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Measles Control in Guangxi, China: High Risk Counties Selection and its Mass Campaign from 1999-2008

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Abstract

Goal: Trying to find a suitable strategy to control and eliminate measles in the developing country.

Method: Annually carried out mass campaign in the measles outbreak high risk counties selected based on inter-epidemic years interval of the latest epidemic curves of historical surveillance data.

Results: About 20 to 30 high risk counties has been selected annually in the whole Guangxi and mass campaign was implemented to the target children of 8 months to 14 years old in the first campaign period of 1999-2003, the target children shifted to 8 months to 10 years old children in the second campaign period of 2004-2007. The incidence of measles has been dropped from 13/100,000 in 1998 to 2.1/100,000 in 2008.

Conclusion: Selecting the measles outbreak high risk counties based on latest epidemic curves and implementing mass campaign target 8 months to 14 years old children in the selected counties is a best way and feasible tool to control, even eliminate measles in developing country.

Keywords: Measles; Guangxi; Immunization

Introduction

Measles is a highly contagious children infectious disease. Even today with the effective vaccine available, there is still 43 million cases and 1 million death annually, and is the top killer in developing countries [1,2]. Guangxi is used to be the endemic region for it is located in the sub-tropic area [3]. However, the incidence has been dropped so remarkably with the high risk counties has been selected based on the interval of historical epidemic curves and mass campaign has been implemented target 8 months to 14 years old children since 1999 [4]. This paper is reported in detail as following.

Methodology

Clinical definition

The measles clinic case-definition is any person with a fever and macula popular rash and cough/coryza/conjunctivitis, confirmed case of measles had laboratory evidence of infection that included positive serology for measles immunoglobulin M (IgM), or a 4-fold rise in serum immunoglobulin G (IgG) from the acute to convalescent samples [5].

The National Notifiable Diseases Reporting System (NNDRS) reports the basic epidemiological data including name, age, sex, date of the disease onset and the residency on all clinically and laboratory diagnosed cases by posting a card to the Center for Disease Control from 1950 to 2000, with telephone then posting a card together from 2001 to 2004, with internet since 2005. This system was strengthened in Guangxi for its establishing the Three Network System which is composed of administrative responsibility, information delivery and rescue network systems [6] to deal with public health emergency event which more likely is infectious disease outbreak since 2001. The laboratory network system has been set up in the prefecture Center for Disease Control with more cases with laboratory results, especially the outbreak cases since 2004, for before just in the provincial CDC has the laboratory with the IgM and IgG test.

Make the historical curve of measles incidence

Make the historical curve of measles incidence by county with the mandatory infectious disease reporting system since 1950 with EXCEL table.

Selecting the high risk outbreak counties

Each county has its historical epidemic curve since 1950. For the outbreak year is different from one county to another, in order to avoid the outbreak happening, we just select those counties with the outbreak occurring in the coming year and implemented mass campaign. The criteria to choose the high risk outbreak county was to get the interval years between latest two epidemic year peaks then used this span of the years to predict the next outbreak year. For example, if the latest two epidemic cures located in 2005 and 2008 respectively in a county, the next outbreak will come in the 2011, and this county will be selected as high risk Outbreak County in 2001, and the implemented mass campaign will be implemented before the April, the epidemic season.

By analyzing all counties surveillance data and the interval between last two epidemic peaks, the first batch of the candidate high risk county was selected from those counties with the last epidemic peak of the incidence ≥ 20/100,000 and the coming years since the last outbreak peak matched the last epidemic interval; the second batch of the candidate high risk county was selected from those counties with the last epidemic peak of the incidence ≥ 10/100,000 and the coming years since the last outbreak peak matched the last epidemic interval; The third batch of the candidate are of high risk county and was selected from those counties with the last epidemic peak of the incidence ≥ 20/100,000 and the outbreak was not happened with the last interval and the coming year matched the second interval years; The forth batch of the candidate high risk county was selected from those counties with

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the last epidemic peak of the incidence ≥ 10/100,000 and the outbreak was not happened with the last interval and the coming year matched the second interval years; The fifth batch of the candidate high risk county was selected from those counties with the last epidemic peak of the incidence ≥ 5/100,000 and the coming years since the last outbreak peak matched the last epidemic interval; The sixth batch of the candidate high risk county was selected from those counties or urban area with no epidemic about 8 years or more and the incidence less than 5/100,000.

High risk counties finalization

Select the higher incidence, higher birth counties as the high risk out break counties among the candidates, and estimate the target children amount in about the same of the vaccine amount available, if vaccine is available in more than the target children, select some neighbouring county around the high risk county joined the high risk counties to get wider herds immunity. The procedure of selecting high risk county of measles outbreak and 8 month to 14 or 10 years old children campaign with measles vaccine are showed in figure 1. Some counties nearby the high risk county were also been included in the supplement immunization for the reason to get the cluster immunization in the same area, and those poorly performing in the routine immunization were also been selected to implement supplement twice continuously to avoid outbreak happened. For the first round campaign the target was 8 month to 14 years old children from 1999 to 2003, the target was shifted to 8 month to 10 years old children from 2004 to 2008. The procedure of selecting high risk Outbreak County of measles (Figure 1), and the population and target children of the high risk counties and the vaccine doses delivered in 1999-2008 are shown in table 1.

Vaccine supplying

The mass campaign covered about 1/5 of the whole province population annually, and the total amount of vaccine was about 2 million targeting 8 month to 15 years old including 1.2 consume index. The detail of the amount of vaccine distribution is in the table 1.

Getting the outcome by comparing the measles outbreak between before and after high risk counties prediction

Heath Bureau announced the high risk counties annually at the end of January or at the beginning of February, and required the high risk counties implemented the mass campaign in the end of February or March, which is ahead of the measles outbreak season, meanwhile strengthening the surveillance to find and contain any possible outbreak.

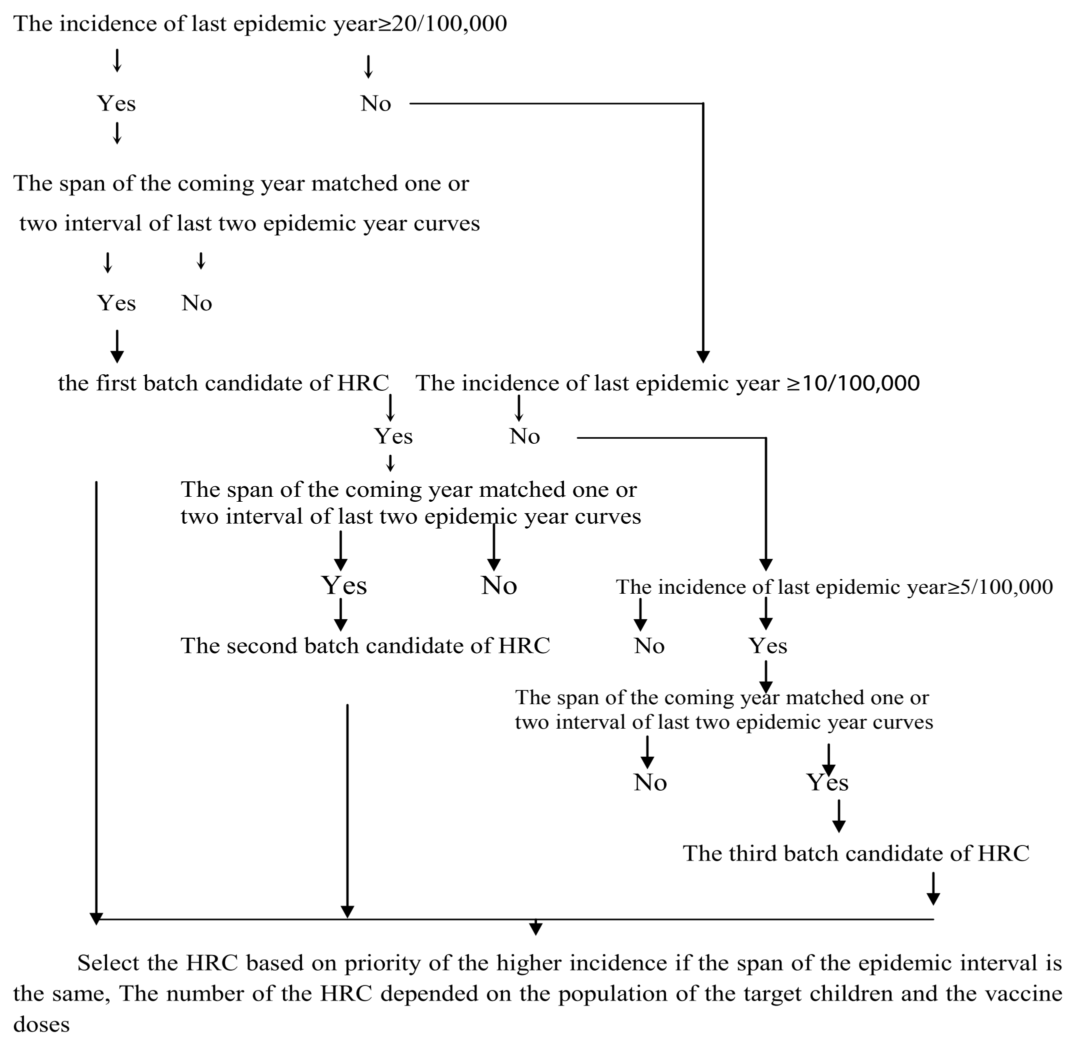

Figure 1: The Procedure of Selecting High Risk Outbreak County of Measles Outbreak in Guangxi.

Results

The cycling regulation of measles epidemic in Guangxi and the measles outbreak the interval between the two latest epidemic curves

The comparison of measles outbreak once every three years before 1966 without introduction of measles vaccine to outbreak every two to three years after measles vaccine available in the urban area though the incidence is lower since 1966 (Figure 2).

Though vaccine available in Guangxi in the late of 1960s, vaccine of measles was actually covered in the rural area from 1974 when the Barefoot Doctor System was fully established, and the coverage is quite high for the highly centralization and commune agriculture working system at that time, which resulted in drooping down the measles incidence remarkably. The coverage got lower for the Barefoot Doctor System bankruptcy since the rural economy reformed at 1978 which had the outcome of big outbreak rebound in 1980 after two years quiet span of lower incidence. The EPI was established and improved since 1983 for Guangxi that was appointed as one of the three pilot provinces of the cold chain of EPI in China in 1983 and the measles outbreak every four years which have high epidemic peak in 1985 and another lower epidemic peak in 1989 and then had the higher epidemic peak in 1993. The epidemic peak became lower in 1997 for the Polio eradication since National Immunization Day began from 1993/1994 and the whole EPI has been enhanced, than had higher peak in 2001 for two lower stages of quiet lower incidence, which means there was still epidemic cycles every 4 years with the interval three years since the routine vaccination implemented (Figures 2 and 3).

A typical measles cycling in a rural county-Rongshui county

Rongshui county is a remote, mountainous and minority area with the incidence of measles dropped very much dramatically, however it has been still with an interval of 5 years measles epidemic, for example 1537/100,000 in 1980, 99.58/100,000 in 1980, 1537/100,000 in 1980, 1537/100,000 in 1980, 1537/100,000 in 1984, 107/100,000 in 1989, 327/100,000 in 1993, 25.4/100,000 in 1998, 53.33/100,000 in 2001 (Figure 4).

The correct rate of the high risk outbreak county with the epidemic interval between the latest epidemic peaks in 1998

In the 40 rural counties selected as the high risk outbreak county with the epidemic interval between the latest epidemic peaks there were 27 counties with the measles outbreak occurred (the epidemic outbreak rates was 67.5%) without the supplement immunization before the outbreak season, comparing to those just 3 counties had measles outbreak (the epidemic outbreak rates was 7.7%) for another 40 non-high risk outbreak counties (Table 2).

The outcome of the high risk county selection and its campaign

With the high risk outbreak counties predicting and supplement

Year	HRCs	Population (million)	Target children 8 month-15 years (million)	Vaccine doses (million)	Incidence of measles (/100,000)
1999	23	8.64	2.26	1.797	7.94
2000	21	7.59	1.98	1.180	12.12
2001	20	7.87	2.08	1.637	13.32
2002	22	10.41	2.72	2.271	7.96
2003	24	8.96	2.34	1.824	4.37
2004	26	12.66	2.12	2.614	2.91
2005	34	16.50	2.00	2.124	2.91
2006	27	11.73	2.03	2.435	1.87
2007	30	10.06	1.74	1.864	2.10
2008	27	11.47	1.65	1.985	2.11

Table 1: The population and target children of the high risk counties and the vaccine doses delivered in 1999-2008 in Guangxi.

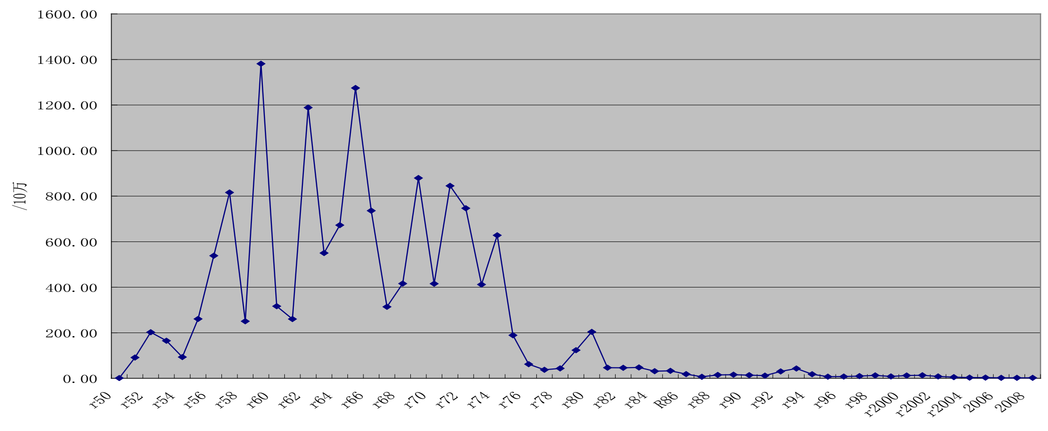

Figure 2: The Measles Epidemic Curves In Guangxi from 1990 to 2008.

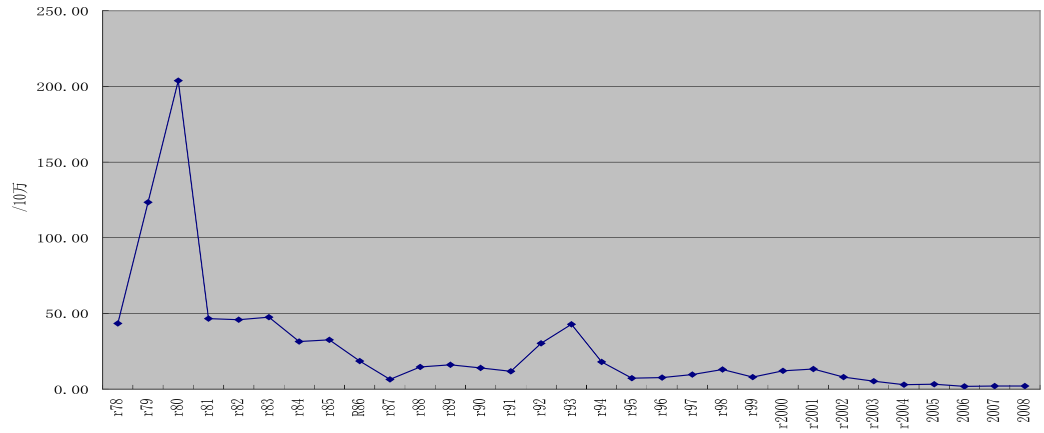

Figure 3: The Measles Epidemic Curves in Guangxi from 1975 to 2008.

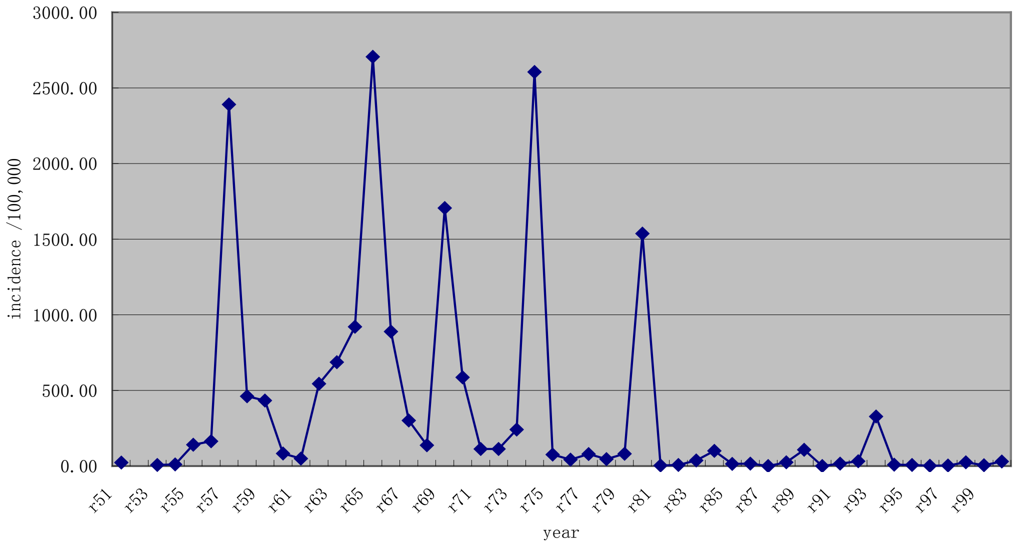

Figure 4: The Measles Incidence of Rongshui County 1961-2001, Guangxi.

immunization since 1999, the measles incidence has been decreased continuously, 13/100,000 in 1998, 8/100,000 in 1999, 12.12/100,000 in 2000, 13.32/100,000 in 2001, 7.96/100,000 in 2002, 4.37/100,000 in 2003, 2.91/100,000 in 2004, 3.23/100,000 in 2005, 1.87/100,000 in 2006 and 2.11/100,000 in 2008 (Table 1). The situation of measles incidence was higher in Guangxi than the average incidence of the whole China getting to lower than that in the whole China in 2004, even the incidence reached to highest in the whole china in 2005, incidence of measles in Guangxi still got lower, and just 0.5/1 million were there in 2010 and 2011 (Table 3 and Figure 5).

There was the outbreak peak in 1980 following three times by every 3 years intervals low incidence year from 1983, 1986 and 1989 respectively; there was another outbreak peak again in 1993 with no special campaign intervention. However, since the high risk counties prediction and measles vaccine campaign target to 8 months to 14 years old children intervention in 1999, this outbreak peaks disappeared and measles incidence got continuously lower than the whole China after 2003 (Figure 5).

Before the high risk county campaign during 1989-1999, nearly 25 counties have the incidence over 20/100,000 annually, even in the first period of campaign during 2001-2003, still 16 counties have the incidence over 20/100,000 annually, finally, it decreased to 2 counties during the second campaign period of 2004-2007 (Tables 4 and 5).

The overall incidence decreased from 16/100,000 before the high risk county campaign in 1993-1998 to 9/100,000 in the first round of high risk county campaign in 1999-2003, the percentage was 44%, it dropped down again to 2.5/100,000 in the second round high risk county campaign in 2004-2007 (Table 6).

Measles incidence decreased 44% both at 1-14 ages and over 14 ages, but just 29% at under 1 age after the first campaign 0f 1999-2003 comparing to before the campaign of 1993-1998, at the second campaign of 2004-2007 period, measles incidence decreased 76% at 1-14 ages and 66% over 14 ages which more than those in the first campaign period comparing with that of 1999-2003. And the rate decreased less than 1 age reached to 46%, also more than that in the first campaign. That results showed longer campaign last, better outcome it got (Table 7).

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Birth rate	High risk outbreak counties				Non- High risk outbreak county			
	outbreak	no outbreak	total	%	outbreak	no outbreak	total	%
High	11	4	15	73	0	7	7	0
Middle	16	0	16	100	3	27	30	10
Low	0	9	9	0	0	3	3	0
Total	27	13	40	67	3	37	40	7.7

Table 2: The measles outbreak in the county with the epidemic interval already met the latest epidemic interval with the birth rate in Guangxi, in 1998.

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Casea	5908	3698	5247	6335	3836	2519	1404	1465	848	989	1006	112	28	26
Incidence (/100,000)	13.1	8.0	12.1	13.3	8.0	4.4	2.9	3.2	1.9	2.1	2.1	0.22	0.05	0.05

Table 3: Measles Incidence in Guangxi, China 1999~2001.

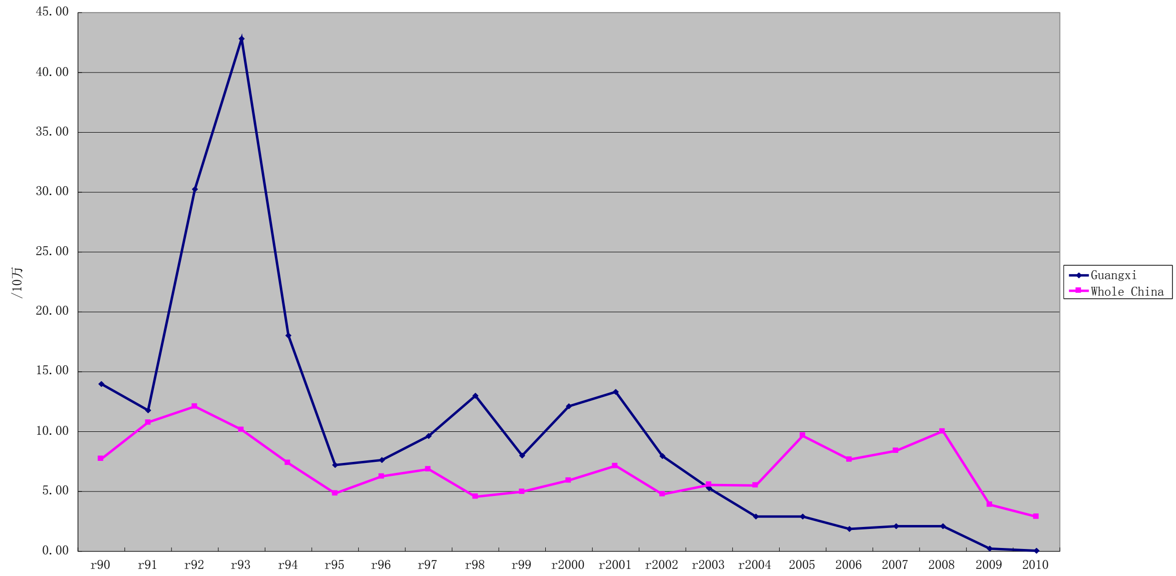

Figure 5: The measles incidence of China and Guangxi from 1990~2010.

Incidence Category	≥20/100,000	15~/100,000	10~/100,000	5~/100,000	1~/100,000	0~/100,000	Total
1989	27	13	18	20	3	8	89
1990	24	10	5	14	20	16	89
1991	16	3	11	18	20	21	89
1992	40	8	9	13	11	8	89
1993	49	3	9	10	16	2	89
1994	31	7	13	15	19	6	91
1995	12	2	8	18	31	20	91
1996	11	5	4	13	42	16	91
1997	16	8	9	28	30	19	110
1998	29	11	11	17	23	22	113
1999	14	5	9	19	32	34	113
2000	26	12	15	19	22	19	113
2001	29	7	11	15	31	20	113
2002	9	6	10	21	32	34	112
2003	5	7	10	15	37	37	111
2004	1	3	1	18	46	41	110
2005	4	3	2	14	37	50	110
2006	2	1	4	4	40	59	110
2007	1	0	0	7	39	64	111

* The total number of the counties was getting larger from 1997 for the county in suburb or near the city merged into the city and became urban counties.

Table 4: The numbers* of counties with difference incidence of measles in Guangxi from 1989-2007.

	≥20/100,000	15~/100,000	10~/100,000	5~/100,000	1~/100,000	0~/100,000
Before (1993-1998)	24.66	6	9	16.83	26.83	14.16
At first campaign (1999-2003)	16.6	7.4	11	17.8	30.8	28.8
At second campaign (2004-2007)	2	1.75	1.75	10.75	40.5	53.5

Table 5: The average numbers of counties annually with difference incidence of measles in Guangxi from difference period of campaign.

During the second campaign period, the incidence of under 1 year old is also the slowest decreased compared with the incidence of the ages else. This indicated that for the schedule of the first dose of measles vaccine is 8 months in China needs more years to control to get the cases down for younger children less than 8 month (Table 8).

The laboratory confirmed incidence of the measles is from 17% increased in 2004 to 40 or over which showed the surveillance system is strengthened and sensitive (Table 9).

The Yellow Card Warning System [7] has been implemented since 2001 to give those poor performing vaccination program county government yellow card and requested them improving their performance to increase the routine coverage by increasing more budget and better management. There 45 counties has been warned and got improved by getting high coverage in routine and got those missing children under 4 years old. The new born registrations has been increased from 530,000 in 2001 to 737,000 in 2006, meanwhile the coverage for newborn in routine immunization increased from 78% in 2001 to 97% in 2006. These achievements surely plays an important role in the decrease in measles incidence, however, the percentage of incidence decreased was the same no matter 1-4 years or 5-9 and 10-14, even the percentage decreased over 5 was little bigger than under 5 years old group (Table 10) which showed the campaign still is the key important for the measles control in Guangxi in the high risk county campaign.

Discussion

In 2001, the World Health Organization' s Regional Committee for the West Pacific Region set a target date of 2012 for measles elimination in the Region. As one of the West Pacific Region's country, China has promised to get the measles elimination done in 2012, facing the challenge of the huge population and the shortage of resource. The birth rate still relatively higher both for the poor economy and the senior people need children support in the rural area so that difficulty to getting coverage high enough [8] of the vaccination. Basing on the measles outbreak recycle of every 3 years in high population area and 4 years in lower population area, the high risk outbreak county has been selected with the epidemic interval between the latest epidemic peaks based on the historical measles surveillance data, then the supplement immunization was implemented for the target children of 8 months to 14 years old before the epidemic season. The measles outbreak has been dramatically dropped after 5 years supplement immunization and decreased to 2.97/100,000 in 2004 and 3.23/100,000 in 2005 [9] and 1.87/100,000 in 2006, 2.1/100,000 in 2007 and 2008. The outcome was very much desirable and less costly which will be suitable and feasible to those developing area [4].

Age	1993-1998 (before campaign)	1999-2003 (in the First round campaign)	2004-2007 (in the second Campaign)
0-	76.92	54.51	29.35
1-	63.53	35.04	10.69
5-	54.84	29.34	6.24
10-	25.69	15.83	2.54
15 and over	2.97	1.63	0.54
Average annually	16.05	9.10	2.46

Table 6: The incidence in age before and after the high risk county campaign (/100,000).

Ages	Decreased at first campaign (1999-2003) (%)	Decreased at second campaign (2004-2007) (%)
1-14	44.20	76.77
Under 1	29.12	46.16
Over 14	44.90	66.51
total	43.28	72.87

Table 7: The percentage of decreased incidence from difference period of campaign (%) comparing with the previous period incidence.

	2004	2005	2006	2007
0~	34.63	44	31.14	22
1~	20.63	23.48	8.94	10.56
2~	17.21	12.09	10	10.14
3~	15.78	13.13	8.13	9.54
4~	12.42	11.82	6.82	7.31
5~	11.81	9.83	5.07	7.66
10~	2.38	2.57	1.23	2.20
≥20	0.32	0.53	0.46	0.28
Total	2.91	3.23	1.87	2.1

Table 8: The measles age incidence from 2004 to 2007 in Guangxi.

The infectious disease prediction is key important for diseases control and prevention, and it is not so much being implemented for not only complication in theory but also hardly feasible. There few predictions being used which can point the target in counties in China. Ge and Chen [10] suggested the tail trace prediction but it is too complicated in calculation to be implemented. Zhou [11] predicted measles outbreak with the hey color model, but its outbreak span more than 10 years which is too long seems impossible. Zeng et al. [12] predicted the meningitis with Bayes, but it just pointed the whole province, not so practical for it's not in a county for the prevention. Lv et al. [13] reported their analysis of measles in different types with mathematics and revealed that measles incidence was completed much before the availability of vaccine and thence prediction would be difficult.

China now promises eliminating measles in 2012. Used to be measles highly epidemic area owing to the sub-tropic area location, Guanxi selected measles high risk counties yearly by the method with

	2004W*	2004L#	2005W	2005L	2006W	2006L	2007w	2007L
0~	34.63	2.78	44	0.28	31.14	12.71	22	11.46
1~	20.63	5.04	23.48	8.18	8.94	3.33	10.56	7.04
2~	17.21	2.21	12.09	10.89	10	4.62	10.14	3.57
3~	15.78	3.90	13.13	7.50	8.13	3.12	9.54	4.15
4~	12.42	1.66	11.82	5.15	6.82	3.03	7.31	2.98
5~	11.81	2.67	9.83	4.28	5.07	2.34	7.66	2.78
10~	2.38	0.29	2.57	1.26	1.23	0.36	2.20	0.49
≥20	0.32	0.06	0.53	0.24	0.46	0.22	0.28	0.14
Total	2.91	0.51	3.23	1.11	1.87	0.78	2.10	0.85
W/R (%)		17.59		34.37		42.09932		40.64

*means the whole incidence, # means the incidence of the Laboratory confirm

Table 9: The measles incidence of reported and Lab confirmed in Guangxi from 2004-2007(/100,000).

Age	Decreased at first campaign (1999-2003) (%)	Decreased at second campaign (2004-2007) (%)
0-	29.12	46.16
1-	44.84	69.48
5-	46.50	78.72
10-	38.36	83.93
15-	45.03	66.51
Total	43.29	72.87

Table 10: The percentage of decreased incidence from difference period of campaign (%) comparing with the previous period incidence.

the epidemic interval between the latest epidemic peaks and then supplement mass campaign has been conducted before epidemic season in the measles high risk counties select since 1999. Though the correct rate is just about 67%, measles incidence is still very much dramatically decreased from 42.82/100,000 in 1993 to 2.97/100,000 in 2004; 3.23/100,000 in 2005 and 1.87/100,000 in 2006, 2.1/100,000 in 2007 and 2008 respectively. The counties with incidence over 20/100,000 remarkably dropped down, especially in the second campaign period. This kind of prediction and its mass campaign, just like the retail investment deposition in the bank and getting the whole sale withdraw; lead to get high outcome with lowest cost. Still more, this implement procedure is very suitable for those un-developed and developing area. It is not only suitable in highly epidemic area in the southern part, but also suitable for the low and long times no epidemic area in the northern part [14] of China.

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