380-91.

3. Pandolfi E, Chiaradia G, Moncada M, Rava L, Tozzi AE. Prevention of congenital rubella and congenital varicella in Europe. Euro Surveill. 2009;14(9):pii=19133. Available from: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19133

4. Tischer A, Andrews N, Kafatos G, Nardone A, Berbers G, Davidkin I, et al. Standardisation of measles, mumps and rubella assays to enable comparisons of seroprevalence data across 21 European countries and Australia. Epidemiol Infect. 2007;135(5):787-97.

Key message: Unvaccinated males and females should get rubella vaccination to protect unborn life

Evidence

In order to protect the foetus from congenital rubella syndrome (CRS) it is essential for women of childbearing age to be immunised against rubella before pregnancy. In the past, only certain segments of the population, for example school-age girls, were targeted by vaccination schedules [1]. This caused immunity gaps, i.e. unprotected cohorts and population subgroups (e.g. males), which can lead to large outbreaks such as the one in Poland with more than 30 000 cases [2]. Recent outbreaks affected more men than women, but the proportion of infected women of childbearing age and of CRS cases can nevertheless be high, as was seen in outbreaks in Poland, Romania and Spain [2, 3, 4].

In order to eliminate rubella, high vaccination coverage must therefore be achieved in young children, adolescents and adults of both genders (1–39 years [5]), which means that some countries must run catch-up campaigns for those who have not yet been vaccinated.

Conclusion

All susceptible women who wish to be pregnant should be vaccinated. In addition, every person between 1 and 39 years of age with unknown immunisation status or no specific IgG antibodies must be considered susceptible and should be vaccinated. It is important to also vaccinate men and young children to eliminate rubella by stopping its transmission. Only if transmission of rubella is terminated, CRS can be stopped.

References: Unvaccinated males and females should get rubella vaccination to protect unborn life

1. Derrough T, Bacci S, Lopalco PL. Letter to the editor: Commitment needed for the prevention of congenital rubella syndrome in Europe. Euro Surveill. 2012;17(10):pii=20106. Available from: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=20106

2. Paradowska-Stankiewicz I, Czarkowski MP, Derrough T, Stefanoff P. Ongoing outbreak of rubella among young male adults in Poland: increased risk of congenital rubella infections. Euro Surveill. 2013;18(21):pii=20485. Available from: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=20485

3. Janta D, Stanescu A, Lupulescu E, Molnar G, Pistol A. Ongoing rubella outbreak among adolescents in Salaj, Romania, September 2011–January 2012. Euro Surveill. 2012;17(7):pii=20089. Available from: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=20089

4. Red de Vigilancia Epidemiológica de la Comunidad de Madrid. Outbreak of rubella in the Madrid region, Spain, 2005. Euro Surveill. 2005;10(27):pii=2742. Available from: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=2742

5. World Health Organization. Weekly epidemiological record. 2011 July 27. 2011;29(86):301–316. Available from: http://www.who.int/wer/2011/wer8629.pdf

Key message: Stopping rubella also means stopping congenital rubella syndrome

Evidence

Despite the pledge to eliminate congenital rubella syndrome (CRS) by 2015, many European countries reported outbreaks in unvaccinated population groups over the last few years. Between 2004 and 2013, Poland [1], Sweden [2], Romania [3], Italy [4], Austria [5, 6], Spain [7] and the Netherlands [8] all reported major outbreaks. It is now highly unlikely that rubella will be eradicated within the original time frame.

In Europe, only girls were initially targeted by national vaccination schedules [9]. This led to unprotected cohorts and population subgroups, particularly men, which in turn led to large outbreaks like the one in Poland with more than 30 000 cases [1]. In order to eliminate rubella within 10 years, high vaccination coverage must be achieved in young children, adolescents and adults (1–39 years [9]), which means that some countries must run catch-up campaigns for those who have not yet been vaccinated.

Rubella occurs with even higher incidence rates in other parts of the world, e.g. Africa and south-east Asia, where vaccination rates are lowest [10]. Global interconnectivity can distribute diseases across huge distances [11], and only high vaccination rates can mitigate the consistent introduction and reintroduction of rubella. If at least 80% of the population are vaccinated with at least one dose of rubella-containing vaccine [9], rubella can be eliminated.

Stopping rubella vaccination in a population can lead to dramatic increases in infection numbers. This was seen, for example, in the Netherlands in 2004/2005, where 29 women of an anthroposophic community contracted rubella during their pregnancy; none of them had been vaccinated. The infections resulted in two foetal deaths and 14 infants with congenital infection. Eleven children had clinical defects including deafness in all cases [8].

Vaccination against rubella helps to protect the individual and at the same time protects others who may be not immune but benefit from so-called herd immunity: when a significant number of people are vaccinated, chains of infections are stopped sooner, which indirectly protects non-immune individuals.

Conclusion

Elimination of rubella in Europe aims at preventing rubella infection and CRS. The goal of elimination is endangered by pockets of non-vaccinated individuals and by high global mobility. Only if at least 80% percent of Europe's population are vaccinated with at least one dose of rubella-containing vaccine, elimination of rubella can be reached and CRS be prevented.

References: Stopping rubella also means stopping congenital rubella syndrome

1. Paradowska-Stankiewicz I, Czarkowski MP, Derrough T, Stefanoff P. Ongoing outbreak of rubella among young male adults in Poland: increased risk of congenital rubella infections. Euro Surveill. 2013;18(21):pii=20485. Available from: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=20485

2. Folkhälsomyndigheten/Public Health Agency of Sweden. Röda hund [internet]. Available from: http://www.folkhalsomyndigheten.se/amnesomraden/statistik-och-undersokningar/sjukdomsstatistik/roda-hund/#statistics-nav

2a. Folkhälsomyndigheten/Public Health Agency of Sweden. Högsta antalet fall av röda hund på 23 år [Highest number of rubella cases on 23 years]. Available from: http://www.folkhalsomyndigheten.se/nyheter-och-press/historik-smi-2003-2013/historik-smi-nyheter/2013/maj/hogsta-antalet-fall-av-roda-hund-pa-23-ar/

3. Janta D, Stanescu A, Lupulescu E, Molnar G, Pistol A. Ongoing rubella outbreak among adolescents in Salaj, Romania, September 2011–January 2012. Euro Surveill. 2012;17(7):pii=20089. Available from: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=20089

4. D'Agaro P, Dal Molin G, la Zamparo E, Rossi T, Micuzzo M, Busetti M, et al. Epidemiological and molecular assessment of a Rubella outbreak in North-Eastern Italy. Journal of Medical Virology [internet]. 2010 May 23; 82, 11 (2010) 1976. Available from: http://peer.ccsd.cnrs.fr/docs/00/57/73/37/PDF/PEER_stage2_10.1002%252Fjmv.21874.pdf

5. Kasper S, Allerberger F, Aberle S, Holzmann H, Redlberger M, Daghofer E, et al. Rubella in Austria 2008–2009: no longer a typical childhood disease. Pediatr Infect Dis J. 2010 May;29(5):448-52.

6. Schmid D, Kasper S, Kuo HW, Aberle S, Holzmann H, Daghofer E, et al. Ongoing rubella outbreak in Austria, 2008-2009. Euro Surveill. 2009 Apr 23;14(16) pii: 19184. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19389340

7. Derrough T, Bacci S, Lopalco PL. Letter to the editor: Commitment needed for the prevention of congenital rubella syndrome in Europe. Euro Surveill. 2012;17(10):pii=20106. Available from: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=20106

8. Hahné S, Macey J, van Binnendijk R, Kohl R, Dolman S, van der Veen Y, et al. Rubella Outbreak in the Netherlands, 2004-2005: High Burden of Congenital Infection and Spread to Canada. Pediatr Infect Dis J [internet]. 2009 Sep;28(9):795-800.

9. World Health Organization. Weekly epidemiological record. 2011 July 27. 2011;29(86):301–316. Available from: http://www.who.int/wer/2011/wer8629.pdf

10. World Health Organization. Immunization surveillance, assessment and monitoring [internet]. Available from: http://apps.who.int/immunization_monitoring/en/

11. Brockmann D, Helbing D. The hidden geometry of complex, network-driven contagion phenomena. Science. 2013 Dec 13;342(6164):1337-42.

Annex A. Leaflets on measles immunisation

Table A-1. Evaluation grid for leaflets on measles immunisation

Standards for media coverage of health issues											
filename	Explain goal of medical treatment or prevention	Define target population	Explain aetiology	Provide epidemio–logical data	Communi–cate treatment effects in absolute numbers	Include visuali–zations to illustrate treatment effects to address a wide range of people	Communic ate cost estimates to convey an idea of individual and public health invest–ments	Mention alternatives to treatment	Use compara–tive figures	Disclose uncertainti es and what is not (yet) known	Disclose conflicts of interests
12-278-13A	+	+	–	+	+ –	–	–	–	–	–	–
5030_Merkblatt_MMR	+	+ –	–	–	–	–	–	–	–	–	–
090521measlesen	–	+	+	+	+	–	–	–	–	–	–
63000001	+	+	–	+	+	–	+	–	–	–	–
brighton_sussex_NHS_measles	–	+	+	–	–	–	–	–	–	–	–
Departement_Gesundheit_Switzerland_measles	+	–	–	+	+	–	–	–	–	–	–
dh_116728	+	–	+	+ –	–	–	–	–	–	–	–
dis -measles-color -office-indepth-info	–	–	+	+	+	–	–	–	+	–	–
DoH_8412_Measles_A5_07_GP_accessible	–	+	–	–	–	–	–	–	–	–	–
dsresource	–	+	+	–	–	–	–	–	–	–	–
dsresource_infant	–	+	+	–	+ –	–	–	–	–	–	–
HNI00461	–	+	+	+ –	–	–	–	–	–	–	–
hug-me	–	–	–	–	–	–	–	–	–	–	–
immunize-MMR-2012	–	+	+	+ –	–	–	–	–	–	–	–
JPEG68221 - Measlesflyer (Croped)(2)(2)	–	–	–	–	–	–	–	–	–	–	–
Kingstonmeaslesleaflet	–	+	+ –	–	–	–	–	–	–	–	–
masern0509	–	–	+	+ –	–	–	–	+	–	–	–
Measles%20infographic	+	+	–	+	–	+	+	–	–	–	–
measles	–	–	+	–	–	–	–	+	–	–	–
Measles_4_08	–	–	+	–	–	–	–	–	–	–	–
measles_factsheel_flyer_-_prf8	–	+	+	+ –	–	–	–	+	–	–	–
measles_fs_ontario	–	–	+	+	+	–	–	+	–	–	–
measles_HSE_Ireland	–	+	–	–	–	–	–	–	–	–	–
measles_leaflet	–	–	+	+	–	–	–	+	–	–	–
measles_leaflet_NHS_norfolk	–	+	+	+	+	–	–	–	–	–	–

Standards for media coverage of health issues											
filename	Explain goal of medical treatment or prevention	Define target population	Explain aetiology	Provide epidemio–logical data	Communi–cate treatment effects in absolute numbers	Include visuali–zations to illustrate treatment effects to address a wide range of people	Communic ate cost estimates to convey an idea of individual and public health invest–ments	Mention alternatives to treatment	Use compara–tive figures	Disclose uncertainti es and what is not (yet) known	Disclose conflicts of interests
measles_na thac	–	+	+	+	–	–	–	–	–	–	–
measles_za	–	–	+	–	–	–	–	–	–	–	–
Measles+Le aflet+Feb+2 013	–	–	+	–	–	–	–	+	–	–	–
measles-pil-cks-april-2011	–	+	+	–	–	–	–	+	–	–	–
MMRCatch UpLeaflet	+	+	+	–	+	–	–	–	–	–	–
mmrleaflet_ north_irelan d	+	+	+	+	+	+	–	–	+	–	–
p4026	–	–	–	–	–	–	–	–	–	–	–
p4209	–	–	+	+	–	–	–	–	–	–	–
p4314	–	+ –	+	–	–	–	–	–	–	–	–
PDFFile_14 145_en	–	+	+	+	–	–	–	–	–	–	–
PL-dis-measles-color-office	+	+	+	+	+	+	–	–	–	–	–
switzerland_ measles_va cc	+	–	+	+	+	–	+	+	–	–	–
worchesters hire_NHS_ measles	–	+	+	+	–	–	–	+	–	–	–

Annex B. Summary of EU vaccination policies on rubella for adolescent females or women of childbearing age

ECDC provides an online overview of the rubella vaccination policies in EU countries at http://vaccine-schedule.ecdc.europa.eu. The overview shows that seven countries explicitly recommend catch-up vaccinations for women between 15 and 45 (Austria, Belgium, France, Germany, Italy, Poland and the United Kingdom). Latvia, Lithuania and Sweden recommend catch-up strategies for 12-year-olds. All other countries recommend vaccination against rubella between birth and nine years of age. Eight countries (Belgium, Bulgaria, Estonia, Hungary, Iceland, Norway, Poland, and Romania) recommend that the second dose of rubella should be administered as late as between 10 and 13 years of age. Greece explicitly recommends that women who are seronegative at the birth of their first child should get two doses of rubella in the postpartum period for protection during further pregnancies.

Recent outbreaks of rubella

Several outbreaks of rubella have been reported in the literature over the last years. Below we have listed major outbreaks in EU/EEA Member States since 2005. All outbreaks are characterised by a high number of cases and demonstrate the ubiquity of the rubella and CRS threat. The description of the outbreaks is based on published scientific reports. As these reports frequently refer to ongoing outbreaks, we complemented the summaries with data reported to WHO via the global monitoring system [20].

Table A-2 summarises the percentage of women of childbearing age affected by rubella and the number of cases of CRS reported in the outbreaks (WHO data). The displayed male-to-female ratio shows that rubella is a major problem in male populations. This can probably be explained by older vaccination policies which initially only covered women.

Table A-2. Rubella outbreaks in Europe (2004–2013)

Country	Time period	Male-to-female ratio	Percentage of infected women 15–45 years of age	Number of cases of rubella in pregnancy (confirmed cases)	Number of CRS cases/year (WHO data[30])
Poland[21]	2013, ongoing	10:1	No data	2	2 in 2013[21]
Sweden[22]	2012	1.38:1	6%	no data	0 in 2012
Romania[23]	2011–2012	1.4:1	40.9%	2	55 in 2012
Italy[24]	2008	2.82:1	no data	3	6 in 2009
Austria[25, 26]	2008–2009	1:1.43	41%	1	no data
Spain[27]	2005	1.33:1	39%	no data	5 in 2005
Netherlands[28,29]	2004–2005	No data	No data	29	4 in 2005

Poland. From January to April 2013, Poland experienced a 10-fold increase of rubella cases. According to the ECDC Monthly Measles and Rubella Monitoring report (June 2013; [31]), the outbreak in Poland accounted for 29 741 cases from 1 January to 31 May 2013. The incidence varied strongly between provinces ranging from 7.4–151.1 per 100 000 inhabitants. 81% of the cases were 15–29-year-old males. The outbreak also reflects the history of immunisation policies in Poland, namely selective vaccination of adolescent girls from 1989 to 2003, then universal two-dose measles-mumps-rubella vaccination since 2004. Of the 72% cases for which vaccination status was known, 10% were vaccinated with one dose of rubella-containing vaccine; 2% received two doses of rubella-containing vaccine. Up to April 2013, two CRS cases have been reported [21].

Romania. Romania faced a large outbreak of rubella in 2012. 20 812 cases were reported to WHO in 2012, 3 494 in 2011, leading to 55 cases of CRS in 2012 [20]. Janta et al. cover a smaller outbreak, which took place from September 2011 to January 2012 in Salaj in north-western Romania (1 873 cases, 40.9% in women of childbearing age) [23]. A total of 2.1% of the cases reported in Romania were vaccinated with one dose of rubella-containing vaccine [23].

Sweden. The outbreak in Järna (near Stockholm) originated in an anthroposophic community. The index case contracted rubella during a trip to central Europe. Forty-one children (aged 1–13 years, ten of whom were aged 5–9) and nine adults were infected. 48 people were unvaccinated. Two adults were reported to have been vaccinated against rubella [22, 32, 33, 34].

Italy. Italy reported an outbreak of rubella from January to June 2008 in two residential homes for mentally and physically disabled young adults [24]. The epidemic subsequently spread to the general population. In total, 4 847 cases of rubella were reported to WHO in 2008 [20], followed by six CRS cases in 2009. According to

D'Agaro et al., the outbreak affected mostly young adult cohorts. The majority of cases were male (73.8%), with a mean age of 26.6 years in males and 27.4 in females. 133 cases (111 laboratory confirmed) were observed [24]. Although the proportion of infected women of childbearing age was low, three pregnant women were infected. Two pregnancies were terminated, and one fetus was tested positive for rubella virus. As of June 2009, no increase in CRS cases was observed. The proportion of susceptible women of childbearing age in north-east Italy was estimated at 5.5%.

Austria. The rubella outbreak in 2008/09 affected two provinces, Styria and Burgenland. Of 355 cases (146 of whom were female), the 15–19-years-olds (44.4%) and the 20–24-year-olds (32.4%) were most affected [25]. Of the 230 cases for whom vaccination status was available, 10% had received one dose of MMR vaccine; no case had received two doses. One laboratory-confirmed rubella infection in a pregnant 18-year-old woman resulted in elective abortion. The woman 'had not been vaccinated in childbed after her first delivery a year earlier although she had been identified as non-immune to rubella infection' [26].

Spain. Between January and May 2005, the region of Madrid reported a rubella outbreak with a total of 431 cases, most patients were between 20 and 29 years old [27]. The majority of the patients (58%) were of foreign, mainly Latin American, origin. Thirty-three percent of cases were in immigrant women of childbearing age, compared with 6% in Spanish women of childbearing age; 360 of 431 cases were confirmed [27]. In total, 185 (43%) patients were female, with 170 (92%) of childbearing age. This resulted in three voluntary abortions because of the risk of CRS.

Netherlands. A rubella outbreak in an unvaccinated orthodox religious subpopulation in 2004/05 spread to a Canadian community which shares historical, religious and social links with the affected Dutch community [28, 29]. In the Netherlands, a total of 410 cases of rubella were reported to WHO [20] (2004 and 2005). In Canada, 320 rubella cases and two CRS cases were reported between 2004 and 2005. In the Netherlands, 29 women were infected with rubella virus during their pregnancy, none of whom was vaccinated. The outbreak resulted in two foetal deaths and 14 infants with congenital infection. Eleven children had clinical defects, including deafness in all cases [29]. The estimated vaccine effectiveness was 99.3% [29].

Summary. During the latest reported outbreaks, rubella infection affected more men than women (due to older vaccination policies targeting predominantly women). Nevertheless, there is still a sizeable proportion of infected women of childbearing age. Public health efforts need to be directed at both women of childbearing age and unvaccinated men.

CRS due to recent outbreaks

As summarised in Table A-2, Romania had a high incidence of CRS; Poland may see similar numbers because of recent large-scale outbreaks. Six terminated pregnancies due to rubella infections and CRS risk were reported, but the actual number is probably much higher. There is no recent literature which covers abortions conducted because of CRS risk.

Policies and recommendations in Europe: recommendations on rubella vaccination, rubella screening, and post-partum vaccination

Rubella vaccination in Europe

Vaccination against rubella was introduced in the 1970s [38]. As of December 2009, all European countries have introduced rubella-containing vaccine in the routine schedule [39]: all children should receive immunisation against rubella by means of the MMR vaccine, which is a combination vaccine against measles, mumps and rubella.

European vaccination strategies are directed at two goals: the first goal is the protection of pregnant women and their unborn children, as rubella infection shortly before or during early pregnancy entails a high risk of miscarriage, foetal death, or congenital defects (congenital rubella syndrome, CRS). Vaccinating young children ensures sustained reduction in the incidence of rubella and CRS [40]. The second goal is to interrupt the transmission of rubella and eventually eliminate rubella and prevent CRS by achieving 80% vaccine coverage with at least one dose of rubella-containing vaccine [40]. Since rubella vaccine is usually combined with vaccination against measles, elimination of rubella will benefit from the goal of 95% coverage for the MMR vaccine. As measles is more contagious than rubella, higher coverage is needed to reach elimination.

Vaccination against rubella was introduced later than vaccination against measles. In the past, many European countries only targeted girls in their vaccination schedules [40]. This led to unprotected cohorts and population subgroups, particularly males, which in turn led to large outbreaks like the one in Poland with more than 30 000 cases in 2013 [21]. WHO recommends that in order to eliminate rubella within 10 years, high vaccination coverage must be achieved in young children, adolescents and adults (1–39 years), which means that some countries must run catch-up campaigns for those who have not yet been vaccinated [39,41].

Screening before and during pregnancy

Women who wish to be pregnant should be advised to check their immunity status by a blood screening. Women with unknown immunisation status or no specific IgG antibodies must be considered susceptible [41]. In most European countries, routine rubella screening by means of a blood test is offered as part of the usual antenatal care [42].

Rubella antibody negative before pregnancy

If a woman of childbearing age is rubella antibody negative she should receive at least one dose of MMR or MMRV vaccine. She should avoid becoming pregnant for 28 days after receipt of MMR vaccine because MMR is a live-attenuated vaccine [40].

Rubella antibody negative during pregnancy

If pregnant women are rubella antibody negative, they should avoid contact with potentially infected individuals if possible. They should be followed until the end of pregnancy and immunised with at least one dose of MMR immediately after delivery [43,44,45].

Inadvertent vaccination against rubella during or shortly before pregnancy

For pregnant women, MMR vaccination is contraindicated because it is a live-attenuated vaccine. Termination of pregnancy is, however, not recommended after inadvertent vaccination during or shortly before pregnancy [40].

Vaccination of susceptible women immediately after delivery

If a woman was susceptible for rubella during her pregnancy, she should receive MMR vaccine immediately after delivery for protection during future pregnancies [41]. The same strategy applies for women after abortions.

References

1. World Health Organization. Global measles and rubella strategic plan: 2012–2020. Geneva: WHO; 2012.
2. Christie AS, Gay A. The measles initiative: Moving toward measles eradication. J Infect Dis. 2011 Jul;204 Suppl 1:S14-7.
3. Betsch C. Innovations in communication: the internet and the psychology of vaccination decisions. Euro Surveill. 2011 Apr 28;16(17).
4. Lewandowsky S, Ecker UKH, Seifert CM, Schwarz N, Cook J. Misinformation and its correction: continued influence and successful debiasing. Psychol Sci Publ Interest. 2012;13(3) 106–131.
5. Betsch C, Sachse K. Debunking vaccination myths – Strong risk negations can increase perceived vaccination risks. Health Psychol. 2013 Feb;32(2):146-55.
6. Gigerenzer G, Gaissmaier W, Kurz-Milcke E, Schwartz LM, Woloshin S. Helping doctors and patients to make sense of health statistics. Psychol Sci Publ Interest, 2007;8, 53–96.
7. Bodemer N, Müller SM, Okan Y, Garcia-Retamero R, Neumeyer-Gromen A. Do the media provide transparent health information? A cross-cultural comparison of public information about the HPV vaccine. Vaccine. 2012 May 28;30(25):3747-56.
8. Reyna VF. Risk perception and communication in vaccination decisions: A fuzzy-trace theory approach. Vaccine. 2012 May 28;30(25):3790-7.
9. Cook J, Lewandowsky S. The debunking handbook. St. Lucia, Australia: University of Queensland; 2011.
10. Zimmerman RK, Wolfe RM, Fox DE, Fox JR, Nowalk MP, Troy JA, et al. Vaccine criticism on the World Wide Web. J Med Internet Res. 2005;7(2), e17.
11. Kata A. A postmodern Pandora's box: anti-vaccination misinformation on the internet. Vaccine. 2010 Feb 17;28(7):1709-16.
12. Kata A. Anti-vaccine activists, Web 2.0, and the postmodern paradigm – an overview of tactics and tropes used online by the anti-vaccination movement. Vaccine. 2012 May 28;30(25):3778-89.
13. Leask J, Chapman S, Cooper Robbins SC. 'All manner of ills': The features of serious diseases attributed to vaccination. Vaccine. 2010 Apr 9;28(17):3066-70.
14. Slovic P. Perception of risk. Science. 1987 Apr 17;236(4799):280-5.
15. Sackett DL, Rosenberg WM, Gray JA, Haynes RB, Richardson WS. Evidence based medicine: what it is and what it isn't. Clin Orthop Relat Res. 2007 Feb;455:3-5.
16. Gellin BG, Maibach EW, Marcuse EK. Do parents understand immunizations? A national telephone survey. Pediatrics. 2000 Nov;106(5):1097-102.
17. Editors of The Lancet. Retraction – Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children. Lancet. 2010 Feb 6;375(9713):445.
18. Montgomery SM, Morris DL, Pounder RE, Wakefield AJ. Paramyxovirus infections in childhood and subsequent inflammatory bowel disease. Gastroenterology 1999;116(4):796-803
19. Goldacre B. The MMR hoax. The Guardian. Archived from the original on 30 August 2008.
20. World Health Organization. WHO vaccine-preventable diseases: monitoring system. [internet] Available from: http://apps.who.int/immunization_monitoring/globalsummary
21. Paradowska-Stankiewicz I, Czarkowski MP, Derrough T, Stefanoff P. Ongoing outbreak of rubella among young male adults in Poland: increased risk of congenital rubella infections. Euro Surveill. 2013;18(21):pii=20485
22. Folkhälsomyndigheten/Public Health Agency of Sweden. Röda hund (rubella). [internet]. 2012 [cited 2014 Jul 30]. Available from: http://www.folkhalsomyndigheten.se/amnesomraden/statistik-och-undersokningar/sjukdomsstatistik/roda-hund/?t=com
23. Janta D, Stanescu A, Lupulescu E, Molnar G, Pistol A. Ongoing rubella outbreak among adolescents in Salaj, Romania, September 2011–January 2012. Euro Surveill. 2012;17(7):pii=20089.
24. D'Agaro P, Dal Molin G, Zamparo E, Rossi T, Micuzzo M, Busetti M, et al. Epidemiological and molecular assessment of a rubella outbreak in North-Eastern Italy. J Med Virol. 2010 Nov;82(11):1976-82.

25. Kasper S, Allerberger F, Aberle S, Holzmann H, Redlberger M, Daghofer E, et al. Rubella in Austria 2008-2009: no longer a typical childhood disease. Pediatr Infect Dis J. 2010 May;29(5):448-52.

26. Schmid D, Kasper S, Kuo HW, Aberle S, Holzmann H, Daghofer E, et al. Ongoing rubella outbreak in Austria, 2008–2009. Euro Surveill. 2009 Apr 23;14(16). pii: 19184.

27. Red de Vigilancia Epidemiológica de la Comunidad de Madrid. Outbreak of rubella in the Madrid region, Spain, 2005. Euro Surveill. 2005;10(27):pii=2742

28. an der Veen Y, Hahné S, Ruijs H, van Binnendijk R, Timen A, van Loon AM, de Melker H. Rubella outbreak in an unvaccinated religious community in the Netherlands leads to cases of congenital rubella syndrome. Euro Surveill. 2005;10(47):pii=2839.

29. Hahné S, Macey J, van Binnendijk R, Kohl R, Dolman S, van der Veen Y. Rubella outbreak in the Netherlands, 2004–2005: high burden of congenital infection and spread to Canada. Pediatr Infect Dis J. 2009 Sep;28(9):795-800.

30. World Health Organization. Immunization monitoring: rubella (CRS) reported cases [internet]. Geneva: WHO; 2013. Available from: http://apps.who.int/immunization_monitoring/globalsummary/timeseries/tsincidencecrs.html

31. European Centre for Disease Prevention and Control. Measles and rubella monitoring – June 2013. Stockholm: ECDC; 2013. Available from: http://www.ecdc.europa.eu/en/publications/Publications/Measles-rubella-monitoring_June_2013.pdf

32. Folkhälsomyndigheten/Public Health Agency of Sweden. Högsta antalet fall av röda hund på 23 år. [internet]. 2012 [cited 2014 Jul 30]. Available from http://www.folkhalsomyndigheten.se/nyheter-och-press/historik-smi-2003-2013/historik-smi-nyheter/2013/maj/hogsta-antalet-fall-av-roda-hund-pa-23-ar/

33. Folkhälsomyndigheten/Public Health Agency of Sweden. Röda hund (rubella). [internet]. 2012 [cited 2014 Jul 30]. Available from: http://www.folkhalsomyndigheten.se/amnesomraden/statistik-och-undersokningar/sjukdomsstatistik/roda-hund/?t=com

34. Folkhälsomyndigheten/Public Health Agency of Sweden. Epidemiologisk årsrapport 2012. Stockholm: SMI; 2012. Available from: http://www.folkhalsomyndigheten.se/documents/statistik-uppfoljning/smittsamma-sjukdomar/2012/norovirus-epidemiologisk-arsrapport-2012-2013-101-8.pdf

35. Skurnik I, Yoon C, Park D, Schwarz N. How warnings about false claims become recommendations. J Consum Res. 2005; 31:713-724.

36. Betsch C, Sachse K. Debunking vaccination myths – Strong risk negations can increase perceived vaccination risks. Health Psychol. 2013;32:145-155.

37. Lewandowsky S, Ecker KH, Seifert CM, Schwarz N, Cook J. Misinformation and Its Correction: Continued Influence and Successful Debiasing. Psychological Science in the Public Interest. 2012:106-131.

38. European Centre for Disease Prevention and Control. Rubella – Factsheet for general public [internet]. Available from: http://www.ecdc.europa.eu/en/healthtopics/rubella/Pages/public.aspx

39. World Health Organization. Weekly epidemiological record. 2011 July 27. 2011;29,86: 301–316 Available from: http://www.who.int/wer/2011/wer8629.pdf

40. World Health Organization. Rubella vaccines: WHO position paper. Wkly Epidemiol Rec. 2011 Jul 15;86(29):301-16. Available from: http://www.who.int/wer/2011/wer8629.pdf

41. Derrough T, Bacci S, Lopalco PL. Letter to the editor: Commitment needed for the prevention of congenital rubella syndrome in Europe. Euro Surveill. 2012;17(10): pii=20106. Available from: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=20106

42. European Centre for Disease Prevention and Control. Rubella Factsheet for health professionals [internet]. Available from: http://ecdc.europa.eu/en/healthtopics/rubella/Pages/professionals.aspx

43. Pandolfi E, Chiaradia G, Moncada M, Rava L, Tozzi AE. Prevention of congenital rubella and congenital varicella in Europe . Euro Surveill. 2009;14(9):pii=19133. Available from: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19133

44. Tischer A, Andrews N, Kafatos G, Nardone A, Berbers G, Davidkin I, et al. Standardization of measles, mumps and rubella assays to enable comparisons of seroprevalence data across 21 European countries and Australia. Epidemiol Infect. 2007;135(5):787-97

45. Marin M, Güris D, Chaves SS, Schmid S, Seward JF. Advisory Committee on Immunization Practices, et al. Prevention of varicella: Recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep. 2007;56(RR-4):1-40

46. Tookey PA, Jones G, Miller BH, Peckham CS. Rubella vaccination in pregnancy. CDR London Engl Rev 1991; 1(8):R86-8