

COST-BENEFIT ANALYSIS OF RUBELLA VACCINATION PROGRAM FOR MEDICAL PERSONNELS IN SRINAGARIND HOSPITAL. (MEDICAL SCHOOL HOSPITAL)

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การวิเคราะห์ต้นทุน-ผลได้ ของการฉีดวัคซีนป้องกันหัดเยอรมัน แก่เจ้าหน้าที่ทางการแพทย์ของโรงพยาบาลศรีนกรินทร์

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การฉีดวัคซีนป้องกันหัดเยอรมัน นิจดุประสังค์หลักกือ ป้องกันการเกิดเด็ก
พิการแต่กำเนิด เนื่องจากเจ้าหน้าที่ทางการแพทย์ของโรงพยาบาลส่วนใหญ่เป็นหญิง
ในวัยเจริญพันธุ์ และเสี่ยงต่อการได้รับเชื้อระหว่างตั้งครรภ์ และเป็นพำนหนาเชื้อสู่
ผู้ป่วย จึงได้ศึกษาถึงต้นทุนผลได้ของการฉีดวัคซีนแก่เจ้าหน้าที่ทุกคน โดยไม่ต้อง
ตรวจระดับภูมิคุ้มกันทางก่อนอาสาสมัครครรภ์ 137 คน ซึ่งอยู่ในวัยเจริญพันธุ์ได้รับการ
เจาะเลือดทุกคนก่อนฉีดวัคซีนหัดเยอรมัน (WISTAR RA 27/3, HUMAN DIPLOID
CELLS) และตรวจส่วนระดับภูมิคุ้มกันทางจากเลือดที่เจาะ พร้อมทั้งติดตามผลข้างเคียง
ของการฉีดวัคซีน จากนั้นจึงประเมินค่าใช้จ่ายต่างๆ เพื่อหาต้นทุน-ผลได้ ผลของการ
ศึกษาพบว่าความชุกของภูมิคุ้มกันในเจ้าหน้าที่หล่านี้เท่ากัน 87% และมีอาการข้างเคียง
ประมาณ 17% ในสาขานาฬิกา แต่ไม่รุนแรง การฉีดวัคซีนหัดเยอรมันได้บันทึกไว้ต้อง
ตรวจหาระดับภูมิคุ้มกันทางก่อนจะได้ผลได้สูงมากกว่า และข้อสรุปนี้บ่งน่าจะใช้ได้
ในโรงพยาบาลทั่วไป ซึ่งต้องเสียค่าใช้จ่ายสูงในการตรวจหาระดับภูมิคุ้มกันทาง

The main purpose of rubella immunization is the eradication of congenital rubella syndrome. The majority of medical personnels are female in reproductive age. Those personnels with negative rubella antibody are at risk of developing rubella infection during pregnancy. It is not known whether screening for rubella antibody first and vaccinate only those with negative antibody is more cost benefit than routine vaccination without screening.

137 volunteer female medical personnels have had their blood drawn for rubella antibody before vaccination with attenuated live virus strain wistar RA 27/3, human diploid cells. All direct and indirect costs are calculated in order to analyse the cost-benefit of each program.

The results indicated that the prevalence of positive rubella antibody was 67%. About 17 of the vaccinees, with and without antibody against rubella experienced side-effects, most of them were mild. From the perspective of hospital administrator, routine rubella vaccination without screening has more cost-benefit than screening before vaccinating only those who are susceptible.

Rubella is a well known viral disease which typically manifests as a self-limited benign disease characterized by erythematous maculopapular rash, low grade fever, suboccipital lymphadenopathy and mild upper respiratory symptoms.

The major concern of this disease is that it can cause a serious and often fatal congenital rubella syndrome in new-borns, especially when the infection occurs during the first trimester of pregnancy. The syndrome when occurs can result in psychological decline of the family as well as the economical lost to the family and the society.⁽¹⁻³⁾

The first report of a rubella outbreak in Thailand was in 1967-68 while the last reported epidemic occurred in 1983-84⁽⁴⁾

It has been known both in foreign countries and Thailand that epidemics have recurred every 6-9 years, thus there is

likely to be another epidemic in the years 1989-1990. Hospital personnel are among the groups known to be at risk of this contagious disease (Prevalence of immunity among hospital personnel is approximately 70-75%).⁽⁴⁻⁶⁾ An outbreak of rubella among hospital personnel are of particular concern for two reasons⁽⁷⁾ : Firstly, there are large numbers of women of reproductive age in this occupation and they are at high risk of exposure to rubella during an outbreak. The major concern is given particularly to those in early gestation; secondly, due to the nature of their work, there is a significant risk that health care personnel could transmit rubella to susceptible pregnant patients⁽⁸⁾, therefore it is reasonable to provide the vaccine to those personnel. The efficacy of rubellar vaccine has been reported, however the side effect of this vaccine has not been evaluated in economic jargon before.

In order to protect these personnel from acquiring rubella during pregnancy and prevent transmission of the disease, it is necessary to vaccinate susceptible personnel.^(2,9) It is not known whether routine vaccination without screening (program I) would be more cost-benefit than a screening prior to vaccination. (program II) in terms of unnecessary absence from work due to side effect of the vaccine.

The objective of this study was to compare the cost-benefit of two programs of rubella vaccination among hospital personnel from the perspective of a hospital policy makers.

Materials and Methods

Subjects : 137 female volunteer medical personnel of reproductive age working at Srinagarind Hospital, Khon Kaen University, in Northeast Thailand. Exclusion criteria included pregnant, sterilized or hysterectomized women, or having history of rubella vaccination. Although there was

no conclusive evidence that vaccination during pregnancy could cause congenital rubella syndrome⁽⁹⁾, the vaccinees were informed that they should not become pregnant within three months following vaccination. If pregnancy was suspected, the vaccination was withheld until the next menstruation.

Procedures : All medical personnel had approximately 5 millilitres of venous blood drawn for rubella antibody titer by a hemagglutination inhibition test. Immediately after the blood sample was taken the subjects were vaccinated with 0.5 millilitre of live attenuated virus vaccine against rubella (Wistar RA 2713 M strain cultured on human diploid cells) injected subcutaneously. In this study, we assumed that the efficacy of vaccination is 100%.

Laboratory method : Rubella hemagglutination inhibition test (HI test) was performed. The protective serum hemagglutination inhibition antibody titer is the 1:10 dilution or more of serum which show complete inhibition of hemagglutination.

Adverse effects of vaccination and work absentee were measured by self report and confirmed by the principal investigator (P. Tatsanavivat)

Outcome measurements

1. Costs

1.1 costs of rubella antibody titer test or screening test will include costs of rubella antigen, equipment, personnel, syringe, needles and alcohol. (Table I)

1.2 Costs of rubella vaccination were estimated for both single and multiple doses vials, also the costs of needle, syringe, alcohol and personnel were included. The multiple doses vial could be used to vaccinate 8 cases instead of 10 cases as initially intended to. (Table I)

2. Benefit

When assuming that the efficacy of the vaccine is 100%, the main point of

concern of the hospital policy makers would be the amount of work loss resulting from implementation of a vaccination program comparing to the costs. That is the work loss of the program is the disbenefit of that program. Therefore calculated amount of benefit of each program is assigned as a negative value, before analysis for cost-benefit of the two programs.

Results

1. Costs

1.1 Costs of screening test was estimated at 32.2 baht per case. (Table I) (Details of calculation are available on request to Dr. W. Kosuwon)

1.2 Costs of Rubella vaccination

The current cost for a single dose vial rubella vaccine is 27 baht/case and for multiple doses vial is 9.5 baht/case.

When the costs of syringes, needles, and alcohol were included in the calculation, the total vaccination cost per person was 29.3 baht for a single dose vial vaccine and 11.81 baht for multiple dose vial vaccine. (Table I)

From Table I, costs were calculated :

Costs of program I (without screening);

When single dose vaccine was used the cost per 100 subjects was

$$29.31 \times 100 = 2931 \text{ baht} \quad (1)$$

When multiple dose vial was used

The cost per 100 subject was

$$\begin{aligned} &= 11.81 \times 100 \\ &= 1181 \text{ baht} \end{aligned} \quad (2)$$

Costs of program II (with screening test) ;

Total cost of screening per 100 subjects was

$$32.23 \times 100 = 3223 \text{ baht} \quad (3)$$

From 137 subjects, only 49 of them were non immune, hence need vaccination (33%).

Therefore only 33 from 100 subjects would be vaccinated.

The cost of vaccination

When single dose vaccine was used

$$33 \times 29.31 = 967.32 \quad (4)$$

When multiple doses vial was used

$$33 \times 11.81 = 389.73 \quad (5)$$

Therefore,

The costs of program II per 100 subjects :

When single dose vaccine was used

$$= (3)+(4)$$

$$3223 + 967.32 = 4190.32 \text{ baht} \quad (6)$$

When multiple doses vial was used

$$= (3)+(5)$$

$$3223 + 389.73 = 3612.73 \text{ baht} \quad (7)$$

Work loss

A total of 31 adverse effects of vaccination were reported in 23 cases. Almost all of these were mild including fever, myalgia, headache, rash and local skin reaction at the injection site. One workday lost was noted because of headache and myalgia. (table 2) The data were analysed to assess whether there were any significant differences in the frequency of adverse reactions due to vaccination between the non-immune and to the immune groups. A Chi-square test showed no statistically significant difference between the two groups. (table 3)

From the decision tree (fig 1) screening before vaccination showed that 33% of this group were non immune cases. About sixteen percent (16.78%) of the vaccinated subjects (23/137) experienced adverse reactions but only 4.4% of them (1/23) were absent from work for one day. Based on the statistical test of significance that the adverse reaction between the two programs had no statistically significant difference, the chance of work absence was calculated as equal in both programs. The cost of work loss was calculated from the average salary of the personnel (3500 baht/month) plus 60% of the salary as a fringe benefit (2100 baht/month) there were average 22 working days per month, thus one workday loss was 254.5 baht (5600/22) for a total vaccinee of 137. From the decision

tree the cost of work loss or disbenefit of program 1 would be

$$254.5 \times 0.0437 \times 0.1678 \times 0.33 \times 100 = 61.58 \text{ Baht/100 cases.} \quad (8)$$

program 2 would be

$$254.5 \times 0.0437 \times 0.1678 \times 0.33 \times 100 = 61.58 \text{ Baht/100 cases.} \quad (9)$$

From this cost benefit analysis equation⁽¹⁰⁾ “(Cost 1-Cost 2) - (Benefit 1-Benefit 2) = CBA” The cost benefit analysis of the two programs, single dose vial vaccines and multiple doses vial vaccines, was done.

When single dose vaccine will be used for vaccination 100 subjects the cost benefit analysis will be

$$\text{Cost I} = \text{Cost of program I} = 2932 \text{ baht from (1)}$$

$$\text{Cost II} = \text{Cost of program II} = 4190.32 \text{ baht from (6)}$$

$$\text{Benefit I} = \text{work loss in program I} = -186.62 \text{ baht from (8)}$$

$$\text{Benefit II} = \text{work loss in program II} = -61.58 \text{ baht from (9)}$$

$$\text{Therefore the CBA will be} \\ (2931 - 4190.32) - \{(-186.62) - (-61.58)\} = -1134.28$$

That is program I is cost benefit than program II and would have save for the hospital about 1134 baht per 100 vaccinees when single dose vaccine is used.

If multiple dose vial vaccine will be used instead.

From (2), (7), (8) and (9) the CBA will be

$$(1181 - 3612.73) - \{(186.62) - (-61.58)\} = -2306.69$$

That is Program I is cost benefit than program II and the hospital would have save about 2306 baht per 100 vaccinees when multiple doses vial is used (table 4). From the hospital executive's viewpoint thus it is cost benefit to give routine vaccination without screening for rubella antibody compares to a policy of screening first for the presence of antibody then vaccinating only those who are non immune.

Discussion

From the result above there may be one question to be raised.

That is sample size of the study is too small to yield enough power to detect any difference of adverse reactions among the immune and non immune cases if there is actually any difference. Therefore the calculation of cost benefit analysis based on the equal chance of adverse reaction may be inappropriate.

In order to test whether the program I was still cost benefit comparing to program II if the rates of adverse reactions were not the same. An estimation was done, given that adverse reactions among those non-immune cases was 20%^(2,3) and the adverse reaction is expected to be 50% higher in the immune cases. That is the adverse reaction was 30% among immune cases. While the work loss rate remained to be 4.37% of the total adverse reactions. Thus a new decision tree will be as figure II

$$\begin{aligned} \text{Cost of work loss in program I would be} \\ & \{(254.5 \times 0.0437 \times 0.2 \times 0.33) + (254.5 \times 0.0437 \times 0.3 \times 0.67)\} \times 100 \\ & = 73.40 + 223.54 \\ & = 296.94 \text{ Baht/100 cases} \end{aligned}$$

$$\begin{aligned} \text{Cost of work loss in program II would} \\ \text{be} \end{aligned}$$

$$\begin{aligned} & 254.5 \times 0.0437 \times 0.2 \times 0.33 \times 100 \\ & = 73.40 \text{ Baht/100 cases.} \end{aligned}$$

The costs of work loss have not remarkably changed when the non immune rate has changed.

Therefore program I was still cost benefit comparing to program II despite different rates of adverse reactions among the two programs.

When includes the cost of workloss into the present cost of vaccination per each program, it is clearly seen that the cost of screening (32.23 Baht/case) is still much higher than vaccination by multiple dose vial vaccine ($11.81 + 1.86 = 13.67$ Bath/

case) and is slightly higher than single dose vial vaccine ($29.31 + 0.61 = 29.92$ Baht/case). Therefore, at any rubella susceptibility rate it is always cost minimized to give rubella vaccine at the present costs, without screening. Regardless any types of vaccine will be used.

In order to generalize the results of this study to other hospital settings, we have to consider the cost of the screening test which will be much varied among different hospitals. This study was carried out in the medical school hospital where it is more likely to have more tests to be done per laboratory setting, which results in decreasing in cost per test when compare to other smaller hospitals where there are fewer tests to be done. Accordingly. It is clearly seen that the cost of screening test will be lower at this medical school hospital than other provincial or smaller hospitals. That is the cost of program 2 will be higher at other smaller hospitals. Therefore the program 1 should have even more cost benefit than program 2 when it is implemented in those smaller hospital settings.

Conclusion

For hospital personnel and from the perspective of hospital executive, routine rubella vaccination without screening has more cost-benefit than screening for the presence of antibody then vaccinating only those who are susceptible regardless which type of rubella vaccine being used, and at any rubella susceptible rate among hospital personnel.

Acknowledgement

The authors are in debt to Punnipa Siripermpool and Chotchana Wilailaksanakana from Faculty of Associated Medical Sciences, Khon Kaen University, for special serologic studies; to the personnel of Srinagarind Hospital, Khon Kaen who volun-

teered to participate to make the study possible; to Khon Kaen Clinical Epidemiology Unit personnel for preparing this

manuscript. We also thank the Rockefeller Foundation for some partially funding that has made the study possible.

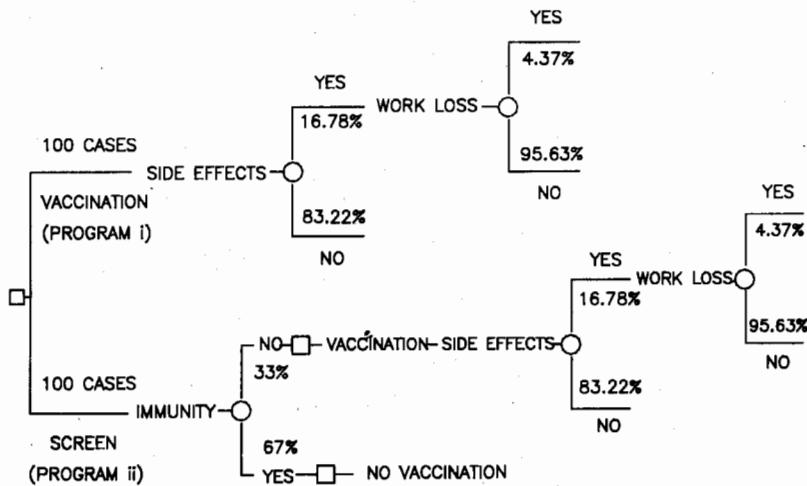


Figure 1 DECISION TREE OF THE TWO PROGRAMS OF VACCINATION.

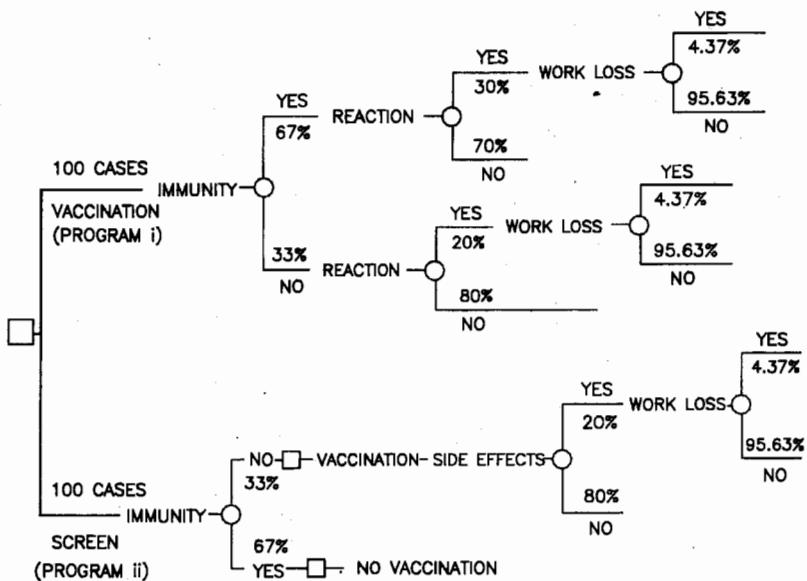


Figure 2 DECISION TREE OF THE TWO PROGRAMS OF VACCINATION WHEN THERE ARE DIFFERENCE IN SIDE EFFECTS AMONG VACCINES.

COSTS OF VACCINATION (BAHT/CASE)

	<u>SINGLE DOSE VACCINE</u>	<u>MULTIPLE DOSES VACCINE</u>
VACCINE	27 / CASE	9.5 / CASE
NEEDLE, SYRINGE & ALCOLOL	2.311	2.311
<u>TOTAL</u>	<u>29.31</u>	<u>11.81</u>

COSTS OF SCREENING (BAHT/CASE)

REAGENTS USED IN RUBELLA HI TEST	20
EQUIPMENT	12.23
<u>TOTAL</u>	<u>32.23</u>

Table 1 COST OF VACCINATION AND SCREENING.

MYALGIA	=	3
FEVER	=	17
FAINT RASH	=	1
HEADACHE	=	6
LOCAL REACTION	=	3
WORK ABSENCE	=	1
<u>TOTAL</u>	<u>=</u>	<u>31 EPISODES</u>

Table 2 ADVERSE EFFECTS IN 23 SUBJECTS.

	ADVERSE REACTIONS		TOTAL
	PRESENT	ABSENT	
IMMUNED SUBJECTS	18	70	88
NON-IMMUNE SUBJECTS	5	44	49
TOTAL	23	114	N=137

$$\chi^2 \text{ 1df} = 1.69 \quad P > 0.10$$

Table 3 ADVERSE EFFECTS IN IMMUNED AND NON-IMMUNED SUBJECTS.

<u>COST-BENEFIT ANALYSIS</u>					
<u>COST</u> (BAHT/100 SUBJECTS)	PROGRAM I		PROGRAM II		
SINGLE DOSE VACCINE	2931		4190.32		
MULTIPLE DOSE VIAL VACCINE	1181		3612.73		
<u>BENEFIT</u>	-186.62		-61.58		
<u>COST-BENEFIT ANALYSIS EQUATION (CBA)</u>					
$(COST \text{ I} - COST \text{ II}) - (BENEFIT \text{ I} - BENEFIT \text{ II})$					
<u>RESULTS</u> (BAHT/100 CASE)					
SINGLE DOSE VACCINE	CBA	=	-1134.28		
MULTIPLE DOSE VIAL VACCINE	CBA	=	-2306.69		

Table 4 COST-BENEFIT ANALYSIS OF THE VACCINATION PROGRAMS AND THE RESULTS.

REFERENCES

1. Gudnadottir M. Cost Effectiveness of Different Strategies for Prevention of Congenital Rubella Infection : A practical example from Iceland. *Reviews of Infectious Disease* 1985 March-April; 7 (suppl 1) : S200-209.
2. Schoenbaum SC, Hyde JN, Bartoshesky L, Crampton K. Benefit-Cost Analysis of Rubella Vaccination Policy. *N Engl J Med.* 1976; 294 (6) : 306-310.
3. Golden M, Schapiro GL. Cost-Benefit Analysis of Alternative Programs of Vaccination Against Rubella in Israel. *Publ. Hlth, Lond.* 1984; 98: 179-190.
4. Puthavathana P, Wasi C, Kositanont U, Lamkom R, Thongcharoen P. Rubella Outbreak in Thailand 1983-1984 : A study at Siriraj Hospital. *Southeast Asian J Trop. Med. Pub. Hlth* 1985 Jun; 16 (2) : 207-213.
5. Punnarugsa V. Natural Rubella Infection in Thai Red Cross Nursing Students. *Chula Med J* 1985 Aug; 29(8):873-877.
6. Punnarugsa V, Yenbutraa D. Rubella Antibody in Selected Groups of Thai Woman. *Chula Med J* 1983 May; 27(3): 109-116.
7. Polk BF, white JA, Degirolami PC, Modlin JF. An Outbreak of Rubella among Hospital Personnel. *N ENGL J Med* 1980; 303:541-5
8. McLaughlin MC, Gold LH. The New York Rubella Incident : A Case for Changing Hospital Policy Regarding Rubella Testing and Immunization. *AJPH* 1979 March; 69(3):287-289.
9. Hinman AR, Bart KJ, Orenstein WA, Preblud SR. Rational Strategy for Rubella Vaccination. *Lancet* 1983; Jan 1/8:39-41.
10. Guy Carrin, *Economic Evaluation of Health Care in Developing Countries.*, Croom Helm Ltd. 1984; 53-89.