2006

Annual Report on Asthma Deaths Among Individuals Ages 2-34 and 45-54 in Michigan

An African American preteen was on his way home from a friend's house when he collapsed. His brothers carried him home and called 911. He had breathing problems more than twice per week and his physical activity was limited all the time due to breathing problems. He was hospitalized for asthma three times in the year prior to his death. The Asthma Mortality Review Panel believed causal factors included: secondhand smoke in the home, short acting bronchodilator overuse, inadequate use and prescription of corticosteroids, need for referral for high-risk patients, lack of adult supervision, and lack of CPR knowledge by the family.

A Caucasian female in her forties had an asthma attack and died after giving the family's new shorthaired kitten a bath. She had no other medical conditions; however, her husband stated she had an undiagnosed allergy to dust and longhaired cats. She used inhaled corticosteroids regularly. The Asthma Mortality Review Panel suggested the primary causal factors were an overuse of short acting β-agonists and a lack of the patient's knowledge of allergen triggers. Other causal factors included a need for a referral to a specialist and inadequate evaluation of the severity of the patient's asthma by the primary care physician.

An African American preteen male was playing basketball outside and came into the house saying he could not breathe and felt dizzy. His father began a breathing treatment for the deceased, which did not seem to help. He became unresponsive and EMS was called. He died in the Emergency Department. Corticosteroids were not regularly used and his nebulizer was used 4-6 times per day. The Asthma Mortality Review Panel concluded the causal factors in this case were: inadequate use of corticosteroids, a need for a referral for high-risk patients, inadequate testing done for diagnosis, and lack of adult supervision.

A Hispanic male in his late forties died after having an asthma attack in the fall. His girlfriend told the hospital staff the deceased had his attack after an episode of alcohol consumption and marijuana use. The deceased's other medical conditions included diabetes, hypertension and a family history of premature coronary artery disease. Medical records stated the deceased used his Albuterol MDI six times per day. The Asthma Mortality Review Panel believed the casual factors in this case included: substance abuse, inadequate use and prescription of corticosteroids, overuse of short acting β-agonist drugs, a need for high-risk patient referral, and lack of regular medical care.

2006 Annual Report on Asthma Deaths Among Individuals in Michigan

A Joint Report

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The investigators of this project invite you to comment on this report and how you might use the information it provides by taking a brief online survey.
Please visit the following weblink to complete the survey:
http://www.surveymonkey.com/s.aspx?sm=Q8VjJ1IXbI4MMUFZkNhTAQ_3d_3d

Executive Summary

This is the fifth Annual Report of Asthma Deaths in Michigan. Although death from asthma is relatively rare (.01% of individuals with asthma), the circumstances surrounding these deaths are dramatic and are indicative of problems with asthma diagnosis and treatment among Michigan's 500,000 – 900,000 asthmatics. The deaths are particularly tragic because most are preventable. **Ninety-two percent of the 100 deaths in Michigan with sufficient autopsy information to classify the type of asthma death were of the slow onset type and therefore preventable.** The majority of the deaths were among males (57%) and African Americans (89%). They were most likely to occur among residents of Wayne County (44%). The deaths typically occurred before the individual reached the hospital. Case summaries of the deaths are in Appendix I.

The primary causal factor identified over the past five years of investigation is the lack of patient compliance with good asthma management techniques, which includes regular use of inhaled corticosteroids rather than dependence on short acting β-agonists and elimination of asthma triggers such as cigarette smoke and pets. Major deficiencies were noted in asthma management by health care providers, including poor appreciation of the severity of the patient's condition and risk of future adverse events as indicated by a lack of timely referral to a specialist and inadequate prescription of inhaled corticosteroids. The low percentage of decedents with asthma action plans (only 23%) would suggest that more can be done by the health care system to provide information to patients to better manage their asthma. Particular recommendations were made for:

- Provider education on asthma risk and control, including the importance of the prescription of adequate levels of inhaled corticosteroids. This education should reach health care providers in all sectors including primary, urgent care and emergency departments.
- Public and patient education that emphasizes the chronic and potentially fatal nature of asthma and the importance of the use of inhaled corticosteroids.
- Case Management for high-risk patients (patients with an Emergency Department (ED) visit and/or a hospitalization for asthma and/or daily use of a short acting ß-agonist). This includes case management for children with asthma where lack of adequate parental supervision is a problem and adults with psychiatric problems.
- Pharmacy notification to health care providers for patients who repeatedly fill short acting β-agonist prescriptions and/or do not fill controller medication prescriptions for inhaled corticosteroids.
- Consider policies limiting the number of short acting β-agonist refills allowed without a new prescription or communication with the health care provider.
- Provision of more comprehensive asthma care in the ED setting that stops the cycle of repeated treatment of acute episodes. This should include prescription of inhaled corticosteroids at discharge and a system for assuring that patients see a primary care provider for follow-up.
- Referral to specialists for patients with a hospitalization or ED visit for asthma or who use short acting ß-agonists daily.
- Need for health insurance including coverage of medication costs for adults with asthma (not an issue in children).

In-depth investigations of the child asthma deaths in 2006 were again undertaken for children 2-18 years of age. In-depth investigations of adult asthma deaths were changed from 19-34 years of age in previous years to 45-54 years of age for 2006, in order to investigate the race disparity previously noted among this age group over the past few years. In recent years, the asthma mortality rate for African Americans compared to Caucasians ranged from two to nine times higher among adults in the 45-54 year age category. In 2006, the race disparity for African-Americans was not found in this age group. Eleven of the 14 deaths in this age category were Caucasian. As asthma deaths among the 45-54 year old group were reviewed, the expert panel noted that 7 of the 14 and potentially as many as 9 of the 14 deaths in the 45-54 age category coded as asthma deaths were felt by the review panel to be primarily caused by something other than asthma. For deaths occurring in 2007 we have continued to conduct in-depth investigations in the 45-54 year age group as well as among children. We are not planning to continue in-depth investigations in the 45-54 year old age group in 2008.

Table of Contents

Background

In response to a request for a proposal from the Centers for Disease Control and Prevention (CDC), the Michigan Department of Community Health (MDCH) in conjunction with Michigan State University (MSU) successfully competed to obtain funds to develop a rapid asthma death notification and investigation system for the State of Michigan. At the request of the CDC, this system was limited to investigations of asthma deaths among children and young adults ages 2-34 in the first four years of the project 2002-2005. CDC selected this age group because of the increased likelihood that deaths ascribed to asthma among 2-34 year olds were truly caused by asthma. For individuals younger than two years or older than 34 years the number of other medical conditions that may present with symptoms similar to asthma increases.

In 2006, in-depth investigations for asthma deaths among 2-18 year olds continued, the focus for in-depth investigations of adult asthma deaths changed to 45-54 year olds, and a less intensive review of asthma deaths in all other age groups was added. The age group 45-54 was selected because a marked disparity in African American deaths was noted in this age group. A review of all other asthma deaths was added to address concerns that only 20% of the asthma deaths were being intensively investigated, and that important information was being overlooked by not reviewing the remaining 80% of asthma deaths. This report summarizes the first five years of investigations that cover asthma deaths occurring between January 1, 2002 and December 31, 2006.

Mortality from asthma in the United States has increased two-fold since the 1970's [1,2]; although recent data suggest the asthma mortality rate has stabilized [3]. Over-use of β-agonists [4,5] and under-use of inhaled corticosteroids[6-8] have been associated with increased asthma mortality. Smoking, drinking, substance abuse[9] and family problems have been associated with increased asthma mortality, while the use of peak flow meters and a written asthma action plan have been associated with decreased asthma mortality[10]. Fatal asthma has also been associated with specific work exposures [11].

Mortality is not evenly distributed across the population. Studies have shown high rates of asthma mortality among African Americans, low-income populations and populations with low educational levels[12]. Reasons suggested for the racial disparity include differential access to care, exposure to environmental pollutants[13], and crowded conditions leading to increased exposure to allergens and infections[14].

The asthma mortality rate in Michigan is lower than the rate for the United States (11.8 and 12.8 per million, respectively). Age specific asthma mortality rates in Michigan are higher than the rates for the United States among those 5-14 years and 15-34 years of age. Overall, asthma mortality rates in Michigan have declined significantly between 2000 and 2006. A decrease was observed for all age groups except children 5-14 years. The mortality rate in Michigan for asthma in African Americans of all ages (26.6 per million) was almost three times that of Caucasians (9.2 per million) in 2006. Asthma mortality rates for 15-34 and 35-64 year age groups were over four times higher among African Americans compared to Caucasians.

In Michigan, from 1990 to 2006, there were a total of 2,836 deaths where asthma was the underlying cause of death; 463 occurred among the 2-34 year age group and 384 among the 45-

54 year age group. The annual number of deaths in the 2-34 year age group has ranged from 15-39 deaths per year. Asthma deaths in the 2-34 year age group were almost equally distributed between males (246, 53%) and females (217, 47%). Two hundred sixty four (57%) of the deaths were among African Americans and 194 (42%) were among Caucasians. From 1990-2006, there have been 14-38 deaths annually among the 45-54 year age group. For the 45-54 year olds, the distribution between men and women was 129 (34%) males and 255 (66%) females; and 155 (40%) for African American and 223 (58%) for Caucasians.

Asthma deaths in Michigan were not evenly distributed throughout the year. The highest number of deaths is observed in the fall and winter for children and young adults.

Asthma deaths are preventable. Successful disease management techniques are available to provide good control over asthma symptoms and a high quality of life. However, failure to maintain control over the disease results in a higher risk of mortality. Investigation of the reasons why people are not able to obtain and maintain good control allows us to identify preventable risk factors for asthma mortality and recommend ways to address these factors. Interventions that reduce these risk factors can prevent future deaths as well as improve management for all people with asthma.

Methods

Notification of Asthma Deaths: Death Certificates

Division of Health Statistics and Vital Records (DHSVR) staff at MDCH entered information from the death certificate into the master electronic file on a quarterly basis, at which time they provided MDCH asthma staff with a transcript of information on all deaths with asthma as the underlying cause of death. The DHSVR transcript contained a limited set of data from the death certificate, including name, address, date of death, date of birth, sex, county of death, and county of residence. Based on this information, MDCH asthma staff identified asthma deaths that met the study criteria:

- Asthma as underlying cause of death (ICD-10 codes J45 or J46)
- Michigan resident and death occurred in Michigan

Staff requested an administrative copy of the death certificates for deaths meeting these criteria.

Data Collection

Upon receipt of the death certificate, a letter was sent to the next-of-kin listed to explain the project and to request an interview. This letter was sent to the next-of-kin of individuals 2-34 years who died from 2002-2005 and for individuals 2-18 and 45-54 years who died in 2006. Interviews were conducted with the next-of-kin using a standardized questionnaire. All medical records from the year prior to death, pharmacy records, and, if applicable, emergency response records, medical examiner records and the autopsy report were requested and reviewed. Since 2004, enrollment, health care, and pharmacy utilization records for decedents enrolled in Medicaid programs were acquired from the MDCH Data Warehouse as a means to identify

medical records; this was especially helpful for the deaths where next-of-kin were not available for interview. After an interview with the next-of-kin was attempted or completed and after available records were reviewed, a one to two page summary of the circumstances surrounding the death for each of the individuals was prepared. In addition to the overall summary, a one-page summary was prepared of each the medical records and autopsy reports reviewed.

For asthma deaths in 2006 among those aged 19-44 and 55 or older, who did not have an in-depth investigation, medical records from the day of death, the medical examiner records and if performed the autopsy report were requested.

Expert Panel Review

Two expert panels were convened: one for adults (reviewing deaths among individuals 19-34 years old in 2002-2005 and ages 45-54 in 2006), and one for children (reviewing deaths for individuals aged 2-18 years). The advisory panels included allergists, asthma educators, ED physicians, family practitioners, internists, nurses, pediatricians, pharmacists, pulmonologists, respiratory therapists, managed care organization medical directors, and social workers. Members of the two panels are listed in Appendix II. Summaries of the data collected were shared with the appropriate advisory panels.

The Adult Mortality Review Panel and the Child Mortality Review Panel each met once to review completed investigations of the 2006 asthma deaths. The advisory panels reviewed the summary materials for individual deaths and were asked to list causal factors and follow-up preventive activities that were suggested by each death. These conclusions are described in the results section.

All medical records have been maintained in a confidential manner. Summaries shared with the advisory panels did not include personal identifiers for the individual who died, their next-of-kin, health care providers, health care systems or insurers. Both the MDCH Human Subjects Committee and the MSU Human Subjects Review Board reviewed this project. The MDCH Human Subjects Committee determined that this project was a surveillance activity and not human research. The MSU Human Subjects Review Board approved the project as human research. To provide further assurance of confidentiality this project was designated a Medical Research Project by the MDCH Chief Medical Executive under the provisions of MCL 333-2631-2635. This designation safeguards the confidential character of research studies conducted by MDCH and provides protection from release of the identifiable asthma mortality review materials for any purpose other than the research project.

Medical records for 2006 asthma deaths in all other age groups were reviewed by a physician who is board certified in internal and preventive medicine. He reviewed the death certificate, medical records from the day of death and an autopsy report when available. Based on this information he reached a conclusion on whether the death was more likely than not secondary to asthma.

Results

Information from Death Certificates

During the five-year study period, there were a total of 673 deaths where asthma was the underlying cause for all ages, with 151 in 2002, 133 in 2003, 134 in 2004, 135 in 2005, and 120 in 2006. One hundred thirty-eight (20.5%) of these deaths were among individuals age 2-34 years and 88 deaths (13.1%) were between the ages 45-54. The total number of deaths per year and age group are reported in Table 1.

Table 1. All Asthma Deaths and Deaths Eligible for In-Depth Study Review, Michigan 2002–2006

	2002	2003	2004	2005	2006	2002-2006
Asthma deaths (all ages)	151	133	134	135	120	673
Study Total	32 (21%)	27 (20%)	29 (22%)	25 (19%)	26 (22%)	139 (21%)
Children 2-18	12*	11*	15*	10*	12*	60
Adults 19-34	20*	16*	14*	15*	13	78
Adults 45-54	20	16	19	19	14*	88
Adults 55+	99	90	86	91	81	447

* Indicates deaths that were part of the in-depth study.

Five asthma deaths occurred to Michigan residents who were out-of-state at the time of death, two in 2004, one in 2005, and two in 2006. Death certificates for these deaths were not obtained. Information for the five out-of-state deaths is included in Tables 1 and 2 and Figure 1 but nowhere else in the report.

The summary of data on asthma deaths among 19-34 year olds from 2001-2005 is presented in the 2005 Annual Report, which is available at www.oem.msu.edu and www.getasthmahelp.org.

Table 2 summarizes the sociodemographic information obtained from the death certificates of the 139 asthma deaths that had an in-depth investigation.

Table 2. Sociodemographic Characteristics of Asthma Deaths, Ages 2-18 (2002-2006), 19-34 (2002-2005), and 45-54 (2006), Michigan

	Children 2002-2006 (2-18 years)	Adults 2002-2005 (19-34 years)	Adults 2006 (45-54 years)	Total 2002-2006
Number of Asthma Deaths	60 (43%)	65 (47%)	14 (10%)	139
Average Age (years)	12.4	27.5	49	-
Sex				
Male	60.0%	58.5%	42.9%	59.0%
Female	40.0%	41.5%	57.1%	41.0%
Race/Ethnicity				
Caucasian, Non-Hispanic	15.0%	47.6%	78.6%	36.7%
African American	80.0%	49.2%	14.3%	59.0%
Other Reported	5.0%	3.2%	7.1%	4.3%
Education Completed				
College Graduate (4 year Degree)	0%	1.6%	14.3%	2.2%
Some College	1.7%	29.7%	0%	14.5%
High School Graduate	3.3%	46.8%	50.0%	28.2%
Grades 6-11	58.3%	20.3%	21.4%	37.0%
Grades 5 and less	36.7%	1.6%	14.3%	18.1%
Place of Death (Pronounced)				
Hospital	91.7%	72.3%	71.4%	80.6%
Home	8.3%	24.6%	28.6%	18.0%
Vehicle	0%	3.1%	0%	1.4%
Autopsied	76.7%	80.0%	35.7%	74.1%

Age

The average age of children who died in 2002-2006 was 12.4 years (range: 2-18 years). The average age of adults ages 45-54 who died in 2006 was 49, (range 45-54).

Gender

Thirty-six (60%) of the children who died were males and 24 (40%) were females (1.4 times as many males). In 2006 there were six (42.9%) males and eight females (57.1%) ages 45-54 (1.3 times as many females).

Race/Ethnicity

Forty-eight (80%) children who died were African American, while only nine (15%) were Caucasian. The remaining three deaths were reported to be Mexican-American or Asian/Bangladeshi on the death certificate.

For adult's ages 45-54 in 2006, eleven (78.6%) were Caucasian, two (14.3%) were African American and one was Hispanic.

The age group 45-54 was selected in 2006 for in depth review, because in recent years there had been a marked African American/Caucasian disparity in this age group with mortality rates two

to nine times higher among African Americans than Caucasians. In 2006, the disparity in this age group did not occur.

Education
Of the 14 adults ages 45-54 in 2006 in the study, two (14.3%) had completed a four-year college degree, seven (50%) completed high school, three (21.4%) completed grades 6 to 11, and two (14.3%) did not complete any school.

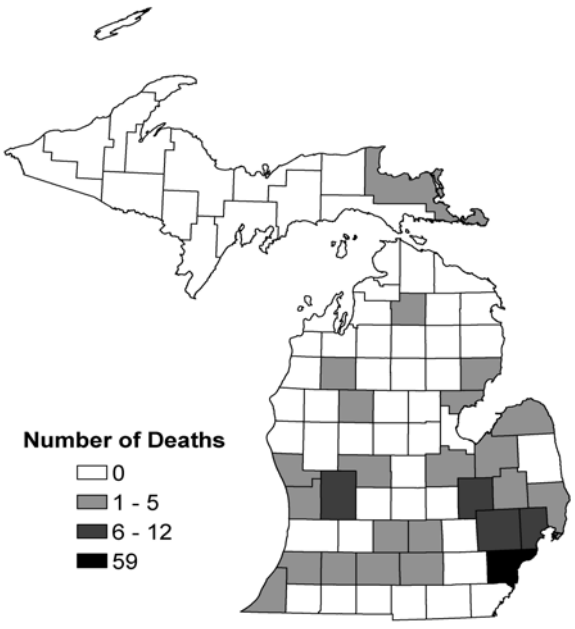
Place of Death
The place of death listed in Table 2 reflects where the 139 people were pronounced dead, not where their fatal asthma attack occurred.

In 2006, 10 adults ages 45-54 were pronounced dead in the hospital. Five of the 10 hospital asthma deaths were non-responsive and in code status when the individual reached the hospital. Of the five who were awake in the ED, all five died after being admitted to the hospital. Four deaths listed home and 10 listed hospital as the "actual place of death".

Of the 56 children who were pronounced dead in a hospital, the death certificate for three of these children indicated that their home was the "actual place of death". All but two of these 51 children were non-responsive and in code status on arrival to the ED. Of the two who were awake in the ED, one child died after being admitted to the hospital and the other died in transport to another hospital. The "actual place of death" listed on the death certificate for all 60 children were 53 hospital deaths and 7 home deaths.

Autopsy
Seventy-seven percent of the children were autopsied but only 36% of adults 45-54 years of age were autopsied. In comparison, 52 (80%) adults ages 19-34 in the years 2002-2005 were autopsied. The presence of mucus plugging has been used to distinguish asthma deaths with slow onset from sudden onset. Of the 103 deaths from 2002-2006 with autopsies, 92 (89.3%) showed mucus plugging in their bronchi, eight (7.8%) had empty/dry bronchi, for one (1 %) individual the autopsy report did not address the airways and for two (1.9%) of the out-of-state deaths, the autopsies were not available. If one uses the presence of mucus plugging to characterize a death as slow onset versus the absence of mucus plugs as sudden onset of severe airway closure, then 92 of 100 (92%) would be characterized as slow onset versus 8 of 100 (8%) as sudden onset.

Figure 1. Asthma Study Deaths by County of Residence, Michigan, 2002-2006



Location in State
Wayne County was the most common residence of the deceased (59) (Figure 1). There were four counties that had between six and 12 deaths (Genesee, Kent, Macomb, and Oakland). Twenty-one counties had between one and five deaths (Arenac, Berrien, Calhoun, Chippewa, Eaton, Huron, Ingham, Iosco, Jackson, Kalamazoo, Lapeer, Montcalm, Muskegon, Osceola, Otsego, Ottawa, Saginaw, Saint Clair, Tuscola, Van Buren, and Wexford).

Occupation/Industry
Table 3 lists the most common occupations of adults ages 45-54 in 2006 as homemaker/disabled. The most common occupations listed on the death certificates for adults ages 19-34 were laborer and homemaker/unemployed/disabled. The most common industries listed on the death certificates of these adults were automotive, healthcare industry, manufacturing, and education.

Table 3. Occupation and Industry of Adult Asthma Deaths Ages 45-54, Michigan, 2006

Number	Occupation	Industry
4	At Home - Homemaker/disabled	
10	Avian Specialist; Hammerman; Groundsman; Installer; Mechanic; Nurse; Office Manager; Packager; Waitress; Warehouse	Retail; Manufacturing; Auto Repair; Private Estate; Entrepreneur; Nursery; Technicolor; Restaurant; Healthcare (2)

Day of Death Medical Record Information and Autopsy Results, When Available, for Asthma Deaths Ages 2 and Greater

Review of medical records from the day of death and available autopsy reports found that 68% of all the 2006 deaths coded with asthma as the underlying cause of death seemed consistent with that determination. The percentage differed by age, ranging from 100% among 2-18 year olds to 23% among those 85 years or older (Table 4). Table 5 lists the conditions more likely to be the cause of death among the 32% of deaths that were indeterminate for asthma as the underlying cause of death. The overall autopsy rate was 29%. The percentage autopsied differed by age, ranging from 92% among children to 0% among deaths of individuals age 75 years or older. Both autopsy reports and medical records from the day of death were important elements in the determination of cause of death. Autopsy reports helped to confirm whether an individual had asthma or a different medical condition that caused the death. The clinical information preceding the death was also important since a decedent could have asthma (identified through the medical records) without the death certificate indicating an acute asthma episode. The medical information available on the more elderly decedents was limited. Additional information might have changed the classification. However, the less intensive review of asthma deaths in all other age groups proved useful in documenting inaccuracies in the recording and coding of cases of asthma as the underlying cause of death on death certificates and reinforced the importance of conducting intensive investigations for children and young adults

Table 4. Review of Deaths Coded with Asthma as Cause of Death (10th ICD J45 or J46), Michigan 2006

Age Group(Years)	Deaths	Autopsies		Asthma Related Death Based on Medical Records and Autopsy Results		
	#	#	%		#	%
2-18	12	11	92	Yes	12	100
				No	0	--
19-34	13	9	69	Yes	11	85
				No	2	15
35-44	12	6	50	Yes	9	75
				No	2	17
				Indeterminate	1	8
45-54	14	5	36	Yes	7	50
				No	7	50
55-64	15	2	13	Yes	12	80
				No	3	20
65-74	13	1	8	Yes	9	69
				No	3	23
				Indeterminate	1	8
75-84	26	0	--	Yes	17	65
				No	9	35
85+	13	0	--	Yes	3	23
				No	10	77
Total	118	34	29	Yes	80	68
				No	36	30
				Indeterminate	2	2

Table 5. More Likely Cause of Death Among Individuals Originally Coded as an Asthma Death, Michigan 2006

Age Group (Years)	More Likely Cause of Death
19-34	PneumoniaPneumonia/Opiates
35-44	Acute Pulmonary Edema Cardiac Disease
45-54	Congestive Heart Failure Cardiac Disease (2) Lupus Erythematosus Pulmonary Hemorrhage COPD Cerebral Palsy/Seizure Disorder
55-64	Esophageal Cancer Lung Cancer Pneumonia
65+	Sudden Cardiac Death Pulmonary Embolism COPD/Dementia Aspiration Pneumonia S/P Surgery COPD Pneumonia (3) COPD/Pneumonia Congestive Heart Failure (3) Cerebrovascular Accident Cardiac Arrhythmia Alzheimers Dementia Small Bowel Obstruction

Asthma Death Review Process: In-Depth Investigations Completed for Ages 2-18, 2002-2006 and Ages 45-54, 2006

The average time between the death occurring in Michigan and project staff being notified to commence an investigation was 108 days in 2002, 125 days in 2003, 197 days in 2004, 135 days in 2005 and 119 days in 2006. The increase in time to notification in 2004 was secondary to equipment issues in Vital Statistics.

Among the 26 asthma deaths ages 2-18 and 45-54 from 2006 in Michigan, the major difficulty in completing the next-of-kin interviews involved locating the next-of-kin. We were unable to locate four next-of-kin (one adult and three child deaths) and three next-of-kin refused to participate (two adult and one child death).

At least partial medical records were obtained for all of the decedents in 2006 in the age groups with in-depth investigations. The Michigan Medicaid utilization data allowed for the identification of additional medical records for the deceased who had Medicaid whether or not they had a next-of-kin interview. See Table 6 for additional information on the investigations.

Table 6. Asthma Mortality Investigations, Ages 2-18 (2002-2006), 19-34 (2002-2005) and 45-54 (2006), Michigan

	Children (2002-2006) 2-18	Adults (2002-2005) 19-34	Adults (2006) 45-54
Deaths Eligible for Review	59	63	14
Unable to Locate Next-of-Kin	14 (23.7%)	7 (11.1%)	1 (7.1%)
Next-of-Kin Refused Interview	8 (13.6%)	6 (9.5%)	2 (14.3%)
Interviews Completed	37 (62.7%)	50 (79.4%)	11 (78.6%)

Information from Data Collection

The following discussion includes all children from 2002-2006 and adults ages 45-54 in 2006.

The denominators for the different risk factors listed below vary due to the availability of records or whether all of the next-of-kin interviews were completed. After each percentage is the number with a positive response and the denominator for that factor. Table 7 summarizes the risk factors.

Insurance
As determined from the medical record review and next-of-kin interview, 96% (53 of 55) of children and 100% (14 of 14) of adults ages 45-54 from 2006 where insurance status was known had medical insurance.

As determined from querying Medicaid enrollment files, 80% (47 of 59) of children, 56% (35 of 63) of adults 19-34 years old (2002-2005), and 71% (10 of 14) of adults 45-54 years old (2006) were enrolled in Medicaid at some time during their life. At the time of their death, 71% (42 of 59) of children, 41% (26 of 63) of adults ages 19-34 (2002-2005), and 50% (7 of 14) of adults ages 45-54 (2006) were enrolled in Medicaid.

Among the sixty-seven individuals with medical insurance where information about co-payment was known, 87% (33 of 38) had co-pays of $10 or less, one had a 10% co-pay, one had $15-20 co-pay, two had a $20 co-pay, and one had an 80% co-pay. Six percent (2 of 36) of the children's next-of-kin or health care providers mentioned that co-pays or cost of referrals for specialists and testing interfered with the patient's management (one had a 20% co-pay, one co-pay was unknown).

Co-morbidities
Ninety-two percent (12 of 13) of adults ages 45-54 and 36% (19 of 53) of children were reported to have one or more co-morbid medical conditions, such as Down's Syndrome, Crohn's disease, diabetes, hypertension, cerebral palsy, spinal muscular atrophy, hypoxic encephalopathy, mental

retardation or seizures which complicated their asthma management. Another five had a psychiatric condition, such as major depression, bipolar disease or schizophrenia; this accounted for 4% (2 of 46) of children and 25% (3 of 12) of adults ages 45-54.

Substance Abuse
Forty-six of 59 (78%) children and 5 of 14 (36%) of adults were autopsied. Of the available toxicology reports, one adult and two children tested positive for illicit drug use at autopsy. The adult tested positive for cocaine and alcohol and both children tested positive for marijuana. Substance abuse issues were mentioned by the next-of-kin or a health care provider in 46% of the adult deaths (6 of 13), and 2% of the child deaths (1 of 45). One adult and one child who were positive for illicit drugs also had their next-of-kin mention substance abuse during the interview.

Family Dysfunction
There appeared to be a lack of parental supervision or family dysfunction that interfered with asthma management in 25% (10 of 40) of the child deaths. Examples of family dysfunction include: psychological disorder, alcohol/drug abuse, incarceration among caregiver/parents or caregiver/parents not around, parental dysfunction noted in the medical record, and involvement of child protective services.

Triggers
Sixty-nine percent (9 of 13) of adults 45-54 years old who died of asthma were current cigarette smokers. The proportion of current smokers in this age group was 2.6 times greater than the percentage of smokers in the general population 26.3% (95% CI 23.6-29.3)[15]. Of the adults ages 45-54 who did not smoke, 26% were exposed to secondhand smoke at home. Forty-six percent (19 of 41) of the deceased children lived with a cigarette smoker and 12% (5 of 42) of the deceased children smoked. Forty-seven percent (18 of 38) of children and 67% (6 of 9) of adults ages 45-54 had dogs and/or cats living in their homes at the time of their death.

Routine Asthma Management
About 71% (34 of 48) of children and 85% (11 of 13) of adults were taking an inhaled or oral corticosteroid. Of those who were taking corticosteroids, about 40% (19 of 48) of children and 38% (5 of 13) of adults were taking only inhaled corticosteroids; and 8% (4 of 48) of children and 23% (3 of 13) of adults were taking only oral corticosteroids. Twenty-three percent (11 of 48) of children and 23% (3 of 13) of adults were taking both inhaled and oral corticosteroids.

Other aspects of lifetime medical care included:

- ***Allergist Care:*** 0% of adults ages 45-54 and 64% (23 of 36) of children had ever seen an allergist during their lifetime.
- ***Pulmonologist Care:*** 70% (7 of 10) of adults ages 45-54 and 49% (18 of 37) of children had ever seen a pulmonologist.
- ***Combined Specialist Care:*** 0% of adults ages 45-54 and 64% (14 of 22) of children had seen both an allergist and pulmonologist; 27% (3 of 11) of adults ages 45-54 and 28% (11 of 40) of children had seen neither an allergist nor a pulmonologist during their lifetime. The remaining 73% of both adults ages 45-54 and children had seen either a pulmonologist or an allergist. National guidelines contain recommendations for when

patients should be seen by a specialist [16]; the majority of these patients met one of the criteria in the year prior to their death.

- ***Pulmonary Function Testing:*** 55% of children and 56% of adults 45-54 years old had ever had pulmonary function testing that included at least spirometry during their lifetime. It is recommended that spirometry be used to aid in the management of asthma after treatment is initiated and symptoms have stabilized to document "normal" airway function, and at least every 1 to 2 years to assess the maintenance of airway function[16].
- ***Peak Flow Meter:*** 73% (29 of 40) of children and 33% (3 of 9) of adults ages 45-54 owned a peak flow meter (only sixteen of the children and none of the adults with a peak flow meter used it regularly per next-of-kin reporting).
- ***Asthma Action Plan:*** None of the adults ages 45-54 and 33% (13 of 40) of the children had an asthma management plan.

Urgent Asthma Management

Fifty-six percent (5 of 9) of adults and 27% (11 of 41) of children had a history of prior intubation in their lifetime. Eighty-four percent (37 of 44) of children and 73% (8 of 11) of adults ages 45-54 had been previously admitted to the hospital for respiratory problems, including 52% and 45%, respectively, in the year prior to death. Eighty-six percent (36 of 42) of children and 91% (10 of 11) of adults had an ED visit for respiratory problems in their lifetime, including 68% and 73%, respectively, in the year prior to death.

Obesity

At the time of their death, 64% (9 of 14) of adults were considered obese, with a body mass index (BMI) of 30 or greater. None of the adults were considered overweight (BMI of 25 to 29). The prevalence of obesity among the deceased adults was 1.99 times higher than that for the general adult population of Michigan. According to the 2006 Michigan Behavioral Risk Factor Survey, 32.1% (95% CI 29.0-35.3) of 45-54 year olds are obese[15].

The percentage of children considered obese (BMI-for-age of 95th percentile or greater) at the time of death was higher than expected compared to national data. Thirty-two percent (18 of 57) of the children had a BMI that was at the 95th percentile or greater for their age, 21% (12 of 57) were in the 85th to 94th percentile and 47% (27 of 57) were less than the 85th percentile. The BMI of two children was unknown. Weight status data for the general population of Michigan children is not available. Nineteen percent of U.S. children 6-11 years and 17% of U.S. children 12-19 years have a BMI at the 95th percentile or greater for their age[17].

Table 7. Asthma Management Characteristics, Ages 2-18 (2002-2006), 19-34 (2002-2005) and 45-54 (2006), Michigan

	Children 2-18 (2002-2006)	Adults 19-34 (2002-2005)	Adults 45-54 (2006)	Total
Insurance Status				
Deceased Had Some Form of Health Insurance	96%	79%	100%	89%
Insurance Had Co-Pays	30%	56%	29%	42%
Co-pay Mentioned as Reason for Not Filling Medication, Seeing Specialist, or Getting Tests	6%	6%	38%	9%
Deceased Had Co-Morbid Condition	37%	45%	92%	46%
Deceased Had Psychological Illness	4%	19%	25%	14%
Significant Substance Abuse Noted	2%	29%	46%	20%
Family Dysfunction	25%	12%	11%	17%
Exposure to Triggers				
Current Smoker	12%	43%	69%	35%
Smoker in the Home	46%	57%	64%	54%
Pets in the Home	47%	60%	67%	55%
Routine Asthma Management				
Taking Only Inhaled Corticosteroids	40%	35%	38%	37%
Taking Only Oral Corticosteroids	8%	14%	23%	13%
Taking Both Inhaled and Oral Corticosteroids	23%	14%	23%	19%
No Corticosteroids	29%	37%	15%	31%
Seen by Specialist	73%	65%	73%	69%
Seen by Allergist	64%	52%	0%	52%
Seen by Pulmonologist	49%	44%	70%	47%
Ever Had Pulmonary Function Testing	55%	52%	56%	54%
Had a Peak Flow Meter	73%	56%	33%	61%
Regularly Used Peak Flow Meter	62%	8%	0%	37%
Had a Nebulizer	84%	71%	77%	77%
Asthma Management Plan	33%	9%	0%	23%
Urgent Asthma Management				
Prior History of Intubation	27%	34%	56%	33%
Previously Hospitalized for Asthma in Lifetime	84%	64%	73%	73%
Hospitalized in Year Prior to Death	52%	45%	45%	48%
Previous ED Visits for Asthma in Lifetime	86%	88%	91%	87%
ED Visit in Year Prior to Death	68%	68%	73%	69%
Average Number (range) of Asthma ED Visits In Year Prior to Death	3 (1-8)	7.3(1-52)	3.3 (1-10)	5.1 (1-52)

Weight				
Children 2-18		***Adults***	***19-35***	***45-54***
$\geq$ 95 percentile	32%	Obese (BMI 30+)	47%	64%
$\geq$ 85-94th percentile	21%	Overweight (BMI 25-29)	24%	0%
< 85th percentile	47%	Not Overweight (BMI<25)	29%	36%

Weight status among the deceased children and adults did not vary significantly by race. Among African American children, 37% (14 of 38) had a BMI that was at the 95th percentile or greater versus 38% (3 of 8) of Caucasian children. Among African American adults, 53% (16 of 30) had a BMI of 30 or greater versus 55% (12 of 22) of Caucasian adults.

Asthma Death Review Findings: Causal Factors

Causal factors may include: patient-related factors (such as adherence to prescribed medication regimen, trigger avoidance, and the need for patient education); physician-related factors (such as the need for education or changes in practice behavior); and system-related factors (such as lack of health care, need for changes in health care provision, or asthma management provisions in foster care systems). Table 8 provides causal factors identified for the 14 adult asthma deaths reviewed in 2006. Table 9 provides causal factors for the 59 child deaths reviewed from 2002-2006.

Adults:
The most frequent causal factors for adult deaths 45-54 years of age cited by the panel were:

1. *Compliance issues, such as following advice to eliminate asthma triggers and using prescribed corticosteroids.*

2. *The need for a specialist referral for high-risk patients.*

3. *The inadequate prescription of corticosteroids by health care providers.*

4. *Lack of regular medical care with a primary care physician, and a lack of health insurance.*

Children:
The most frequent causal factors for asthma deaths in children were:

1. *Inadequate use of corticosteroids and over-use of short acting β-agonists, including the improper use of a home nebulizer*[18].

2. *Compliance issues such as lack of elimination of triggers.*

3. *The need for specialist referral for high-risk patients.*

4. *The inadequate prescription of corticosteroids by health care providers.*

5. *Lack of adequate adult supervision and regular maintenance health care visits.*

Table 8. Causal Factors for Asthma Mortality, Ages 45-54, Michigan, 2006

Factor	Number of Deaths*
Patient-Related Factors	
Inadequate Use of Corticosteroids/Over-use of Short Acting β-agonists	5
Compliance	4
Drug Abuse	2
Depression/Psychiatric Disorder	1
Obesity	1
Lack of Knowledge about Allergen Triggers	1
Physician-Related Factors	
Needed Referral or Inadequate Diagnosis for High-Risk Patients	6
Inadequate Prescription of Corticosteroids	4
System-Related Factors	
Lack of Regular Medical Care	4
Lack of Health Insurance	3

*Multiple causal factors are possible for each of the seven deaths the expert review panel determined were truly caused by an asthma attack; the expert review panel did not consider the other seven deaths to be caused by asthma.

Table 9. Causal Factors for Asthma Mortality, Ages 2-18, Michigan, 2002-2006

Causal Factor	Number of Deaths*
Patient–Related Factors	
Inadequate use of Corticosteroids/Over-use of Short Acting β-agonists	30
Compliance: Trigger Avoidance; Pets; Referral to Specialist	27
Co-Morbid Conditions	5
Inadequate Appreciation of Severity	3
Aspirin Sensitivity	1
Physician-Related Factors	
Needed Referral or Inadequate Diagnosis for High-Risk Patients	23
Inadequate Prescription of Corticosteroids/Over Prescription Bronchodilator	14
Need to have Nurse Visit Home	1
System-Related Factors	
Lack of Adequate Adult Supervision	18
No Regular Maintenance Health Care Visits	10
Repeated Refill of Bronchodilators	5
Psycho Social and Psychiatric Issues	4
Lack of Knowledge of CPR by Family Members	2
Delay on EMS Response	1
Lack of Insurance to Cover Medication	1

*Multiple causal factors are possible for each of the 59 deaths.

Other Issues Raised During the Death Reviews

The absence of deaths related to certain risk factors was also an important finding. There were only three asthma deaths that the panel felt were related to care received for the fatal attack in the Emergency Department. There were seven asthma deaths where illegal drug usage may have been a factor in compliance but none in which it was related to the immediate cause of death. Although peak flows meters were available but rarely used by the deceased, the lack of regular use of peak flow meters was felt by both the child and adult advisory panels to be symptomatic of more important health care management deficiencies rather than a direct causal factor. Both the adult and child advisory panels felt that it was more important to put emphasis on steroid use rather than peak flow usage.

The expert panels questioned whether the death was caused by asthma in eleven of the 26 cases with in-depth reviews in 2006. This was particularly true among the adults ages 45-54 where the panel questioned whether as many as nine of the deaths were secondary to asthma. Some of this difference has to do with whether medical examiners are provided sufficient clinical information that would allow them to accurately record the cause of death. The expert panels had medical records from the year prior to death. Additionally, panel members questioned whether, under certain circumstances, the federal algorithm developed by the National Center for Health Statistics that is used to code the cause of death will code a death as asthma when asthma is only listed on the death certificate as "other significant conditions contributing to the death" but not in the causal chain of events/conditions.

A large percentage of the adults and children who died were obese, 64% and 32% respectively. These percentages are greater than those found in the general population, 32% for 45-54 year-old adults[15] and 16% in children[17]. There has been some disagreement in the medical literature over whether obesity is a consequence of decreased physical activity among people with asthma and not a risk factor for asthma[19] and/or whether the increase in asthma symptoms reported by obese individuals is truly asthma or is a consequence of misdiagnosis of asthma among obese individuals[20]. Mechanisms for obesity that adversely affect respiratory function have been described but further longitudinal studies are needed to better understand the cause of the association[21].

Asthma Death Review Panel Recommendations

Adults

The major issue for adult deaths in the 45-54 year old group was the need to ensure that cause of death was more accurately recorded on the death certificate. The fact that the autopsy rate was 36% in adults 45-54 years old in comparison to 69% among younger adults ages 19-34 contributed to the difficulty in ensuring an accurate cause of death.

Suggested interventions involved education on the prescription and use of corticosteroids for both health care providers and patients (see Table 10) and education of health care providers on the need to refer high-risk patients to specialists.

The need for case managers for high-risk patients was also recognized. Active case management for individuals with repeated hospitalizations and emergency department visits is needed. A

mechanism to provide case management is needed, including home visits even for patients who are not compliant with physician visits. Case management currently provided to patients generally involves patients who keep appointments for routine health care visits and is not provided to less compliant patients.

A system level change suggested by the expert panels was to include a mechanism to prompt health care providers to reassess the medication regime. An example of a system level change would be pharmacy notification to health care providers of patients who frequently fill β-agonist prescriptions, or restricting the patient from refilling β-agonist prescriptions after a certain number of refills have been given. The overuse of inhaled β-agonists was intertwined with the under-use of inhaled corticosteroids; it should be noted that we were not able to separate these closely related factors.

Education to improve patient compliance with the regular use of inhaled steroids and eliminating triggers was a high priority. The low percentage of deceased asthmatics with written asthma management plans supported the review boards' conclusion that patient education and coordination of care are areas where significant improvement could be made.

Table 10. Recommended Interventions for Asthma Mortality for Adults Ages 45-54, Michigan, 2006

Recommendation	Number of Deaths
Educate Health Care Providers	
Need to Refer High-Risk Patients to Specialists	5
Need for Inhaled Corticosteroids	4
Need for Pulmonary Function Tests	3
Educate Patients	
General Asthma Education and Need for Regular Care	7
Need to Use Corticosteroids	5
Smoking Cessation	1
System Level Changes	
Pharmacy Notification of Excessive Short Acting β-agonist Use/Under Use of Inhaled Corticosteroids	4
Need for Case Management	3
Improve Insurance Coverage for Asthma Medication	2
Medical Examiners	
Develop Clear Criteria for Identifying Asthma Deaths	9

Children

Like adults, education on the prescription and use of corticosteroids for both health care providers and patients was the highest priority (see Table 11). Some mechanism, such as notification of health care providers by pharmacies to monitor or restrict the refilling of β-agonist prescriptions to reduce β-agonist over-use was favored. The overuse of inhaled β-agonists was intertwined with the under use of inhaled corticosteroids and we did not attempt to separate these closely related factors. Timely referral to a specialist was also indicated. Interventions specific to

children included: setting up a focus group of teenagers with asthma to better understand how to conduct asthma education in this age group; attention to foster care environment (i.e. presence of asthma triggers); and a school-based asthma plan.

Insurance issues, either coverage or co-pays, were not noted to be a significant problem with children.

Table 11. Recommended Interventions for Asthma Mortality for Children Ages 2-18, Michigan, 2006

Recommendation	Number of Deaths
Educate Health Care Providers	
Referrals for High-Risk Patients	15
Need for Inhaled Corticosteroids, Include ED Doctors	14
Limitation of Refills for Bronchodilators Without a Physician Visit or Active Approval	4
Need for Pulmonary Function Test	3
Educate Patients	
Education of Patients/Family, Possibly Focus Groups for Teenagers	38
Dangers of Aspirin Sensitivity	1
System Level Changes	
Case Manager for High-Risk Cases	26
Pharmacy Notification of Excessive Bronchodilator Use or if Long Term Controls Prescription Not Filled	14
School Based Asthma Program	10
Child Protective Services Including Attention Needed for Foster Care Environment	6
Inadequate Emergency Medical Response	2
Development and Dissemination of Generic Action Plan	1
Better Labeling of Aspirin Products	1
Transportation Costs in Rural Area for High-Risk Cases	1
Improve Accessibility to Children's Special Health Care Program	1
Resolve Multiple Formulary Plans	1
CPR Training of Family Members, Part of Hospital Discharge Planning	1
Medical Examiners	
Develop Clear Criteria for Identifying Asthma Deaths	2

Discussion

Asthma is a chronic, but manageable condition. This project is based on the premise that all asthma deaths are preventable with appropriate asthma management.

The 673 asthma deaths from 2002 through 2006 represent only a small percentage (0.16%) of all 431,692 deaths that occurred in Michigan during this same 5-year period. However, asthma is a treatable condition and each asthma death is a tragedy that could have been prevented, particularly the 138 deaths that occurred to children and young adults. The problems identified

among individuals dying from asthma are the same problems that have been associated with increased morbidity, increased impairment with lost work and school days and increased health care costs among the estimated 900,000 Michigan residents with asthma.

The primary causal factor identified in the first five years of investigation for adults in both age groups and children was a lack of patient compliance with good asthma management; this includes regular use of inhaled corticosteroids rather than dependence on β-agonists and elimination of asthma triggers such as cigarette smoke and pets. Major deficiencies noted in health care providers' management of their patients with asthma include a lack of appreciation of the severity of the patient's condition with no referral to a specialist and inadequate prescription of inhaled corticosteroids. The small percentage of people with asthma with an asthma management plan (only 19%) suggests the health care system could do more to provide patients information to better manage their asthma. Particular recommendations were made for:

- Emphasis on the chronic and potentially severe nature of asthma and the importance of prescription of inhaled corticosteroids by health care providers in all sectors (primary and urgent care) and their use among people with asthma.
- Case Management for high-risk patients (patients with an ED visit and/or a hospitalization for asthma and/or daily use of a short acting β-agonist). This includes case management for children with asthma where lack of adequate parental supervision is a problem and adults with psychiatric problems.
- Pharmacy notification to health care providers for patients who repeatedly fill β-agonist prescriptions and/or do not fill controller medication prescriptions for inhaled corticosteroids.
- Consider policies limiting the number of short acting β-agonist refills allowed without a new prescription or communication with the health care provider.
- Provision of more comprehensive asthma care in the ED setting that stops the cycle of repeated treatment of acute episodes. This should include prescription of inhaled corticosteroids at discharge and a system for connecting patients with a primary care provider for follow-up.
- Public and patient education that emphasizes the chronic and potentially fatal nature of asthma and the importance of the use of inhaled corticosteroids.
- Provider education on asthma risk and control, including the importance of the prescription of adequate levels of inhaled corticosteroids. This education should reach health care providers in all sectors including primary, urgent care and emergency departments.
- Referral to specialists for patients with a hospitalization or ED visit for asthma or who use short acting ß-agonists daily.
- Need for health insurance including coverage of medication costs for adults with asthma (not a problem in children).

It has been suggested by some researchers that asthma deaths can be divided into two types: 1) slow onset, late arrival for care and poor use of corticosteroids because of psychological, social and cultural factors; and 2) sudden onset of severe airway closure[22]. The pathology on autopsy in the first type of death shows abundant sticky mucus plugging in the airways and in the second there are empty/dry airways suggesting sudden airway closure by a neural mechanism. The second type of asthma death, sudden onset, is more difficult to prevent. One hundred Michigan asthma deaths had an autopsy from 2002-2006 where in-depth investigations were performed. **Ninety-two percent were the slow onset type and therefore were preventable.**

The National Heart, Lung, and Blood Institute has issued new guidelines for diagnosing and managing asthma in both children and adults[23]. Our findings are in accordance with these new guidelines which emphasize the importance of inhaled corticosteroids, increased use of spirometry as an objective test for both diagnosis and management of asthma patients, and the need for referral to a specialist.

Actions Taken

Annual reports were distributed to asthma stakeholders and policy makers across Michigan, including members of the Michigan Asthma Advisory Committee and its subcommittees; contacts at all local asthma coalitions; all local public health officers in Michigan; and all managed care plan medical directors and quality improvement directors in Michigan. Copies have also been sent to the Michigan State Library; Michigan State Medical Society; Michigan College of Emergency Physicians; and the Michigan Nurses' Association. The report was distributed widely within the state health agency including to the MDCH Director; Surgeon General; directors of Chronic Disease, Maternal Child Health, and Health Disparity Reduction programs. The report has also been distributed to health care providers who requested a copy, Centers for Disease Control and Prevention asthma staff, and asthma contacts in all 50 states.

The findings have been presented to staff in the Michigan Department of Community Health's Public Health Administration; to the Michigan Asthma Advisory Committee and its Quality Improvement in Asthma Care Work Group, including members for MDCH Medical Services Administration, to the Michigan Child Death Review State Advisory Board, MDCH Medicaid Clinical Advisory Board, and through selected presentations to local asthma coalitions, physicians and allied health workers through grand rounds, conferences, and national meetings. Data have also been presented to the Medical Directors and Quality Improvement Directors of the Michigan Association of Health Plans, Implementation Committee of the Michigan Quality Improvement Committee, and the Michigan College of Emergency Physicians. Data were also presented to the organization representing Medical Examiners to discuss criteria for recording a death as being secondary to asthma.

These findings have also had a national audience. The methods and results were presented per request to CDC asthma program staff and other state asthma programs nationally via teleconference. Findings on nebulizer use were presented at the Annual Meeting of the College of Chest Physicians[18] and picked up by national media. Findings on a secondhand smoke-related death were published in a national journal and were also picked up by the national media.

A number of actions have been taken based on these findings:

- The findings and methods have contributed to development of an asthma protocol for Child Death Review.

- A physician education activity, including online CME course (www.oem.msu.edu), has been developed from the blinded case studies used for panel review.

- The Michigan Asthma Advisory Committee (MAAC) used the findings and recommendations in past annual reports to help shape the revision of the state's strategic plan for addressing asthma.

- The Michigan Medicaid Drug Utilization Review Board used these recommendations to support the implementation of pharmacy utilization reporting and develop educational materials to the providers of Medicaid patients who are filling many prescriptions for short-acting Beta agonists without filling any prescriptions for long term controllers.

- The MAAC's Quality Improvement in Asthma Care work group developed of a set of standardized discharge instructions for asthma patients treated in the Emergency Department (available at www.GetAsthmaHelp.com) and distributed it to all emergency departments in the state. This group has also developed a similar discharge plan for urgent visits to other outpatient settings.

- The American Lung Association of Michigan and MDCH Asthma staff partnered with the Child Death Review Staff at the Michigan Public Health Institute to strengthen the link between local asthma coalitions and local Child Death Review Teams. It is hoped that these organizations will work together to share expertise and assist with implementation of recommendations that may arise for community deaths. The MPHI staff presented information on the Child Death Review teams and process at the Michigan Asthma Coalition Summit and contact information has been shared with both sets of organizations.

- This experience has been used by many of the panel members to initiate policy and procedure reviews within their own organizations.

Next Steps

Investigation of these deaths from asthma has identified a number of avenues to reduce asthma mortality. Action needs to occur at many levels, including health care providers, patients and system-level changes. The findings from these investigations will continue to be shared with the many asthma stakeholders who have the expertise and position to institute these recommendations.

Further work is needed to disseminate the findings and initiate changes. Efforts needed include:

- Providing prescriptions for inhaled corticosteroids and asthma education in conjunction with ED visits as well as a system to ensure follow-up by a primary health care provider.

- Developing a basic reading level fact sheet on benefits, safety, and use of inhaled corticosteroids.

- Working with Medical and Quality Improvement Directors of Michigan health plans to enhance asthma management, particularly among Medicaid patients.

- Sharing the findings with Michigan's Tobacco program and coalitions to assist with efforts to reduce secondhand smoke exposure in homes, schools, day care settings, and workplaces.

Continued tracking of asthma deaths in Michigan is planned to identify risk factors that can be addressed to prevent such deaths. The overall number of asthma deaths was 151 in 2002, 133 in 2003, 134 in 2004, 135 in 2005, and 120 in 2006. The major decrease has occurred in the older age groups where the accuracy of the reported underlying cause of death is more questionable than in the younger age groups. Our experience in conducing in-depth investigations in the 45-54 age groups clearly demonstrated this inaccuracy. The advisory panel felt that 50% of the deaths in this age group were not likely to be from asthma and questioned whether asthma was really the cause of death in another 14% of the deaths. This age group also did not have the expected African American to Caucasian disparity seen in previous years. The plan is to continue to conduct in-depth investigations in this older adult group, at least for the deaths occurring in 2007.

We do not have the resources to conduct in-depth investigations on all asthma deaths that occur each year, but we are able to review death certificates, day-of-death records, and medical examiner reports and findings. Review of all 2006 asthma deaths in the state has identified problems with the accuracy of the cause of death on the asthma death certificate. Therefore, we will continue to review this limited set of records similarly for all 2007 asthma deaths.

We also plan to continue to disseminate the information learned to educate health care providers, policy makers, and Michigan citizens to promote policy actions and system changes at state and local levels based on the panels' recommendations.

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APPENDIX I

More comprehensive although still de-identified case summaries are available upon request for use in educational programs for health care providers. A web based CME course with detailed information on four of the deaths can be found at www.oem.msu.edu/cme.asp.

2006 Case Narratives

Adults

1. A Caucasian female in her forties had an asthma attack and died after giving the family's new shorthaired kitten a bath. She had no other medical conditions however the husband stated she had an undiagnosed allergy to dust and longhaired cats. She used inhaled corticosteroids regularly. The panel suggested an overuse of β-agonists, and a lack of patient's knowledge of allergen triggers. Other causal factors included a need for referral to a specialist and inadequate evaluation by the primary care physician.

2. A Caucasian adult female died from asthma. She had several other conditions including lupus, chronic pain, COPD, and osteoarthritis. Prior to her death she was taking oral and inhaled corticosteroids. She was wheelchair bound and on continuous oxygen at home. The panel felt this was not an asthma death.

3. A Caucasian female in her late forties died from asthma while her significant other was out getting her asthma prescriptions filled. She was intubated three times in her life for her asthma. She had a dog and parrot in her home. The panel stated causal factors included inadequate use of corticosteroids, patient compliance issues, need for referral to a specialist for high-risk patients, and inadequate health insurance for medications.

4. A Caucasian female in her fifties had multiple medical conditions including cerebral palsy with spastic quadriplegia, asthma, recurrent aspiration pneumonia, seizure disorder, mental retardation, schizophrenia, blindness, and bipolar disorder. The deceased's roommate in a group home found the deceased not breathing one morning in the early summer. She had 4-5 episodes of pneumonia every year for last 6 years of her life. The panel felt this was not an asthma related death.

5. An African American male in his late forties died from asthma in the spring. He had cut the grass the day prior to his fatal attack, which by history exacerbated his asthma. His wife said the deceased had asthma with daily breathing problems and also had chest pain that occurred 1-2 times per month over the last year of his life. She stated the deceased would take his medications on and off. The panel decided this death was not from asthma.

6. A Caucasian adult male died from asthma while sleeping. He drank alcohol and smoked cigarettes daily. He had daily breathing problems. He took inhaled corticosteroids and had a health history that included COPD, emphysema and hepatitis C. The panel stated causal factors included cigarette and alcohol abuse, inadequate testing done for diagnosis, lack of regular medical care, and insurance issues.

7. A Caucasian adult female died from asthma as an inpatient in a hospital. She had been on antibiotics the week prior to death for a strep throat infection. She then went to the ED because she was coughing up blood. Her medical conditions included asthma, hypertension, diabetes, reflux and obesity. She had cats and birds in her house. She was seen in the ED approximately 70 times in her life for asthma. The panel felt this was not an asthma death.

8. A Caucasian male died at home while his wife was in the hospital for a myocardial infarction. He had multiple medical conditions including asthma, severe COPD requiring continuous home oxygen, sleep apnea, morbid obesity, hypertension, cor pulmonale, and chronic back pain. He saw doctors regularly over the last year of life. The deceased smoked for most of his life. The panel did not believe this person died from asthma.

9. A Caucasian male in his early fifties died from COPD and asthma. He was disabled because of his diagnosis of bipolar disorder. He would run out of his medications and end up in the ED. He started smoking 3-4 weeks prior to his death. He was on home oxygen. The panel decided the causal factors in this case included a compliance issue regarding smoking, psychiatric disease, and inadequate testing done for diagnosis.

10. A Caucasian male in his late forties died from a myocardial infarction, asthma and diabetes. His medical history included congestive heart failure, hypertension, COPD, asthma, non insulin-dependent diabetes mellitus, hepatitis C, and a history of coronary artery bypass surgery 11 years prior. He smoked one pack of cigarettes per day for the past 40 years and smoked marijuana daily. The panel felt this was not an asthma death.

11. An African American adult female was sitting on her couch with shortness of breath when EMS arrived. She became combative then unresponsive as she arrived in the ED. Her medical conditions included asthma and hypertension. The causal factors in this case included illicit drug use, inadequate use and prescription of corticosteroids, overuse of β-agonist drugs, and lack of regular medical care.

12. A Caucasian female in her fifties went to the ED complaining of shortness of breath. She was then admitted to the hospital and coded shortly after she arrived on the floor. She had a history of smoking one pack of cigarettes and drinking a fifth of whiskey per day. The panel concluded this was not an asthma death.

13. A Hispanic male in his late forties died after having an asthma attack in the fall. His girlfriend told the hospital staff the deceased had his attack after an episode of alcohol consumption and marijuana use. The deceased's other medical conditions included diabetes, hypertension and a family history of premature coronary artery disease. Medical records stated the deceased used his Albuterol MDI six times per day. The panel decided the casual factors in this case included substance abuse, inadequate use and prescription of corticosteroids, overuse of β-agonist drugs, need for high-risk patient referral, and lack of regular medical care.

14. A Caucasian female died from asthma early on a fall morning. Her health problems included COPD, obesity, severe anxiety, and back/neck pain. She was hospitalized for breathing problems three times in the year prior to death. Causal factors from the panel discussion included smoking, inadequate use and prescription of corticosteroids, and overuse of β-agonists.

Children

1. An African American preteen was on his way home from a friend's house when he collapsed. His brothers carried him home and called 911. He had breathing problems more than twice per week and his physical activity was limited all the time due to breathing problems. He was hospitalized three times in the year prior to death for his asthma. The panel believed causal factors included secondhand smoke in the home, bronchodilator overuse, inadequate use and prescription of corticosteroids, need for referral for this high-risk patient, lack of adult supervision, and lack of CPR knowledge by the family.

2. An African American preteen died from asthma in the evening after dinner. Before the asthma attack, the cooking of the dinner created some smoke in the house. This child had well-child visits, which included PFT's, along with several visits to his primary doctor in the year prior to death. He took his medication on a regular basis, which included an inhaled steroid. The panel decided causal factors included bronchodilator overuse, medication compliance, inadequate testing done for diagnosis, need for high-risk patient referral, inadequate prescription of corticosteroids, lack of adult supervision, and psychosocial and psychiatric issues.

3. An African American male teenager died in the middle of a hot summer night from asthma. He was diagnosed with asthma as a child. He played basketball outside the day prior to death. He was taking frequent nebulizer treatments and using his albuterol MDI prior to death. He was taking no corticosteroids prior to death. He was exposed to secondhand smoke in his home. Causal factors from the panel discussion included bronchodilator overuse, triggers in the home, inadequate use and prescription of corticosteroids, lack of understanding of asthma severity by the patient, need for high-risk patient referral, inadequate testing done for diagnosis, and lack of adult supervision.

4. An African American teenager died from asthma in the summer while doing her chores. She was diagnosed about one year prior to death and only refilled her Albuterol MDI two times in that year. The panel decided the causal factors included triggers in the home, inadequate use of corticosteroids, inadequate testing done for diagnosis, no regular maintenance healthcare visits, and a delay in EMS response

5. An African American female toddler died from asthma on a spring day. She had mild intermittent asthma according to medical records 1 ½ years prior to death. The panel felt causal factors included triggers in the home, lack of awareness of asthma severity by parents, need for high-risk patient referral and lack of adequate adult supervision.

6. An African American teenager who was wheelchair bound died from an asthma attack. Her school never knew of her asthma diagnosis. Her other medical conditions included cerebral palsy and seizures. Causal factors included inadequate prescription of corticosteroids, lack of visiting nurse evaluation, lack of adult supervision, and no regular maintenance health care visits.

7. An African American female elementary aged child was found unresponsive and not breathing in the fall. She had regular doctor appointments with her primary care physician and an allergist. Inhaled and oral corticosteroids were prescribed and picked up by the family. She was in an ICU and intubated three times in her life. The panel felt causal factors in this case included bronchodilator overuse and lack of adult supervision.

8. An African American preteen male was playing basketball outside and came into the house saying he could not breathe and felt dizzy. The father began a breathing treatment for the deceased, which did not seem to help. He became unresponsive and EMS was called. He died in the ED. Corticosteroids were not regularly used and his nebulizer was used 4-6 times per day. The panel concluded inadequate use of corticosteroids, referral for this high-risk patient, inadequate testing done for diagnosis, and lack of adult supervision were causal factors in this case.

9. A Caucasian teenage male had severe asthma and died from an asthma attack after having breathing problems throughout the day. He was overweight but had no other medical conditions. He went to see his pediatrician along with his allergist and pulmonologist regularly. The panel decided causal factors included inadequate use of corticosteroids, referral for high-risk patient, lack of adequate adult supervision, and confusion over medication coverage.

10. An African American teenage male died from an asthma attack in the late fall. He had asthma all his life. He had emotional issues and entered the juvenile detention system. He had an unstable family life with parents who had abused alcohol and drugs. Causal factors included bronchodilator overuse, psychiatric illness, referral for high-risk patient, lack of adequate adult supervision, and no regular maintenance health care.

11. A Caucasian teenage boy died from asthma after going home from school in the morning. He wasn't feeling well and went home for the day. The father took him to visit a relative's home where there was a pet and adults who smoked cigarettes. The deceased had regular medical care and was prescribed an inhaled steroid. The panel agreed causal factors included triggers at the relative's house, inadequate testing done for diagnosis, and lack of adult supervision.

12. An African American preteen female died from an asthma attack in the winter after playing outdoors. She was seen by her primary care doctor more than one month prior to death and the doctor reported nothing abnormal. The panel did not believe there was adequate information to comment on this case, however, there was no bystander CPR being done when EMS arrived.

APPENDIX II

Members of Adult and Child Asthma Mortality Review Panels

2005 Adult Asthma Mortality Review Panel Members

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