ORIGINAL ARTICLE

Did We Do it Right? - An Evaluation of the Colour Coding System for Antenatal Care in Malaysia

J Ravindran, FRCOG*, K Shamsuddin, Dr PH , S Selvaraju, DPH*****

*Department of Obstetrics & Gynaecology, Seremban Hospital, 70300 Seremban, Malaysia, **Department of Community Health, Universiti Kebangsaan Malaysia, Kuala Lumpur, ***Family Health Division, Ministry of Health, Kuala Lumpur

Summary

Identification of pregnancies that are at greater than average risk is a fundamental component of antenatal care. The objective of this study was to assess the level of appropriate management and outcomes among mothers with hypertensive disorders of pregnancy, postdates and anemia in pregnancy, and to determine whether the colour coding system had any effect on the maternal mortality ratios. A retrospective follow-through study confined to users of government health services in Peninsular Malaysia was carried out in 1997. The study areas were stratified according to their high or low maternal mortality ratios. The study randomly sampled 1112 mothers out of 8388 mothers with the three common obstetric problems in the selected study districts. The study showed that the prevalence of anemia, hypertensive disorders in pregnancy and postmaturity among mothers with these conditions were according to known international standards. There was no significant difference in the colour coding practices between the high and low maternal mortality areas. Inappropriate referrals were surprisingly lower in the areas with high maternal mortality. Inappropriate care by diagnosis and by assigned colour code were significantly higher in the areas with high maternal mortality. The assigned colour code was accurate in only 56.1% of cases in the low maternal mortality areas and in 55.8% of the cases in the high maternal mortality areas and these two areas did not differ significantly in their accurate assignment of the colour codes. The colour coding system, as it exists now should be reviewed. Instead, a substantially revised system that takes cognisance of evidence in the scientific literature should be used to devise a more effective system that can be used by health care personnel involved in antenatal care to ensure appropriate level of care and referrals.

Key Words: Risk assessment, Colour coding system

Introduction

The risk approach system using colour codes has been used in Malaysia since 1989. This system grades all antenatal mothers according to the level of severity of risk factors. The checklist was made into a format and attached to the antenatal card. A self-adhesive colour tag was placed on the upper right hand corner of the mother's antenatal card.

This article was accepted: 18 October 2002

Corresponding Author: Ravindran Jegasothy, Department of O&G, Seremban Hospital, Jalan Dr. Muthu, 70300 Seremban, Negeri Sembilan

Four colours were utilised. Red signified that the risk factor required immediate hospital referral and admission. Yellow indicated that the patient had to be monitored antenatally by a doctor. Green indicated that the risk factor required monitoring by a senior nurse. The white code indicated no or low risk. Although white coded cases were considered suitable for supervised home delivery, the patients had to be monitored by going through the checklist at each visit. The checklist and colour coding were basically a set of instructions intended for rural health staff to enable them to differentiate between cases they could continue to see and those that should be referred and to refer cases to the appropriate level of care; to ensure that referred cases went directly to the appropriate level without unnecessary delay; and to ensure that the appropriate category of staff in health centres or hospitals treated the cases without delay.

In 1991, guidelines on the management of high risk cases were reviewed and revised to further enable midwives/ community nurses to know their role in the management of these cases.

The colour coding system should not be confused with a risk assessment or prediction system as the risk approach or colour coding system was a managerial tool to identify levels of care and personnel to handle particular disease conditions in pregnancy. In this system, attention is paid to those individuals and groups whose characteristics are associated with an increased risk of having or developing or being especially affected by a health problem.

Both the positive and the negative predictive values of all scoring and risk assessment systems are poor. Depending on the cut-off point and the test chosen, only between 10 and 30 per cent of women who are allocated to the high risk groups actually experience the adverse outcome for which the risk assessment system declares them to be at risk[1]. Evaluation of risk scores for pre-term birth and low birth weight revealed that between 20 and 50 per cent of mothers who deliver pre-term or low-birth weight infants have low risk scores[2, 3].

Screening of risk mothers using the colour coding system was designed to rapidly identify different degrees of risk associated with pregnancy and ensure appropriate action. The main purpose of screening for risk factors was to detect those women who were more likely than others to have an adverse outcome of pregnancy and to refer them to a more skilled and better equipped level of care, both antenatally, for a more accurate assessment, and later for safe management of a potentially more difficult labour. It was hoped that this system if carried out in an effective manner would have an impact on maternal and perinatal health.

This present evaluation was done in order to assess the level of appropriate management and outcome among high risk mothers with 3 conditions that were perceived to be common antenatal problems in areas with high maternal mortality compared to those in areas with lower maternal mortality. These were hypertensive disorders of pregnancy, postdates and anemia in pregnancy. Appropriateness of care was determined by the guidelines issued to health nurses that included the appropriate colour code, level of care and treatment for varying severity of these conditions. The study was coordinated by the Family Health Division of the Ministry of Health, Malaysia.

Materials and Methods

This was a retrospective follow-through study confined to Peninsular Malaysia. High risk mothers using services in government health facilities with specific medical problems i.e. hypertensive disorders of pregnancy, postdates and anaemia in pregnancy were chosen.

Sampling Method

There were three levels of selecting the study sites, health facilities and the sample units.

Level 1: Determination of districts for selection of study site

As part of a larger study, the study sites were chosen through multistage sampling of health districts and subsequently health facilities. Sixteen health districts were chosen through stratified random sampling of health districts in Peninsular Malaysia stratified by their level of reported maternal mortality ratios as collected by the Family Health Development Division of the Ministry of Health. The Health Division has collected data on maternal mortality by health districts since 1991 through the Confidential Enquiry into Maternal Deaths (CEMD) and this has been shown to have a higher coverage than that collected by either the Statistics Department or the Information and Documentation System of the Ministry of Health.

The 81 health districts were ranked by levels of maternal mortality ratios and classified into districts with low or high maternal mortality based on being higher or lower than the median. Due to the observed fluctuation of the maternal mortality ratios especially in small districts, an additional criteria indicating stability was incorporated into the definition of areas with low or high maternal mortality. In this study, the maternal mortality ranking by district for 1992 was randomly selected as the sampling frame and districts ranked as having low maternal mortality in 1992 and continuing to be ranked as such in 1994 were considered areas with low maternal mortality and likewise areas with maternal mortality higher than median in 1992 and continuing to be such in 1994 were considered high maternal mortality areas. Thus areas having stable maternal mortality status were eligible for selection. Using the Table of Random Numbers, eight districts from areas with low and eight districts with high maternal mortality ratios were chosen giving a total number of 16 randomly selected districts for the larger study on the evaluation of the risk approach strategy.

In this study, 5 districts were randomly chosen from the 16 selected districts included in the larger study. The low maternal mortality districts included in the study were Melaka Tengah and Seremban, while the high maternal mortality areas were Kuala Selangor, Bentong and Larut Matang and Selama districts.

Level 2: Determination of Health Facilities for Selected Health Districts.

Fifty percent of health clinics in each selected district were randomly selected and automatically all community clinics under the selected health clinics were included in the study.

For the selection of hospitals, all government hospitals present in the selected districts were automatically included in the study. However, when the selected district had no government hospital, the nearest referral hospital in the same state was chosen. When cases were referred to several government hospitals, the first referral hospital was considered in this study. Table I shows the number of health facilities selected for this study.

Level 3: Selection of sampling units, the antenatal cards for assessment

Antenatal cards of mothers who delivered between July 1996 to June 1997 were assessed for the three medical conditions chosen for this follow-through study. The selection of antenatal cards was done through sieving all cards in the health facilities selected for the three conditions of interest this study. Fifty percent of the antenatal cards with each of the selected conditions were then randomly selected. Once the antenatal cards for these three conditions were identified and selected, they were listed according to the identity card numbers and this list was then forwarded to the medical record officers in the hospitals concerned for help in the retrieval of hospital records for further analysis.

The head of the O&G department in the respective hospitals were also informed so that this process was facilitated.

For cases that were not referred, where hospital records could not be retrieved or where they were transferred to hospitals outside the state during the period of data collection, the sample unit was not dropped from the study but the assessment of their management in the health facilities was continued. Follow-through for cases which were referred to several government hospitals was confined to the first referral government hospital within the district only.

Data was abstracted and entered using the formats FH-RAS 2/1.1997 for anaemia in pregnancy, FH-RAS 2/2.1997 for hypertensive disorders in pregnancy and FH-RAS 2/3. 1997 for postdates. Major outcomes, accuracy of colour coding assignment, appropriateness of care and feedback received among referred and admitted cases were then analysed.

The criteria for appropriateness of care is summarised in Table II. Appropriateness of care was determined to be in accordance with the instructions issued when the colour coding system was introduced. For anemia in pregnancy, a haemoglobin level of <8gm/dl at any gestation was coded red as was a haemoglobin level of 8-9 gm/dl when the gestation was equal to or more than 32 weeks. When the gestation was less than 32 weeks in the latter category (Hb 8-9 gm/dl) such patients were coded yellow and thus required the attention of the medical and health officer at the health clinic. However, if the gestation was equal to or more than 32 weeks with a haemoglobin level of between 9-10 gm/dl such cases were also coded yellow and required similar action. In this category of patients who were less than 32 weeks, attention from a staff nurse was deemed appropriate (green code). Upon referral to hospital with a red code, such patients would have to be admitted and investigation and treatment instituted. If the haemoglobin was less than 8 gm/dl then a peripheral blood film would have to be done in order to classify for appropriate care.

The definitions of hypertensive disorders of pregnancy were more complex. A patient at a gestation of less than 36 weeks with a blood pressure of 140/90 or more without albuminuria was coded yellow. In such cases if the gestational period was more than 36 weeks or in any gestational period with the presence of albuminuria in association with an elevated blood pressure, the case was coded red. The red code was also utilised for a case with elevated blood pressure of 160/110 with or without albuminuria and for cases with eclampsia. In the hospital care was deemed appropriate if the patient was admitted, the management was in consultation with a medical officer or specialist, an anti-hypertensive was prescribed and there was a delivery plan outlined. An anti-convulsant should also have been prescribed if the case was diagnosed to be eclampsia.

Postmaturity was defined as a period of gestation of 42 weeks and above. Such cases were to be coded yellow and referred to hospital within a day of the clinic visit. In the hospital, the doctor was expected to document confirmation of the diagnosis and then admit the case for appropriate intervention. The intervention was left to the clinical judgement of the doctor taking care of the patient.

Collected data were coded and saved in dbf. (DBASEIV) and xls. (EXCEL version 6) datafiles. The statistical package used throughout the analyses was SAS (Version 6.09, SAS Institute Inc., Gary, North Carolina, USA). Analyses were descriptive using weighted frequency and percentage distributions. Data was weighted to represent the original 5 selected districts selected for the follow-through study. The weights were calculated as the inverse of the probability of cases with the specified conditions to enter the study from among the total number of antenatal cards identified to have those conditions in the selected health facilities. Applying these

sampling weights, the weighted sample in this study contained a total of 554, 252, and 283 cases of anaemia, hypertensive disorders in pregnancy and post-maturity respectively while analysis of the combined conditions contained 1089 observations.

Datasets on each of the condition as well as combining the three conditions was analysed using the univariate logistic regression analyses. The crude effects of the level of maternal mortality on the main implementation outcome measures of the risk approach strategy and colour coding system were estimated. The measures of associations and confidence presented are the odds ratio and its 95% confidence intervals.

Results

Anaemia in Pregnancy:

The number of cases with anaemia were 562 cases (Table III). Of these, 311 cases were in low maternal mortality areas and the remainder, 251 cases were in high maternal mortality areas. The incidence of anaemia was higher in areas with high maternal mortality compared to that in areas with low maternal mortality (7.7% versus 6.3%).

The selection rate varied from 51.1% to 63.7% in the low and high maternal mortality areas respectively. The information on management by the health staff was not available in only one case. This was not surprising as the study was based on records held in the health clinics. However, information on management in the hospital sector was not detailed in 21 cases out of 88 cases referred to the hospitals. In 12 of these cases, the hospital records themselves could not be traced. In the rest, the information required in the study could not be discerned from the available records. These cases were equally distributed in both areas. Birth outcomes were not available in 66 cases in the low maternal mortality areas and 16 cases in the other areas (Table IV).

In the weighted analysis, the number of anemia cases was 309 in the low maternal mortality areas and 245 cases in the high maternal mortality areas. Further analysis showed that there was a higher number of anemia cases in the severe (haemoglobin<8g/100ml) and moderately severe (haemoglobin 8-9 g/dl) categories in the low mortality areas compared to cases in the high maternal mortality areas ($p<0.05$). The distribution of the anemia cases among the four colour codes were found similar in both areas. However, five cases were not given the colour code in the high mortality area and this did not happen in the low mortality area.

The red colour code was inappropriately given in 84.8% of cases in the low mortality areas compared to 81.5% of cases in the high mortality areas. In cases with severe anemia, 84 cases were assigned the yellow code in both areas, 8 cases the green code and 3 cases were even assigned the white code! Two cases with severe anemia were not assigned any code in the high mortality areas. There tended to be overcoding in the low mortality areas with 7 cases being assigned the red code when it should have been yellow and 4 cases red when green would be appropriate. This was not seen in areas with high maternal mortality.

Table V indicates the accuracy of colour coding was 42.6% in the low and 45.5% in the high mortality areas respectively. Table VI shows that this difference in coding accuracy in the two areas did not differ significantly (OR=0.9; 95% CI=0.6-1.3).

There were inappropriate referrals to the hospitals in the vast majority of cases (90.1% in low mortality and 83.8% in high mortality areas). In the high mortality areas, inappropriate referral was found to be significantly lower than that from low mortality areas (OR=0.6, 95% CI= 0.3-0.97).

Probably as a result of the inaccurate colour coding given, care was deemed inappropriate by diagnosis in 283 of the 554 patients (varying from 59.5% in low mortality areas to 40.3% in high mortality areas). The risk of inappropriate care by diagnosis was significantly lower in high compared to low mortality areas (OR=0.5, 95% CI= 0.3-0.7). In contrast, the care given was deemed appropriate by assigned colour code in the vast majority of patients in both areas (84.8% in low and 82.2% in high mortality areas respectively). Similarly, the appropriateness of the category of personnel attending to the patients was also correct in more than 75% of the patients in both areas (Table V).

Hospital staff tended to give appropriate care according to the protocols outlined in the risk coding guidelines in 47.4% of patients in the low mortality areas compared with only 9.0% in high mortality areas and this difference was found to be statistically significant ($p<0.05$) (Table V). There was also poor feedback from the hospital sector to the health staff. In fact, no feedback was given in 62 patients and the status of feedback was unknown in 34 patients out of a total of 160 cases with anemia admitted to hospitals during the study period. The risk of poor feedback was higher in high compared to low mortality areas (OR=3.0, 95% CI=1.5-6.2).

Overall the maternal outcomes were unknown in 131 of 309 mothers (42.4%) in the low mortality areas compared to 14 of the 245 mothers (5.6%) in the high maternal mortality areas.

Hypertensive Disorders of Pregnancy:

Table IV shows that 257 cases with hypertensive disorders of pregnancy were identified in the study districts and 136 cases were selected for the follow- through study. The selection rate was 53.2% in the low mortality and 52.2% in the high mortality areas respectively. Out of the 136 cases selected, there were 10 cases with missing information by health staff (7 in the low mortality and 3 in the high mortality areas respectively). There were 37 cases in which information sought in the study was not found in the notes. There were 119 admissions to the hospital in the group of 257 cases studied. Hospital records were not traceable in 12 patients (all in low mortality areas).

After weighting, 169 cases in low mortality and 83 cases in high mortality areas were analysed for hypertensive disease in pregnancy. The distribution of cases among the various disease categories and colour codes were similar in both groups.

The accuracy of the assigned colour code was 45.9% in low mortality areas and 58.6% in high mortality areas (Table V). Twelve cases which should appropriately have been given a red code (blood pressure >160/110 $\pm$ edema) were categorised wrongly into the yellow code. In addition, two cases in the similar category were allocated the green and white codes respectively.

Referrals to hospitals were noted to be inappropriate in 56.4% of the patients in the low mortality areas whereas this was 35.3% in the high mortality areas (OR=0.4, 95% CI=0.2-0.8).

The care given when classified by diagnosis was also different from that advocated in the protocols in 66.5% of cases in high mortality areas as compared to 85.7% of cases in the low mortality areas (OR=0.3, 95% CI= 0.2 - 0.6). When appropriateness of the care was evaluated by the assigned colour code it was noted to be inappropriate in 192 cases out of the total 252 weighted cases. However, Table IV showed that there was no statistical difference between the two areas in terms of appropriateness of care by assigned colour code.

When the health personnel were analysed with regards to the appropriateness of the care given, it was found to be significantly more appropriate in the high maternal mortality areas compared to low maternal mortality areas (74.7% vs 58.15). The odds ratio of inappropriate care by health staff in high compared to low mortality area was

0.5, (95% CI=0.3-0.9). Care was determined to be inappropriate in 36.7% of cases handled by hospital staff in high compared with 56.2% of cases in the low maternal mortality areas. However this difference in hospital care in the two areas was not statistically significant (Table VI).

The deficiencies in feedback was again noticeable in Table V with only 36 cases out of 145 cases (29.2%) in the low mortality areas and 21.0% of cases in the high maternal mortality areas receiving a feedback.

There was also a difference in the notation of maternal and baby's outcomes in the maternal health cards of mothers with hypertensive disorders in pregnancy. A significantly increased number of cards in the low maternal mortality areas had this information missing from the cards.

Postdates:

For postdates, 157 out of 293 cases with a similar condition were chosen in the study districts. The selection rate in the study was 53.5%. The characteristics of the cases in both study areas with regards to the colour codes were similar. However, there were three cases (1.4%) with a red colour code in the low mortality areas compared with none in the high maternal mortality area. With regards to case distribution, 89.0% were at more than 41 weeks gestational age in the low maternal mortality areas compared with 75.7% in the low mortality areas ($p< 0.05$).

The colour code assigned was inaccurate in more than 56.8% of cases in both areas. The range of colours assigned ranged from red to white. The care given by diagnosis was inappropriate in the majority of cases. When the cases were more than or equal to 42 weeks gestation, the cases should have been referred to hospitals within 1 day of being seen in the clinic. They should be admitted and appropriate intervention planned. In 92.8% of cases in both study groups, this plan was not followed. For postdates, Table V also showed that the management by the assigned colour code was also found not appropriate in both areas (96.9% and 98.6% in high and low mortality areas respectively). Inappropriate management by health personnel was less pronounced in the high maternal mortality areas compared to that of low maternal mortality areas (65.0% versus 87.8%; OR=0.3, 95% CI=0.1-0.5). However, in contrast to the management by health staff, the level of inappropriate management of postdates by the hospital personnel in low maternal mortality areas was lower, 11.8% compared to 48.4% inappropriate hospital care of postdates in the high maternal mortality areas (OR=2.5, 95%CI= 3.5-7.).

Feedback for postdates was again poor with 125 cases out of the 258 cases having no feedback. However the feedback received was significantly lower in the high maternal mortality areas compared to that of the low maternal mortality areas (30.9% versus 60.0%; OR= 3.4, 95% CI=1.8-3.8).

Table V showed that the outcomes for both mothers and babies were better reported in the postdate mothers compared to those with anaemia or hypertensive disorders of pregnancy.

Analysis of all three conditions combined:

When all the three conditions were analysed together, the following observations were made. The prevalence rates of the three conditions studied are as tabulated in Table III. The overall prevalence of these conditions was as usually quoted in the medical literature. However, the prevalence of hypertension and postdates was noted to be higher in the low mortality areas but the prevalence of anemia was lower in the low mortality area. This could be reflective of better antenatal surveillance and care in the low mortality areas.

Table IV summarises the selection rates in the two study areas and also details the problems with data collection in both the health and hospital sectors alluded to earlier. In view of the

fact that antenatal care is a combined effort between the hospital and health sectors, the problem with feedback between the two sectors will have to be addressed. Numerous studies previously have shown the same problem.

The assigned colour code was accurate in only 43.9% of cases in the low maternal mortality areas and in 44.2% of the cases in the high maternal mortality areas. There was no statistical difference in the accuracy of assigned colour code between the two areas. Table V also showed that the level of inappropriate referrals to hospital was similar in the two areas. Inappropriate care by diagnosis and by assigned colour code were however, significantly lower in the areas with high compared to low maternal mortality. Prevalence of inappropriate care by health personnel in the high mortality areas was significantly lower compared to that of low mortality areas but the opposite is found for inappropriate care by hospital staff in the two areas (Tables V and VI).

Table I : Health Facilities Chosen from Randomly Selected Districts

Selected District	No. of Health Clinics	No. of Health Clinics sampled	No. of RBK/KD*	No. of RBK/KD* sampled	Hospital		
					State Hospital	District Hospital without O&G Specialist	District Hospital with O&G Specialist
Best Area							
Seremban	7	3	10	4	1	-	-
Melaka Tengah	10	5	14	4	1	-	-
Worst Area							
Kuala Selangor	5	3	22	6	-	-	1
Bentong	5	3	14	4	-	-	1
Larut Matang & Selama	11	6	29	7	-	1	-
Total	**38**	**20**	**89**	**25**	**2**	**1**	**2**

*RBK: Midwifery Clinic, KD : Community Clinic

Table II: Appropriateness of Care

Selected Condition/ Risk Factor	Definition of Cases	Recommended Management	
		Health Sector	Hospital Sector
Anemia	Hb <8gm/dl	Refer to hospital	Repeat Hb estimation and do peripheral blood film
	Hb of 8-9gm/dl	<32 weeks gestation refer to doctor at health clinic	
		>32 weeks refer to hospital	Patient is admitted and investigation as well as treatment instituted
	Hb of 9-10gm/dl	< 32 weeks, treat with haematinics by nursing staff	
		>32 weeks refer to doctor	
Hypertensive Disorders in Pregnancy	BP 140/90 without Albuminuria gestation<36 weeks	Refer to doctor	Admit Management in consultation with MO/ specialist Anti-hypertensive used Plan for delivery Anti-convulsant for eclampsia
	BP 140/90 without Albuminuria	Refer hospital immediately	
	BP>140/90 with albuminuria and oedema	Refer hospital immediately	
	BP>160/110 with/without albuminurua	Refer hospital immediately	
	Eclampsia	Refer hospital Immediately	
Postmaturity	Period of gestation 42 weeks and above	Refer to hospital within 1 day of detection	Confirm diagnosis Admit case for appropriate intervention

Table III : Prevalence Rates of Selected Medical Conditions Among Mothers from Study Areas, Rate Per 100 Antenatal Mothers

Selected Medical Conditions	Levels of Maternal Mortality					
	Low (N=4916)*		High (N=3472)*		Total (N=8388)	
	f	%	f	%	f	%
Anaemia	311	(6.3)	251	(7.2)	562	(6.7)
Hypertensive disorders in pregnancy	169	(3.4)	88	(2.5)	257	(3.1)
Postdates	202	(4.1)	91	(2.6)	293	(3.5)

* Number of antenatal cards sorted in the selected study areas

Table IV : Selection and Response Rates of Anaemia, Hypertensive Disorders in Pregnancy, Postdates and Combined Medical Conditions in Follow-Through Study from Districts with Different Levels of Maternal Mortality

Status	Aneamia		Hypertensive		Postdates		All 3 conditions	
	Low MMR	High MMR	Low MMR	High MMR	Low MMR	High MMR	Low MMR	High MMR
No. of cases identified	311	251	169	88	202	91	682	430
No. of cases selected	159	160	90	46	109	48	358	254
Selection rate (%)	(51.1)	(63.7)	(53.2)	(52.2)	(53.9)	(52.7)	(52.5)	(59.1)
No. of cases with missing information on management by health staff	1	0	7	3	4	0	12	3
No. of cases with missing information on management by hospital staff*	10/(47)	11/(41)	18/(77)	19/(42)	17/(98)	19/(40)	45/(222)	49/(123)
No of cases with missing information on birth outcomes	66	16	19	6	10	3	95	25
Hospital cards not traceable (Based on written comments)	7	5	12	0	8	10	27	15

* among those were admitted in hospitals

Table V: Differences in Color Coding Practice and Case Management in Different Types of Conditions Based on Follow Through Study of Cases from Districts with Different Levels of Maternal Mortality

Status	Aneamia		Hypertensive		Postdates		All 3 conditions	
	Low MMR (n=309)	High MMR (n=245)	Low MMR (n=169)	High MMR (n=83)	Low MMR (n=202)	High MMR (n=81)	Low MMR (n= 680)	High MMR (n= 409)
Assigned colour code								
Red	(6.9)	(2.9)	(19.7)	(9.6)	(1.4)	(0.0)	(8.4)	(3.7)
Yellow	(70.9)	(70.3)	(70.2)	(74.7)	(39.4)	(53.9)	(61.4)	(67.7)
Green	(21.0)	(23.8)	(8.9)	(15.7)	(48.0)	(34.6)	(26.0)	(24.1)
White	(1.2)	(1.2)	(1.2)	(0.0)	(11.2)	(13.6)	(4.2)	(3.4)
Not coded	(0.0)	(1.9)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(1.2)
Measures of care								
Accuracy of assigned colour code								
Accurate	(42.6)	(45.5)	(54.0)	(41.4)	(37.5)	(43.2)	(43.9)	(44.2)
Inaccurate	(57.4)	(54.5)	(45.9)	(58.6)	(62.5)	(56.8)	(56.1)	(55.8)
Appropriateness of referral to hospital								
Appropriate	(9.9)	(16.2)	(43.6)	(64.7)	(69.3)	(64.6)	(35.9)	(35.6)
Inappropriate	(90.1)	(83.8)	(56.4)	(35.3)	(30.7)	(35.4)	(64.1)	(64.4)
Appropriateness of care by diagnosis								
Appropriate	(40.4)	(59.7)	(14.2)	(33.5)	(7.2)	(7.2)	(24.0)	(44.0)
Inappropriate	(59.5)	(40.3)	(85.7)	(66.5)	(92.8)	(92.8)	(75.9)	(55.9)
Appropriateness of care by assigned colour code								
Appropriate	(84.8)	(82.2)	(24.8)	(21.5)	(1.4)	(3.1)	(45.1)	(54.2)
Inappropriate	(15.2)	(17.8)	(75.2)	(78.5)	(98.6)	(96.9)	(54.9)	(45.8)
Appropriateness of care given by health personnel								
Appropriate	(75.5)	(81.4)	(58.1)	(74.7)	(12.2)	(35.2)	(47.6)	(70.9)
Inappropriate	(24.4)	(18.6)	(41.9)	(25.3)	(87.8)	(65.0)	(52.4)	(29.2)

Appropriateness of care given by hospital personnel *								
Appropriate	(47.4)	(9.0)	(43.8)	(63.3)	(88.2)	(51.6)	(66.0)	(44.0)
Inappropriate	(52.6)	(91.0)	(56.2)	(36.7)	(11.8)	(48.4)	(34.0)	(56.0)
Feedback recorded by health personnel **								
Yes	(51.7)	(26.1)	(29.2)	(21.0)	(60.0)	(30.9)	(48.1)	(25.9)
No	(28.2)	(51.2)	(47.9)	(32.8)	(22.5)	(37.8)	(33.1)	(40.4)
Unknown	(20.1)	(22.6)	(23.0)	(46.2)	(17.5)	(31.3)	(18.8)	(33.7)
Birth outcomes								
Maternal outcomes								
No reported complications	(56.5)	(88.2)	(73.4)	(72.1)	(83.6)	(81.7)	(68.8)	(83.7)
Reported complications	(1.1)	(5.5)	(5.9)	(17.7)	(6.7)	(12.1)	(3.9)	(9.2)
Reported Maternal death	-	(0.7)	-	-	-	-	-	(0.4)
Unknown	(42.4)	(5.6)	(20.7)	(10.8)	(9.7)	(6.2)	(27.4)	(6.8)
Baby's outcomes								
No reported complications	(57.5)	(88.3)	(73.9)	(73.3)	(89.4)	(88.9)	(71.1)	(85.4)
Reported complications	(0.0)	(1.5)	(5.1)	(11.0)	(0.9)	(4.9)	(1.6)	(4.1)
Reported baby's death	-	(0.8)	-	(2.4)	-	-	-	(1.0)
Unknown	(42.5)	(9.4)	(20.9)	(13.3)	(9.7)	(6.2)	(27.4)	(9.6)

Table VI: Estimated Odds Ratio and 95% Confidence Interval of Inappropriate Management Outcomes in High Compared to Low Maternal Mortality Areas

	Aneamia		Hypertensive		Postdates		All 3 conditions	
Poor outcomes	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Inaccurate colour coding practice								
(Low MMR)								
High MMR	0.9	(0.6 - 1.3)	1.7	(1.0 - 3.0)	0.8	(0.5 - 1.4)	1.0	(0.8 - 1.3)
Inappropriate referral								
(Low MMR)								
High MMR	0.6	(0.3 - 0.97)	0.4	(0.2 - 0.8)	1.3	(0.7 - 2.3)	1.0	(0.8 - 1.3)
Inappropriate care by diagnosis								
(Low MMR)								
High MMR	0.5	(0.3 - 0.7)	0.3	(0.2 - 0.6)	0.9	(0.3 - 3.1)	0.4	(0.3 - 0.5)
Inappropriate care by assigned colour code								
(Low MMR)								
High MMR	1.2	(0.8 - 2.0)	1.2	0.6 - 2.4	0.4	(0.1 - 3.0)	0.7	(0.5-0.9)
Inappropriate care by health staff)								
(Low MMR)								
High MMR	0.7	(0.5 - 1.1)	0.5	(0.3 - 0.9)	0.3	(0.1 - 0.5)	0.5	(0.4 - 0.6)
Inappropriate care by hospital staff*								
(Low MMR)								
High MMR	8.5	(2.2 - 47.1)	0.5	(0.2 - 1.1)	6.9	(3.2 - 15.1)	2.5	(1.6 - 3.9)
Poor feedback**								
(Low MMR)								
High MMR	2.98	(1.45 - 6.17)	1.63	(0.79 -3.38)	3.41	(1.85 - 6.30)	2.65	(1.83 - 3.84)

(The control or referent groups are case management outcome measures in areas with low maternal mortality)

* (Based on 433 cases admitted to hospital)

** (Based on 640 cases referred or admitted to hospital)

Discussion

While large prospective pregnancy follow-up studies were done in post-industrialised countries, [4,5] information on developing countries is more recent.1 Hospital delivery was recommended based on the poor predictability of complications[4, 5]. Yet in a worldwide effort to improve obstetric results, countries with high perinatal and maternal mortality adopted hospital referral based on risk factors which were mainly identified antenatally[7,9]. Malaysia has adopted the principle of hospital delivery except for those with white codes. In Malaysia about 40% of pregnant women are defined as high risk[9].

The occurrence of the antenatal complications of hypertensive disease in pregnancy, anemia and postdates did not differ from internationally expected figures[10,11]. This demonstrates that the sample chosen for this study was reflective of a standard obstetric population.

The colour coding system was initiated in 1989.This study was performed in 1997 that is after 8 years of use of this system. It is assumed that with the time that this system has been used, all staff would have been trained and become familiar with the intricacies of the colour coding system. However, it is possible that lack of supervision by superior officers and rapid changeover of staff may hinder the accurate implementation of this system. It is a significant finding of the study that the colour codes were correctly assigned in only 56% of all mothers with the 3 conditions with the percentage of correct coding varying between 37.5% for postdates to 54% for hypertension in the low maternal mortality areas. It is important to note that the colour coding system allowed for recoding at each visit and a prescribed format which allowed a checking system was attached to the antenatal card of each mother. Despite this system that allowed correction by both the nursing staff providing antenatal care and the supervisory staff, the accuracy of the colour coding system was poor. Similar reliability problems have been found elsewhere[12]. Despite recoding, predictability improved little and would improve only if coding during labour were added[11]. The colour coding system in Malaysia allowed for coding intrapartum problems as well as postpartum events. In the present study, only hypertensive disease of pregnancy among the three conditions studied had intrapartum risk factors which could be coded. However, the accuracy of the codes did not show a significant difference in hypertensive disease of pregnancy as compared to postdates or anemia in pregnancy. This study confirms that the colour coding system which is time consuming is not sufficiently effective in prediction of risk. This is the finding as well in numerous other studies[14,15,16]. It has been stated that a system with a sensitivity of 50% and specificity of 73%, with a population coverage of over 90% may improve perinatal statistics in areas with a high rate of complications. We have to concur with Geethuysen et al. who state that with the levels seen in Malaysia, predictive values of this system are low[17].

However, one must realize that the system was not meant to predict risk but be a managerial tool. It allowed a midwife the flexibility to admit a patient to a specialist unit without hindrance and allowed a patient with a problem to be evaluated speedily by a specialist. The value of the system as a managerial tool in this respect was not evaluated by the study.

The above data indicate that the colour coding system did not account for the difference in the study areas with regards to maternal mortality. Inaccurate colour coding practice was the same in both areas. This led to inappropriate care by diagnosis, by assigned colour code and by health staff. This was noted in all the three conditions studied in this report. When the level of inappropriate care by diagnosis, by assigned colour code and by health staff for the three conditions combined was compared between the high and low maternal mortality areas, it was noted that these were significantly higher in the high mortality areas.

When the outcomes of the pregnancies were analysed by the various colour codes and the different conditions, it was noted that there were no maternal deaths in the various colour codes in the hypertensive or postdated patients in both the high risk and the low risk areas. The two maternal deaths in this study occurred in patients who were coded green for a haemoglobin level of 9-10 g/dl in a high maternal mortality area. The only fetal deaths were in yellow coded patients for Hb level of 8-9 g/dl and on wrongly coded hypertensive patients with BP>160/110 in a high mortality area. There was no relationship of the number of maternal or fetal complications to the colour code in this study. Thus the colour code did not predict the possible eventual outcome of the pregnancy for both the mother and the baby. The colour coding system may also divert attention from the apparently low risk patients to their own detriment as was demonstrated in the maternal and fetal deaths that occurred in the low risk patients.

The study also demonstrated the oft-found finding of the lack of feedback between the hospital and health sectors that provide care for the pregnant mother. This study was carried out before the introduction of the patient held home based antenatal card. The antenatal card which affords the opportunity of recording the details of antepartum, intrapartum and postpartum care by all sectors providing maternity care would have addressed some of these concerns about feedback. It is nevertheless opportune to concentrate resources and effort in overcoming this continuing bugbear of maternity care.

Antenatal care is often the area where services are sometimes not focused in the most appropriate or consistent manner. In some instances, decisions about tests, interventions and surveillance are arbitrary or varied between professionals18. The colour coding system has not demonstrated its usefulness in the effective management of three common obstetric problems in the maternity care services in this country. Marion Hall and her colleagues have highlighted the possible over-surveillance of the woman during the antenatal period[19]. If these checkups are unwarranted, it is not only a waste of resources, but could impact adversely on the standards that can be achieved. If fewer visits are necessary, it should be easier to plan the workload of individual members of staff, to increase both the level of continuity achieved and the time spent on each visit, thereby improving the quality of care.

Some women used to the more traditional antenatal visiting patterns may feel anxious if they hear of plans to reduce the number of visits. Time should be taken to explain that a reduction in antenatal visits will not mean any less support in pregnancy, but rather that the quality and continuity of care will be improved and waiting times reduced. The system of antenatal care currently in place is cumbersome and a source of concern to professionals and pregnant women alike. Some antenatal patients in this country may receive as much as 20 visits to the private specialists, health sector and to the government hospitals. A national health-financing scheme which rewards only appropriate care may be a way of correcting this defect in our system. A survey of existing practice should be undertaken by purchasers, providers and professionals on a regular basis. As well as reviewing the number of antenatal checkups, the effectiveness of the service in identifying the fetus at risk should also be assessed. Streamlining the current system could achieve improvements for all concerned.

This present study randomly sampled 1112 mothers out of 8388 mothers with three common obstetric problems in five districts in Malaysia, which were stratified according to high and low maternal mortality rates. The study showed that the prevalence of anemia, hypertensive disorders in pregnancy and postmaturity among mothers with these conditions were according to known international standards.

Anaemia was classified as severe and red coded in 18.7% of the mothers with anemia. It was classified as moderate (yellow code) in 40.5% and mild (green code) in 40.2%. With regards to

hypertension in pregnancy, 56.6% were red coded and the others (43.4%) were classified as yellow. For postdates 14.8% were red coded while the rest were coded yellow. It could thus be seen that for hypertension in pregnancy, the existing coding system tended to classify more than half of the patients with this condition in a category that required hospital admission. This could have led to the inappropriate management and admissions due to changes in the protocol at local level to reduce the number of admissions. The classification of the disease tended to be unnecessarily complex and not supported by the evidence in the literature.

The colour coding system, as it exists now should be reviewed. Instead, a substantially revised system that takes cognisance of evidence in the scientific literature should be used to devise a more effective system that can be used by health care personnel involved in antenatal care to ensure appropriate level of care and referrals.

It is also suggested that any screening system that is implemented in future should continue to have coding facilities for intrapartum and postpartum factors to improve sensitivity. The coding system should be jointly developed and implemented by both the health and hospital sectors to overcome the weaknesses identified in the present system.

One particular aspect and weakness that needs to be corrected is the overcoding of some conditions that would require admission in more than half of the mothers with some conditions such as hypertensive disease of pregnancy.

The lack of feedback between the hospital and heath sectors was again found in this study. It is opportune to study whether the introduction of the home-based antenatal card has addressed some of the concerns in this continuing bugbear of maternity care.

This study has provided some definitive answers for policy development. The study confirms other Malaysian and world experience in showing the lack of effectiveness of the risk coding system [22,23] as it is presently used. Attention to the details of antenatal care and streamlining communication between the providers of maternity care rather than spending time on coding should assure that the Malaysian reproductive care programme will continue to improve. We need to heed our own advice with regards to the findings of this study.

Acknowledgements

This study was funded by a grant from the United Nations Population Fund (UNFPA). The authors would like to thank the Director-General of Health of Malaysia for permission to publish this article. We would also like to thank the numerous nursing staff who made this study possible.

References

1. Alexander S, Keirse MJNC. Formal risk scoring during pregnancy In Effective care in pregnancy and childbirth. Chalmers I, Enkin M, Keirse MJNC (eds) Oxford; Oxford University Press 1993: 345-65.
2. Lambotte R. Discussion. In : Pre-term Labour Proceedings of the Fifth Study Group of the Royal College of Obstetricians and Gynaecologists. Anderson A, Berad R, Brudenell JM, Dunn PM. (eds) London: Royal College of Obstetricians and Gynaecologists; 1977: 40-41.
3. Newcombe RG, Chalmers I. Assessing the risk of preterm labour. In: Preterm Labour. Elder MG, Hendricks CH (eds) London: Butterworths, 1981: 47-60.
4. Butler NR, Alberman Ed. (eds) Perinatal Problems. Edinburgh: E&S Livingstone, 1969.
5. Chamberlain G, Zander L. (eds) Pregnancy Care in the 1990's. Proceedings of a Symposium of the Royal Society of Medicine 1991. Casterton Hall: Parthenon Publishing Group, 1992.
6. Kiely M. (ed) Reproductive and Perinatal Epidemiology, Florida: CRC Press, 1991.
7. Backett EM, Davies AM, Petros-Barvazian A. The risk approach in health care: with special reference to maternal and child health, including family planning. Public Health Papers No 76. Geneva: World Health Organisation, 1984.
8. Hertz B, Measham AR. The safe motherhood initiative: proposals for action. Washington DC: World Bank, 1987.
9. Somboonsook B, Wakerman J, Hattch CT, Colloson M, Barnes A, Kyi W, Karim R. An initial assessment of the risk approach to antenatal management in Malaysia. Med J Malaysia 1995; 50 (2): 115-21.
10. Chalmers I, Enkin M, Keirse MJCN. Effective care in pregnancy and childbirth. Oxford: Oxford University Press, 1989.
11. Llewllyn-Jones D. Fundamentals of obstetrics and gynaecology: Vol 1 Obstetrics. 5th Edition.London, Sydney: Faber and Faber, 1990.
12. Hutchinson BG, Milner R. Reliability of the guide to pregnancy risk grading of the Ontario antenatalrecord in assessing obstetric risk. Canadian Med Ass J 1994; 150: 1983-87.
13. Bartlett A III, Paz de Bocaletti E, Bocaletti MA. Reducing perinatal mortality in developing countries: High risk or improved labour management? Health Policy Planning 1993; 8: 360-68.
14. Chamberlain RW. Strategies for disease prevention and health promotion in maternal and child health: The ecologic versus the high risk approach. J Pub Health Policy 1984; June: 185-97.
15. Wall EM. Assessing obstetric risk: A review of obstetric risk scoring systems. J Fam Practice 1988; 27: 153-163.
16. Tinker A, Daly P, Green C, Saxenian H, Lakshminarayanan R, Gill K. Women's health and nutrition: Making a difference. World Bank Discussion Papers No 25.Washington DC: World Bank, 1994.
17. Geethuysen CJ, Isa AR, Hashim M, Barnes A. Malaysian antenatal risk coding and the outcome of pregnancy. J Obstet Gynaecol Res 1998; 24 (1): 13-20.
18. Changing Childbirth: Report of the Expert Maternity Group. Department of Health, United Kingdom. London HMSO 1995.
19. Hall MH. Critique of antenatal care. In Obstetrics Turnbull A, Chamberlain G (eds) Churcill Livingstone Edinburgh 1989 1st edition : 225-33.