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3. Assume that the eligible population (age 65 to 84) in the service area grows by 36 percent by 2020, and that the use rates remain the same. How many patient days can be anticipated in 2020?
4. Would you expect the age-specific use rates to increase by 2020? Why or why not?
5. How many medical and surgical beds are required for CHD patients in 2012 and 2020, assuming 100 percent utilization (each bed is filled all the time)? What about 75 percent utilization? Why is the number of beds needed at 75 percent utilization higher?
6. Assume that age-specific prevalence rates of CHD are projected to increase in 2020 due to the influence of risk factors such as diabetes and obesity. What effect would this have on 2020 use rates and 2020 bed needs?
7. What other factors might affect both use rates and bed needs in 2020?
8. Exhibit 4.2 presents the prevalence of four major risk factors for CHD in Virginia for the 45 to 64 age group, and two years, 2002 and 2009. The table also presents the ten-year risk of CHD (cumulative incidence rate) for men and women with these risk factors. Calculate the weighted average cumulative incidence rate for men and women for 2002 and 2009. The prevalence of each risk factor (or combination) in Exhibit 4.2 is expressed as a percentage, with a total of 100 percent for all eight categories. A weighted average can be calculated as follows, for males and females.

   $\sum_{j=1}^{8} p_j i_j$ where p_j is the prevalence of the jth risk factor expressed as a proportion, and i_j is j=1 the ten-year incidence of that risk factor.

   Assume that the ten-year risk of CHD based on 2002 risk factors gets directly translated into 2012 use rates, and that the ten-year risk of heart disease based on 2009 risk factors gets directly translated into projected use rates for 2020. Assume that the eligible population still grows by 36 percent in 2020, and that 47 percent of the population are males in all years. How many beds are now needed?

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Assuming that the population age 55 to 74 comprises 47 percent males and 53 percent females (2002), the overall rates would be as follows:

113.8 × 0.47 + 85.4 × 0.53 = 98.7 (2012)

119.0 × 0.47 + 89.11 × 0.53 = 103.2 (2020)

Assume that the increase in cumulative incidence rates gets directly translated into use rates. Estimated use rates for medical and surgical CHD patients are calculated as follows:

Medical: (103.2/98.7) × 15,504 = 16,211 patient days, or 16,211/365 = 44 beds at 100 percent capacity, and 59 beds at 75 percent capacity.

Surgical: (103.2/98.7) × 8,967 = 9,385 patient days, or 9,385/365 = 27 beds at 100 percent capacity, and 36 beds at 75 percent capacity.

The increase in cardiovascular risk factors in the population as of 2009 is expected to increase the number of medical and surgical cardiac beds at 75 percent capacity needed in 2020 by four beds and two beds, respectively.

A Strategic Planning Model

A strategic plan is a useful and necessary tool in corporate strategy development—but it is not (nor should it be) the end objective. Strategic planning seeks to define the organization and its future with an emphasis on designing and bringing about a desired future, rather than designing and implementing programs to achieve specific objectives.

While there are a variety of approaches to strategic planning, a general concept does exist. Keck (1986) and colleagues developed a model of strategic planning that divided the strategic planning process into four sets of activities seeking to answer four specific questions:

1. Where are we now?
2. Where should we be going?
3. How should we get there?
4. Are we getting there?

formal process of assessing the healthcare needs in a population for the purposes of program development, and how human resources planning should be based on the underlying model that morbidity translates into services required, which translates into staffing needed to provide those services. Finally, to the extent that planning and marketing are flip sides of the same coin, organizations would benefit from using epidemiology to describe morbidity and risk factor burden of current and potential markets, and using epidemiologic studies to facilitate the promotion of healthcare products to the consumer.

End-of-Chapter Case Exercises

1. Healthy People 2020 sets goals for a number of objectives, including a reduction in the incidence of gonorrhea in females aged 15 to 44 from 279.9 per 100,000 in 2008 to 251.9 per 100,000 in 2020. For males aged 15 to 44, the rate is targeted to decrease from 216.5 per 100,000 (2008) to 194.8 per 100,000 (2020). Assume that there were 61,918,946 females in the United States aged 15 to 44 in 2008, projected to be 64,412,295 in 2020. The corresponding population of 15- to 44-year-old males was 64,087,088 in 2008 and projected to be 66,545,375 in 2020.
   a. How many females aged 15 to 44 had incident cases of gonorrhea in 2008?
   b. How many males aged 15 to 44 had incident cases of gonorrhea in 2008?
   c. How many females aged 15 to 44 would be expected to contract new cases of gonorrhea in 2020 using the 279.9 per 100,000 incidence rate (2008) and the new targeted rate of 251.9 per 100,000?
   d. How many fewer females would contract gonorrhea in 2020 if the objective is met?
   e. How many males aged 15 to 44 would be expected to contract new cases of gonorrhea in 2020 using the 216.5 per 100,000 incidence rate (2008) and the new targeted rate of 194.8 per 100,000?
   f. How many fewer females would contract gonorrhea in 2020 if the objective is met?
2. You are an epidemiologist in the Lexington-Fayette County health department and are asked to do a needs assessment for diabetes services in Lexington, Kentucky, where the population is 485,000 and the prevalence of diabetes is presumed to be 7 percent. Assume that the two major risk factors for diabetes are hypertension and obesity, that 26 percent of the population in Lexington are obese, and that 23 percent

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Suppose you were doing a study on whether coffee drinking increased the risk of heart disease (see Exhibit B.4). Assume that you are no longer at risk of heart disease if you die, leave the study, or get heart disease. You had two group of 110 subjects, each whom you followed for five years.

EXHIBIT B.4
Coffee Drinking and Heart Disease Study

Group 1 (the coffee drinkers): 90 followed for 5 years without getting heart disease, 5 each get heart disease at the end of years 3 and 4, respectively, 5 leave the study at the end of year 2, and 5 die at the end of year 4.

Group 2 (non–coffee drinkers): 100 followed for 5 years without getting heart disease, 2 each get heart disease at the end of years 1 and 2, respectively, 3 leave the study at the end of year 4, 3 die at the end of year 3.

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EXHIBIT E.7
30-Day Readmission Rates

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Acute Myocardial Infarction							
Hospitals	**#R***	**#Cases**	**Rate**	**Lower CI**	**Upper CI**	**US Rate**	**Compare**
Brigham and Women's Hospital	114	548		18.3	23.6	18.3	
Tufts Medical Center	87	438		17.1	23	18.3	
Brigham and Women's Faulkner Hospital	NA	22		NA	NA	18.3	
New England Baptist	NA	5		NA	NA	18.3	
Boston Medical Center	33	215		12.2	18.8	18.3	
Beth Israel Deaconess Medical Center	135	657		18.3	23.1	18.3	
Massachusetts General Hospital	150	805		16.4	20.8	18.3	
Congestive Heart Failure							
Hospitals	**#R***	**#Cases**	**Rate**	**Lower CI**	**Upper CI**	**US Rate**	**Compare**
Brigham and Women's Hospital	214	931		20.8	25.5	23	
Tufts Medical Center	110	443		21.8	28.1	23	
Brigham and Women's Faulkner Hospital	84	344		21.3	28.1	23	
New England Baptist	15	65		18.4	27.5	23	

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EXHIBIT E.7
30-Day Readmission Rates *(continued)*

Hospitals	#R*	#Cases	Rate	Lower CI	Upper CI	US Rate	Compare
Congestive Heart Failure							
Boston Medical Center	164	685		21.2	26.7	23	
Beth Israel Deaconess Medical Center	289	1,166		22.7	27.1	23	
Massachusetts General Hospital	304	1,298		21.3	25.6	23	
Pneumonia							
Hospitals	**#R***	**#Cases**	**Rate**	**Lower CI**	**Upper CI**	**US Rate**	**Compare**
Brigham and Women's Hospital	86	482		15.4	20.5	17.6	
Tufts Medical Center	73	358		17.4	23.6	17.6	
Brigham and Women's Faulkner Hospital	84	411		17.3	23.7	17.6	
New England Baptist	11	64		14.2	22	17.6	
Boston Medical Center	53	281		15.9	22.2	17.6	
Beth Israel Deaconess Medical Center	130	713		16.2	20.8	17.6	
Massachusetts General Hospital	155	781		17.6	22.3	17.6	

Source: Medicare.gov (2014b).
* #R = Readmitted

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Capstone Case F: Mortality in Kentucky: A Comparison of Jefferson and Fayette Counties

By Steven T. Fleming

Fayette County, Kentucky, is home to the University of Kentucky Wildcats and had a population of 308,428 in 2013. According to the US Census, median income was $48,779. The county had a poverty rate of 18.2 percent, and the median age was 34.1 years. Of this population, 78.6 percent are white, 14.9 percent are black, and 6.9 percent are Hispanic. Jefferson County, Kentucky, is home to the University of Louisville Cardinals and had a population of 756,832 in 2013. Median income is $45,352. The county had a poverty rate of 16.5 percent and a median age of 38.1 years. Of this population, 73.7 percent are white, 21.4 percent are black, and 4.7 percent are Hispanic. Exhibit F.1 presents age-specific and overall mortality rates for both Jefferson and Fayette Counties in 2011. The rates are expressed as rates per 100,000 residents.

EXHIBIT F.1 Number and Age-Specific Death Rates, Jefferson and Fayette Counties, Kentucky, 2011

	Jefferson		Fayette	
	Number	Rate	Number	Rate
< 1 year	68	666.8	19	483.0
1–4 years	17	43.6	4	26.6
5–14 years	13	14.2	4	13.2
15–24 years	96	100.3	26	48.7
25–34 years	144	135.8	43	87.1
35–44 years	240	252.0	79	198.5
45–54 years	589	539.5	172	435.6
55–64 years	984	1,025.4	289	859.8
65–74 years	1,089	2,086.2	345	1,968.4
75–84 years	1,831	5,394.3	443	4,463.9
85+ years	2,123	14,403.0	653	14,358.0
All	7,194	963.8	2,077	692.7

Note: Rates for 1–4 years in Fayette County and 5–14 years in Jefferson County based on data from 2007–2011 because of small numbers.

Source: CDC National Center for Health Statistics (2014b).

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Questions

1. How do the overall crude mortality rates for Jefferson and Fayette Counties compare to each other?
2. Does this mean that the risk of dying is higher in Jefferson County than in either Fayette or the state of Kentucky?
3. Exhibit F.2 presents the age distributions of both counties. How do they compare? Why does this matter?

EXHIBIT F.2 Distribution by Age for Jefferson and Fayette Counties, Kentucky, 2011

	Jefferson		Fayette	
	Population	% Distribution	Population	% Distribution
< 1 year	10,198	1.4	3,934	1.3
1–4 years	39,032	5.2	15,030	5.0
5–14 years	94,197	12.6	33,228	11.1
15–24 years	95,746	12.8	53,387	17.8
25–34 years	106,007	14.2	49,352	16.5
35–44 years	95,235	12.8	39,796	13.3
45–54 years	109,184	14.6	39,487	13.2
55–64 years	95,967	12.9	33,611	11.2
65–74 years	52,200	7.0	17,527	5.8
75–84 years	33,943	4.5	9,924	3.3
85+ years	14,740	2.0	4,548	1.5
All	746,449	100.0	299,824	100.0

Note: Population for 1–4 years in Fayette County and 5–14 years in Fayette and Jefferson Counties based on years 2007–2011. All others based on 2011 data.
Source: CDC National Center for Health Statistics (2014b).

Although it would appear that Jefferson County has higher age-specific mortality rates in most age categories, it is still unfair to compare the two counties if Jefferson County has a much higher age mix than Fayette County. To level the playing field between the two counties, there are two main methods (direct and indirect) and four specific techniques. The first direct method uses the pooled population as a standard. Exhibit F.3 presents a template for this method.

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EXHIBIT F.3 Direct Standardization of Kentucky Mortality Rates, 2011

	Population			Age-Specific Rates (per 100,000)		Expected Deaths	
	Jefferson	Fayette	Pooled	Jefferson	Fayette	Jefferson	Fayette
< 1 year	10,198	31,934	14,132	666.8	483.0		
1–4 years	39,032	15,030	54,062	43.6	26.6		
5–14 years	94,197	33,228	127,425	14.2	13.2		
15–24 years	95,746	53,387	149,133	100.3	48.7		
25–34 years	106,007	49,352	155,359	135.8	87.1		
35–44 years	95,235	39,796	135,031	252.0	198.5		
45–54 years	109,184	39,487	148,671	539.5	435.6		
55–64 years	95,967	33,611	129,578	1,025.4	859.8		
65–74 years	52,200	17,527	69,727	2,086.2	1,968.4		
75–84 years	33,943	9,924	43,867	5,394.3	4,463.9		
85+ years	14,740	4,548	19,288	14,403.0	14,358.0		
All	746,449	299,824	1,046,273	963.8	692.7		

Note: Population and age-specific rates for 1–4 years in Fayette County and 5–14 years in Fayette and Jefferson Counties based on data from 2007—2011. All others based on 2011 data.
Source: CDC National Center for Health Statistics (2014b).

This techniques uses the age-specific rates of each county applied to the pooled population in each age stratum to get expected deaths. This figure represents the number of deaths we would expect if the age-specific populations of both counties combined were dying at the rates that they do in either Jefferson or Fayette County.

Questions

4. How many expected deaths would we have in each age category for each county? How many total expected deaths in each county?
5. What are the age-specific mortality rates for Jefferson and Fayette Counties using this method? How do these rates compare to the crude overall mortality rate for each county? What does this mean?

Another method of direct age adjustment is to use the population mix from another (usually geographically larger) region. In this case we can use the Kentucky population distribution. Exhibit F.4 presents the template for this method. This technique uses the age-specific

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rates of each county applied to the age distribution of the entire state of Kentucky (the larger geographical unit) to get the expected number of deaths in each age stratum. This represents the number of deaths we would expect if the entire state of Kentucky were dying at the rates that they do in either Jefferson or Fayette County.

EXHIBIT F.4 Mortality in Two Kentucky Counties, Direct Method of Adjustment Using Kentucky Population as the Standard

	Kentucky Age Distribution	Age-Specific Rates (per 100,000)		Expected Deaths	
		Jefferson	Fayette	Jefferson	Fayette
< 1 year	56,065	666.8	483.0		
1–4 years	225,096	43.6	26.6		
5–14 years	567,946	14.2	13.2		
15–24 years	591,188	100.3	48.7		
25–34 years	569,158	135.8	87.1		
35–44 years	570,028	252.0	198.5		
45–54 years	637,556	539.5	435.6		
55–64 years	560,468	1,025.4	859.8		
65–74 years	334,546	2,086.2	1,968.4		
75–84 years	185,832	5,394.3	4,463.9		
85+ years	71,473	14,403.0	14,358.0		
All	4,369,356	963.8	692.7		

Note: Population and age-specific rates for 1–4 years in Fayette County and 5–14 years in Fayette and Jefferson Counties based on data from 2007–2011. All others based on 2011 data.
Source: CDC National Center for Health Statistics (2014b).

Questions

6. How many expected deaths would we have in each age category for each county? How many total expected deaths in each county?
7. What are the age-specific mortality rates for Jefferson and Fayette Counties using this method? How do these rates compare to the crude overall mortality rate for each county? What does this mean?

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($2,872 without screening), $1,007 at age 65 ($805 without screening), and $374 at age 75 ($282 without screening). Incremental QALYs for universal screening are reported to be 0.003, 0.003, 0.008, 0.003, and 0.002, respectively, for the five age groups.

Questions

26. For each screening strategy, use Exhibit H.6 to calculate the incremental cost associated and the ICER for each age group.
27. How do the ICERs of targeted and universal screening compare across screening ages?

EXHIBIT H.6 Cost-Effectiveness for Targeted and Universal Screening for Diabetes

Age Screened	Targeting Screening					Universal Screening				
	$Cost_u$	$Cost_s$	ΔCost	ΔQALY	ICER	$Cost_u$	$Cost_s$	ΔCost	ΔQALY	ICER
35										
45										
55										
65										
75										

Note: $Cost_u$ = individual cost of those without screening; $Cost_s$ = individual cost of those with screening; ΔCost = incremental cost; ΔQALY = incremental quality-adjusted life years; ICER = incremental cost-effectiveness ratio.

ANSWERS FOR END-OF-CHAPTER CASE EXERCISES

Chapter 2

1. a. (150/300) × 100 = 50%, or 50 per 100
   b. See Exhibit 2.14

EXHIBIT 2.14 Foodborne Outbreak at a Baptist Church Picnic

	Consumed Food			Did Not Consume Food		
	No. people	No. ill	Attack Rate (%)	No. people	No. ill	Attack Rate (%)
Hamburger	200	110	55.0	100	40	40.0
Chicken salad	140	130	92.9	160	20	12.5
Egg salad	75	40	53.3	225	110	48.9
Pumpkin pie	240	140	58.3	60	10	16.7
Pasta salad	80	45	56.3	220	105	47.7

   c. Hamburger 55/40 =1.38; chicken salad 92.9/12.5 = 7.4; egg salad 1.09; pumpkin pie 3.5; pasta salad 56.3/47.7=1.18
   d. Chicken salad because of the highest attack-rate ratio

2. Measles: 1 – 1/15 = 93.3%, smallpox: 1 – 1/6 = 83.3%, influenza: 1 – 1/3 = 66.6%

3. a. Host
   b. Agent
   c. Agent
   d. Host
   e. Environment
   f. Environment

Chapter 3

1. a. (11/1,500) × 1,000 = 7.3 per 1,000
   b. (11 + 6 – 2)/(1,500 – 2) = (15/1,498) × 1,000 = 10.0 per 1,000
   c. 15(cases on 1/1/13) + 5(new cases in 2013) – 2(deaths during 2013)/1,500 – 2(deaths during 2011) – 2(deaths during 2012) = (18/1,496) × 1,000 = 12.0 per 1,000
   d. 6/(1,500 – 11) × 1,000 = 4.03 per 1,000
   e. 7/(1,500 – 11 – 6 – 5) = 4.7/1,000 (ignores deaths in 2014)
   f. Incidence = (6 + 5 + 7) = 18; person-years = (1,500 – 29) × 3 = 4,413 + 4 + 9 + 19 = 4,445; incidence density = (18/4,445) × 1,000 = 4.05 per 1,000 person-years

2. a. Sensitivity
   b. Positive predictive value (PPV)
   c. False positives (FP)
   d. Negative predictive value (NPV)
   e. Specificity
   f. True positives
   g. 56
   h. 100 – 56 = 44
   i. Sensitivity = 56/100 = 56%
   j. Specificity = 99,900 – 1,998 = 97,902/99,900 = 0.98 or 98.0%
   k. PPV = 56/(56 + 1,998) = 0.027 or 2.7%
   l. 100 – 56 = 44 (FN), 99,900 – 1,998 = 97,902 (TN), NPV = 97,902/(44 + 97,902) = 0.999 or 99.9%
   m. FN/(FN + TN) = 44/(44 + 97,902) = 0.00045 or 0.045%

3.

Stage 1	CRC+	CRC–			Stage 2	CRC+	CRC–	
FOBT+	500	3,600	4,100		Colonoscopy+	475	360	835
FOBT–	500	5,400	5,900		Colonoscopy–	25	3,240	3,265
Total	1,000	9,000	10,000		Total	500	3,600	4,100

   a. 10,000 × 0.10 = 1,000 with CRC, 9,000 without. 1,000 × 0.5 = 500 true positives
   b. 9,000 × 0.60 = 5,400 true negatives; 9,000 – 5,400 = 3,600 false positives; PPV = [500/(500 + 3,600] × 100) = 12.2%
   c. 3,600 + 500 = 4,100

f. 111,550 × 0.85 = 94,818
g. 111,550 × 0.95 = 105,973
h. 33,950 × 0.80 = 27,160
i. 33,950 × 0.12 = 4,074
j. 33,950 × 8 = 271,600 visits needed, 260,000 provided, 11,600 unmet need
k. 27,160 require drugs, 30,100 get drugs, 30,100 – 27,160 = 2,940 overmet need
l. 94,818 require drugs, 95,000 get drugs, 95,000 – 94,818 = 182 overmet need

Chapter 5

1. a. (8/28,560) × 1,000 = 0.28/1,000 (UK); (0/18,200) × 1,000 = 0 (CB); (4/15,900) × 1,000 = 0.25/1,000 (SJ)
   b. (8/28,560) × 1,000 = 0.28 per 1,000 (UK); (40/18,200) × 1,000 = 2.2/1,000 (CB); (10/15,900) × 1,000 = 0.63 per 1,000 (SJ)
   c. (31/28,560) × 1,000 = 1.08/1,000 (UK); (15/18,200) × 1,000 = 0.82/1,000 (CB); (10/15,900) × 1,000 = 0.63 per 1,000 (SJ)
   d. Each hospital has the lowest rate for one of the three measures.
   e. Both SJ and UK higher than US for pressure sores. SJ and CB higher than US for catheter infections. All three hospitals higher than the US for falls and injuries. You would need to calculate confidence intervals around rates to see if the US rate fell outside the confidence interval, though.

2. a. (6/213) × 100 = 2.817 per 100 procedures (UK); (1/123) × 100 = 0.813 per 100 procedures (SJ); (2/153) × 100 = 1.307 per 100 procedures (CB)
   b. (60/9,481) × 1,000 = 6.328 per 1,000 catheter-days (UK); (4/8,585) × 1,000 = 0.466 per 1,000 catheter-days (SJ); (11/4,526) × 1,000 = 2.430 per 1,000 catheter-days (CB)
   c. (39/15,602) × 1,000 = 2.500 per 1,000 central line days (UK); (7/9,538) × 100 = 0.734 per 1,000 central line days (SJ); (4/6,447) × 100 = 0.620 per 1,000 central line days (CB)
   d. 6/7.588 = 0.79 (UK); 1/4.036 = 0.25 (SJ); 2/4.946 = 0.40 (CB)
   e. 60/27.491 = 2.18 (UK); 4/14.861 = 0.27 (SJ); 11/6.963 = 1.6 (CB)
   f. 39/37.194 = 1.05 (UK); 7/15.427 = 0.45 (SJ); 4/9.944 = 0.40 (CB)
   g. SSI: colon (SJ); CAUTI (SJ); CLABSI (CB)
   h. UK had 2.18 times the number of UTI-associated catheter infections than would be expected given their patient mix.

Chapter 6

1.

EXHIBIT 6.19 Indirect Age Adjustment Michigan and Ohio

Age	Rate US (per 100,000)	Population Michigan	Population Ohio	Expected Deaths (MI)	Expected Deaths (OH)
0–24	72	3,420,500	3,825,900	2,463	2,755
25–64	370	5,375,000	6,100,000	19,888	22,570
65+	4,300	1,280,000	1,550,000	55,040	66,650
Total		10,075,500	11,475,900	77,391	91,975

a. 77,391
b. 91,975
c. (86,706/77,391) × 100 = 112
d. (106,556/91,975) × 100 = 116
e. Michigan, because its index is lower than Ohio's.
f. Michigan has higher rates relative to US since US is the standard and the index is greater than 100%.

2.

EXHIBIT 6.20 Direct Age Adjustment Kentucky and Tennessee

Age	Rate Kentucky (per 100,000)	Rate Tennessee (per 100,000)	Population US	Expected Deaths (KY)	Expected Deaths (TN)
0–24	80	62	102,506,000	82,005	63,554
25–49	305	317	126,093,000	384,584	399,715
50–74	1,627	1,567	51,189,000	832,845	802,132
75+	8,150	7,992	17,038,000	1,388,597	1,361,677
Total			296,826,000	2,688,031	2,627,078

a. 2,688,031
b. 2,627,078
c. (2,688,031/296,826,000) × 100,000 = 905.6 per 100,000
d. (2,627,078/296,826,000) × 100,000 = 885.1 per 100,000
e. Tennessee has lower age-adjusted rates.
f. No, because you do not know the age distribution for each state.