

OBSTETRICS

Beyond the numbers: classifying contributory factors and potentially avoidable maternal deaths in New Zealand, 2006–2009

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OBJECTIVE: We sought to describe a new classification system for contributory factors in, and potential avoidability of, maternal deaths and to determine the contributory factors and potential avoidability among 4 years of maternal deaths in New Zealand.

STUDY DESIGN: A new classification system for reporting contributory factors in all maternal deaths was developed from previous tools and applied to all maternal deaths in New Zealand from 2006 through 2009.

RESULTS: There were 49 deaths and the maternal mortality ratio was 19.2/100,000 maternities. Contributory factors were identified in 55%

of cases. An expert panel identified 35% of maternal deaths as potentially avoidable. In cases where potential avoidability was determined, there were nearly always 2 or 3 domains where contributory factors were identified.

CONCLUSION: Almost one third of maternal deaths in New Zealand can be considered to be potentially avoidable. This methodology has the potential to identify areas for improvement in the quality of maternity care.

Key words: maternal death, mortality review, potentially avoidable factors, quality improvement

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Maternal deaths are devastating events for families. The number of maternal deaths each year in New Zealand varies from 9–15 (Perinatal and Maternal Mortality Review Committee [PMMRC] 2008).¹ In 2005, the New Zealand Minister of Health established the PMMRC for the purpose of review-

ing both perinatal and maternal deaths. The strength of mortality review is the ability to review deaths both individually and as aggregated data. From the single examination of cases by experts comes information that might otherwise have been overlooked. From the aggregated data come broader themes and trends that can be identified and monitored and with appropriate policy changes and interventions might lead to improvements in outcomes.²

Mortality review should not only focus on definitions and causation of disease but also needs to focus on modifiable features in health systems and the quality of clinical care.² With this in mind, the PMMRC sought to report not only clinical data but also contributory factors and potential avoidability. For example, a woman with preeclampsia dies at 38 weeks from a cerebral hemorrhage and on review of the case the management of hypertension was found to be outside standard practice. This death would be classified as a direct maternal death from hypertension with contributory factors that might include inadequate protocols or guidelines, failure to follow standard practice, and failure to

appreciate the seriousness of the condition. The death can therefore be considered potentially avoidable.

It has been suggested that even in the developed world 50% of all maternal deaths are potentially avoidable.³ A number of models of reporting contributory factors have already been developed.^{4–9} None of these systems adequately met our requirements for identifying potential avoidability. Some failed to provide adequate documentation of the process. For example, we were unable to find a definition of standard care or the methodology used by Centre for Maternal and Child Enquiries (CMACE).^{3,8} Other models covered some dimensions well but were not comprehensive.^{6,7} For example, we sought to report on barriers to accessing or engaging with care and yet none of the classification systems encompassed this dimension. In the case of root cause analysis, it was thought that this only addressed system issues and did not consider the contribution of clinical competence.⁹ The aim of this report is to, first, describe a new classification system for contributory factors incorporating the best of these approaches and, second, to

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TABLE 1

Perinatal and Maternal Mortality Review Committee Contributory Factors form**Have any organizational and/or management factors been identified?**

Poor organizational arrangements of staff
 Inadequate education and training
 Lack of policies, protocols, or guidelines
 Inadequate numbers of staff
 Poor access to senior clinical staff
 Failure or delay in emergency response
 Delay in procedure, eg, cesarean section
 Inadequate systems/process for sharing of clinical information between services
 Delayed access to test results or inaccurate results
 Other reason

Have factors relating to personnel been identified?

Knowledge and skills of staff were lacking (includes failure to maintain competence)
 Delayed emergency response by staff
 Failure of communication between staff
 Failure to seek help/supervision
 Failure to offer or follow recommended best practice
 Lack of recognition of complexity or seriousness of condition
 Other reason

Have factors relating to technology and equipment been identified?

Essential equipment not available
 Lack of maintenance of equipment
 Malfunction/failure of equipment
 Failure/lack of information technology
 Other reason

Have factors relating to environment been identified?

Geography, eg, long-distance transfer
 Building and design functionality limited clinical response
 Other reason

Have barriers to accessing/engaging with care (eg, no, infrequent, or late booking for antenatal care; woman declined treatment/advice) been identified?

Substance use
 Lack of recognition of complexity or seriousness of condition (by either woman or her family)
 Maternal mental illness
 Cultural barriers
 Language barriers
 Not eligible to access free care
 Family violence
 Other reason

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determine the contributory factors and potential avoidability among 4 years of maternal deaths in New Zealand.

MATERIALS AND METHODS

The Maternal Mortality Review Working Group (MMRWG) of the PMMRC is responsible for reviewing all maternal deaths in New Zealand. The members of the working group include obstetricians, midwives, an anesthetist, a psychiatrist, a health care manager, and a pathologist.

Definitions

In New Zealand, a maternal death is defined as the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes.

The maternal mortality ratio is calculated per 100,000 maternities and follows this CMACE approach.³ Maternities are defined as all live births and fetal deaths at ≥ 20 weeks or weighing ≥ 400 g if gestation unknown. Pregnancies ending < 20 weeks are not included in this working definition because the absolute number of pregnancies ending before this time is unknown.

The definitions adopted by the MMRWG are based on the World Health Organization definitions from the *International Statistical Classification of Diseases, 10th Revision* and the cause of each death is subclassified, using the CMACE system³:

- **Direct maternal deaths:** those resulting from obstetric complications of the pregnant state (pregnancy, labor, or puerperium); from interventions, omissions, incorrect treatment; or from a chain of events resulting from the above.
- **Indirect maternal deaths:** those resulting from previous existing disease or disease that developed during pregnancy and not due to direct obstetric causes, but aggravated by the physiologic effects of pregnancy.
- **Coincidental maternal deaths:** those resulting from unrelated causes that happen to occur in pregnancy or the puerperium.

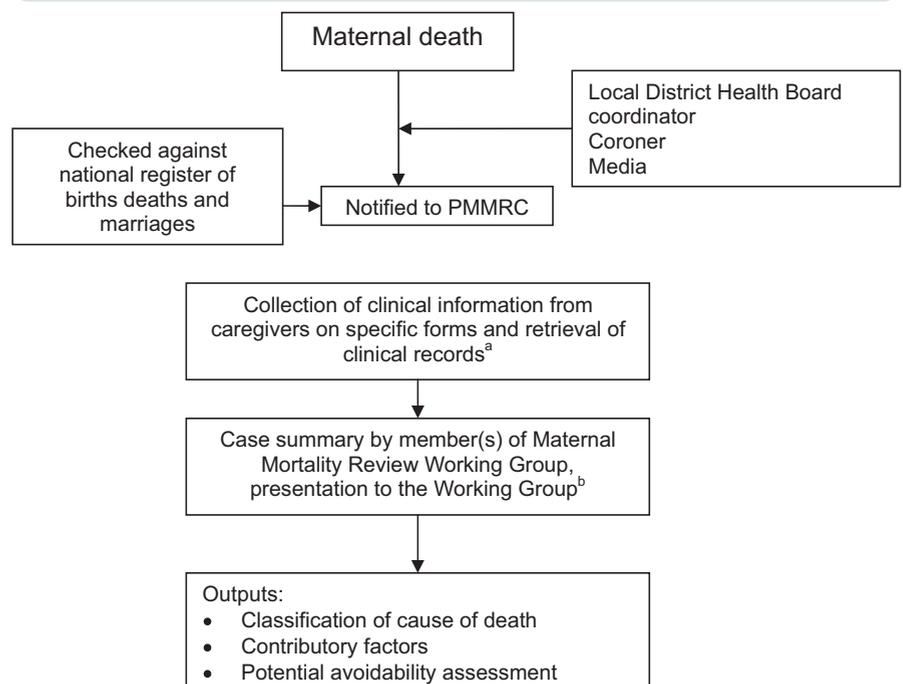
Development of a new classification system for contributory factors

The classification system was developed iteratively following a literature search for similar models, in discussion with the PMMRC, the MMRWG, local coordinators, and Ministry of Health officials of the Quality Improvement Committee. The published classification systems considered in the development of this system for New Zealand include the following:

1. CMACE identifies cases of substandard care and considers the following contributory factors: failures in diagnosis and treatment, errors in management of complications, failures in the organization of health care (structure), and patient factors such as late presentation for treatment, barriers to access to care, social situation, family violence, and drug use.^{3,7} The definition for substandard care (major) is “Contributed significantly to the death of the mother. In many, but not all cases, different treatment may have altered the outcome.” No description of the methods used to identify the contributory factors or substandard care is provided within the report or referenced.
2. The London protocol^{8,10,11} for reviewing critical incidents contains a framework of contributory factors that includes the following: institutional (medicolegal and regulatory), organization and management (financial and policies), work environment (staffing levels and skills mix, the equipment and administrative and management support), team (communication, supervision, leadership), individual staff member (knowledge and skills), tasks (protocols, accuracy and availability of diagnostic tests), and the patient (the complexity of their condition, language, and social factors). This tool was a useful starting point for the methodology developed.
3. The Geller model for scoring preventability includes provider- and system-related preventability.^{6,12,13} Morbidity and mortality cases were assessed by a multidisciplinary team of experts to reach a consensus on classification of death as preventable or not. Prevent-

FIGURE

Process for maternal death review in New Zealand



^aAll health care workers are required to provide information about the mother and baby where a maternal death has occurred under the New Zealand Public Health and Disability Act 2000; ^bLocal review is protected under the Protected Quality Assurance Activities of the Health Practitioners Competency Act and data collection for the MMRWG is protected under the New Zealand Public Health and Disability Act 2000.

MMRWG, Maternal Mortality Review Working Group; PMMRC, Perinatal and Maternal Mortality Review Committee.

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ability was described as “action or inaction on the part of the health care provider, system or patient that may have caused or contributed” to the adverse outcome.¹² A descriptive model for identifying provider- and system-related preventability notes 10 categories to assess but they have not included patient factors in this model. Geller et al,¹³ however, does comment on noncompliance as a contributory factor, stating patient factors as being social factors that limit their ability to access health care as well as actions or delays by the patient that contributed to the death.

4. Root cause analysis approach for identifying factors includes policies, communication, training and competency, fatigue, scheduling, environment, and equipment factors.⁹ Patient factors are not included as causal factors nor is the family included in the mortality review process, citing confidentiality.⁹
5. In the preventability scale of the Perinatal and Infant Mortality Commit-

tee of Western Australia,⁵ the preventability of an adverse event is defined as “an error in management due to failure to follow accepted practice at the individual or system level” and accepted practice is taken to be “the current level of expected performance for the average practitioner or system that manages the patient”⁵ and are based on the preventability score used in the Quality in Australian Health Care Study.¹⁴ This system does not appear to address barriers to accessing and engaging with care.

The new system for classifying potentially avoidable deaths

Following the presentation of each maternal death the role of contributory factors is considered. There are 2 steps. In the first step, the following questions that identify contributory factors are considered:

TABLE 2
Maternal mortalities and cause of maternal deaths 2006 through 2009

Classification and cause of maternal death	Total	Contributory factors present	Potentially avoidable deaths
Direct maternal death	20	11	6
Amniotic fluid embolism	8	4	
Postpartum hemorrhage	3	2	2
Pulmonary embolism	2	1	1
Peripartum cardiomyopathy	1		
Preeclampsia	4	3	3
Sepsis	2	1	
Indirect maternal death	26	16	11
Preexisting medical condition	9	7	4
Nonobstetric sepsis	6	2	2
Intracranial hemorrhage	1		
Suicide	10	7	5
Unclassifiable	3	—	—
Total	49	27	17
Maternal mortality ratio	19.2/100,000 maternities		

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- Have any organizational and/or management factors been identified?
- Have factors relating to personnel been identified?
- Have factors relating to technology and equipment been identified?
- Have factors relating to environment been identified?
- Have barriers to accessing/engaging with care been identified?

Examples of these and the subcategories within each are given in the PMMRC Contributory Factors Form (Table 1).

If contributory factors were identified, the second step was to consider if the maternal death was potentially avoidable. Potential avoidability is defined where there are aspects of care that may have changed the clinical outcome had they been identified. A maternal death was considered potentially avoidable if the absence of the contributory factors would have prevented the death.

Process for data collection for reporting potentially avoidable factors

The process for maternal death review in New Zealand is summarized in the Fig-

ure. Following notification of a maternal death, the national coordinator issues maternal death reporting forms to the appropriate local coordinator, who is then responsible for gathering the relevant clinical information from staff involved with the woman's care. Each completed reporting form, along with relevant clinical records, is reviewed by a designated member or members of the working group, who presents a summary of the case and findings to the working group. Each case is then discussed by the MMRWG in detail, including review of contributory factors and potential avoidability.

The new system for classifying contributory factors and potentially avoidable deaths was applied to all maternal deaths from 2006 through 2009 inclusive. From 2006 through 2008, the MMRWG of the PMMRC prospectively assessed potential avoidability of all maternal deaths but did not use a tool for identifying contributory factors. In early 2010 an expert panel that included a midwife researcher, an obstetrician, and an epidemiologist, one of whom was also a member of the working group, considered each death from 2006 through

2008 individually and completed the classification form retrospectively using the tool (Table 1). During this process small refinements were made to the system and these were applied retrospectively to all cases reviewed. The expert panel's retrospective assessment of potential avoidability was consistent, in 32 of the 35 deaths, with the original assessment of the working group. For 2009 deaths, the working group applied the new tool described here prospectively in reviewing the 2009 maternal deaths.

Details of institutional review board approval

This was not required as this report and the data it contains are covered under the New Zealand Public Health and Disability Act of 2000.

RESULTS

Forty-nine deaths were identified in the 4 years of this study. This is believed to represent complete ascertainment of direct and indirect maternal deaths in New Zealand over this time period. The causes of these 49 deaths are presented in Table 2.^{1,15-17} The maternal mortality ratio for the years 2006 through 2009 was 19.2/100,000 maternities.

The findings of the retrospective review of contributory factors, and potentially avoidable maternal deaths in 2006 through 2009, are shown in Table 3. Contributory factors were identified in 55% of cases overall, and in many cases >1 factor applied. Factors relating to organizational and/or management, personnel, and barriers to access and engagement were more frequent and factors relating to the environment and technology and equipment were less common and not found in cases where the death was potentially avoidable.

Of factors relating to organization/management, the most commonly identified subcategory was lack of policies, protocols, or guidelines. Among factors relating to personnel, the most common were that knowledge and skills of staff were lacking (including failure to maintain competence) and that there had been failures of communication between staff. Reasons for barriers to access or engagement with care most often identified

were factors such as substance use and family violence, and the mother or her family's perceived failure to recognize the complexity or seriousness of her condition.

The death was not thought to have been potentially avoidable in all cases where there were contributory factors identified. The expert panel identified potentially avoidability in 35% of maternal deaths. In cases where death was potentially avoidable, there were nearly always 2 or 3 domains where contributory factors were identified. Table 4 reports on the deaths where contributory factors were present from the 4 years.

COMMENT

This article describes a tool for measuring contributory factors and then determining potentially avoidable maternal deaths in New Zealand. In over one half of cases there were contributory factors present and in over one third of all cases the deaths were considered to be potentially avoidable. The tool was developed after reviewing the literature for root cause analysis and quality improvement as well as previously described classification systems for factors contributing to maternal mortality. Our review of current models for assessing contributory factors revealed many common themes but did not identify a system that adequately met the requirement of our national maternal mortality review. The approach that we have developed draws heavily on the London protocol but goes one step further to determine potential avoidability.^{11,18} Establishing a tool for identifying contributory factors and potentially avoidable deaths provides a standardized framework that we consider will allow maternal deaths and severe maternal morbidities to be "measured" in the same way.

There are limitations to our approach. One limitation is that the review is performed at arms length from the health care setting and that there may be information that the reviewers are unaware of that might have changed the outcome of the review. This concern could be addressed further by a study comparing local review with an external expert panel.

TABLE 3

Contributory factors identified by category in maternal deaths 2006 through 2009

Contributory features identified: (multiple categories may apply)	Direct	Indirect	n = 49	
			n	%
Organizational and/or management			16	33
Poor organizational arrangements of staff	3	1	4	8
Inadequate education and training	4	2	6	12
Lack of policies, protocols, or guidelines	6	7	13	27
Inadequate numbers of staff			—	—
Poor access to senior clinical staff	1	1	2	4
Failure or delay in emergency response	3	1	4	8
Delay in procedure, eg, cesarean	1	1	2	4
Inadequate systems/process for sharing clinical information between services	1	3	4	8
Delayed access to test results or inaccurate results	1		1	2
Other reason	1	1	2	4
Personnel			17	35
Knowledge and skills of staff lacking (includes failure to maintain competence)	4	4	8	10
Delayed emergency response by staff	3	2	5	10
Failure of communication between staff	3	5	8	16
Failure to seek help/supervision	2	1	3	6
Failure to offer or follow recommended best practice	1	1	2	4
Lack of recognition of complexity/seriousness of condition	3	3	6	12
Technology and equipment			1	2
Essential equipment not available			—	—
Lack of maintenance of equipment	1		1	2
Malfunction/failure of equipment			—	—
Failure/lack of information technology			—	—
Environment			3	6
Geography, eg, long-distance transfer	1		1	2
Building and design functionality limited clinical response	1	1	2	4
Barriers to accessing or engaging with care			14	29
Substance use		5	5	10
Family violence		3	3	6
Lack of recognition of complexity/seriousness of condition (by either woman or her family)		6	6	12
Maternal mental illness		1	1	2
Cultural barriers			—	—
Language barriers		1	1	2
Not eligible to access free care		1	1	2
Other, specify ^a	1	6	7	14

^a Unbooked (1), late booking (2), infrequent attendance (2), social circumstances—inability to engage in care (2).

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TABLE 4
Potential avoidability among maternal deaths with contributory factors 2006 through 2009

Case	Was death potentially avoidable?	Direct	Indirect	Contributory factors					
				No. of categories present	Organizational and/or management factors	Factors relating to personnel	Technology and equipment	Environment	Barriers to accessing or engaging with care
Case 1	Yes	Postpartum hemorrhage		3	Yes	Yes			Yes
Case 2	Yes	Preeclampsia		3	Yes	Yes			Yes
Case 3	Yes	Preeclampsia		2	Yes	Yes			
Case 4	Yes	Pulmonary embolism		2	Yes				Yes
Case 5	Yes	Postpartum hemorrhage		2	Yes	Yes			
Case 6	Yes		Suicide	3	Yes	Yes			Yes
Case 7	Yes		Preexisting medical condition	3	Yes	Yes			Yes
Case 8	Yes		Suicide	3	Yes	Yes			Yes
Case 9	Yes		Nonobstetric sepsis	3	Yes			Yes	Yes
Case 10	Yes		Suicide	3	Yes	Yes			Yes
Case 11	Yes		Nonobstetric sepsis	3	Yes	Yes			Yes
Case 12	Yes		Preexisting medical condition	2	Yes				Yes
Case 13	Yes		Suicide	2		Yes			Yes
Case 14	Yes		Preexisting medical condition	2		Yes			Yes
Case 15	Yes		Suicide	2	Yes				Yes
Case 16	Yes		Preexisting medical condition	1		Yes			
Case 17	No	Amniotic fluid embolism		3	Yes		Yes	Yes	
Case 18	No	Amniotic fluid embolism		3	Yes	Yes		Yes	
Case 19	No	Amniotic fluid embolism		1	Yes				
Case 20	No	Sepsis		1		Yes			
Case 21	No	Preeclampsia		1		Yes			
Case 22	No	Amniotic fluid embolism		1		Yes			
Case 23	No		Suicide	2	Yes				Yes
Case 24	No		Suicide	1					Yes
Case 25	No		Preexisting medical condition	1					Yes
Case 26	No		Preexisting medical condition	1		Yes			
Case 27	No		Preexisting medical condition	1					Yes
Total					17	17	1	3	17

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A further limitation is that although we have shown the assessment of potential avoidability to be reliable over time (comparing retrospective review by the

expert panel with prospective review by the working group), we have not provided definitive evidence that the tool, including its assessment of contributory

factors, can be applied reliably across different multidisciplinary groups.

International approaches were considered during the development phase

although only CMACE³ in the United Kingdom and Geller et al⁶ in the United States reported on avoidability in maternal mortality. CMACE classified 70% of direct deaths and 55% of indirect deaths as receiving substandard care in 2006 through 2008 although no description of the method of identifying or classifying substandard care is provided in the report.³ However, common themes between our report and the CMACE report include clinical knowledge and skills, failure to identify very sick women, best management of high-risk women, and improving communication. The Dutch Perinatal Audit Project identified 3 levels of substandard care; professional, organizational, and patient-related and substandard care factors were present in 32% of cases.⁴ Deviations from appropriate guidelines or best practice were used to identify substandard care, and smoking and obesity were included in the list of patient factors. Including these factors in the assessment of potential avoidability is contentious although the link with adverse outcomes is clearly established and addressing these risk factors with weight reduction and smoking cessation programs prior to and during pregnancy has been shown to improve outcomes.¹⁹ We have chosen to exclude these risk factors from our list of contributory factors and to report these comorbidities separately. We also considered the system developed by Geller et al^{6,12,13} for reporting maternal morbidity. This approach identifies contributory provider and system factors and determines preventability and has been used in 1 region in the United States. One reason for not adopting this approach was that the delivery of maternity services in the United States is very different from New Zealand where 85% of maternity care is provided by midwives. A second reason was the lack of recognition of the importance of barriers to accessing and engaging with care.

The implication of this report is that national maternal mortality review with appropriate recommendations and suggestions for implementation could improve maternity services in New Zealand as a proportion of maternal deaths could be prevented. Recommendations could

be directed at any level, eg, government, health care providers, clinicians, or to pregnant women and their families, and may include education, a change in practice or system, or development of clinical guidelines or new policies.²⁰ In the United Kingdom where evaluation of substandard care has been undertaken for 4 triennia there is a reduction in maternal deaths.³ The Dutch perinatal project was a feasibility study and the impact of this methodology on perinatal mortality rates has not yet been reported.⁴ Although there are many studies of hospital mortality review few have considered avoidability or standard of care. One example is the National Health Service Institute for Innovation and Improvement in the United Kingdom. They reported that hospitalized standardized mortality rates were reduced 2% in 1 year after causes of avoidable mortality were identified and a range of interventions were introduced.²¹

In New Zealand, suicide was the most common cause of maternal mortality and 7 of 10 suicides had contributory features and 5 of 10 were found to be potentially avoidable. Barriers to accessing and engaging care were the most common contributory factor, specifically due to the woman's mental health. Other barriers were substance abuse and family violence. Common organizational factors were lack of policies, protocols, or guidelines and inadequate systems/process for sharing of clinical information between services. Factors relating to personnel identified included knowledge and skills of staff were lacking, failure of communication between staff, and lack of recognition of complexity or seriousness of condition. In the CMACE report, family violence and substance abuse was also found to be a contributory factor in deaths from suicide. Of the women known to be involved with psychiatric services (69%), psychiatric care was found to be less than optimal. As a result of maternal mortality review, there have been recommendations for better coordination of mental health services within maternity care, greater recognition of mental health problems in pregnant women, and improved access to mother and baby units. If our approach is successful then the number of

maternal deaths from suicide will hopefully decline.

Reporting maternal mortality is an important first step in measuring the quality and safety of a maternity system. Identifying and reporting on contributory factors associated with mortality and morbidity is the next obvious step and may eventually become a more useful and meaningful measure of the safety and quality of care provided. We consider that this tool could be applied in mortality and morbidity reviews to identify where changes could be made to improve the quality of care. In the future we hope to report on the use of this tool for perinatal mortality and morbidity as well as maternal morbidity. At a national level confidential enquiry and identification of contributory factors and potentially avoidable deaths should lead to the introduction of policy changes and interventions that will contribute to clinical excellence, improve outcomes, and reduce maternal deaths. ■

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