

Analysis of Ophthalmology Workforce and Delivery of Emergency Department Eye Care in Florida

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Objective: To measure annual population-based volume of emergency department (ED) eye care and concurrent ophthalmology on-call coverage.

Methods: Analysis and correlation of the 2006 Florida Agency of Health Care Administration ED and inpatient data sets with the 2007 Florida Physician Workforce Survey.

Results: The Florida Physician Workforce Survey showed 46.3% of ophthalmologists surveyed took ED call in Florida in 2006. Based on estimates derived from the survey, 462 to 532 ophthalmologists participated in ED coverage that year. The level of workload varied consider-

ably depending on *International Classification of Diseases* code diagnosis. Annual workload for open wounds to the eye, on average, ranged from 2.7 to 3.1 per ophthalmologist taking ED call.

Conclusions: Strategic planning for the delivery of ED eye care needs to consider both the number and types of cases presenting to the ED and the availability of ophthalmologists to provide care that other specialists cannot. This preliminary study explores the use of a workload statistic that may help to gauge manpower needs in the future.

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EMERGENCY DEPARTMENTS (EDs) play a crucial role in the delivery of both urgent and nonurgent health care in the United States, including eye care. The National Hospital Ambulatory Medical Care Survey has, for more than 15 years, summarized this work through controlled surveys and statistical estimates.¹ In 2005, there were more than 115 million ED visits in the United States, or nearly 40 visits per every 100 persons in the country.² Demand for ED services may continue to increase as patients lose employer-based health insurance and have no other mechanism by which to enter the health care system. Despite efforts to improve the efficiency of ED through triage and practice management strategies, hospital EDs have difficulty keeping pace with their increasing workload.

The capability of an ED to handle any given workload is a function of patient volume, complexity and severity of case mix, and physician manpower. The physicians who staff the ED are either primary ED physicians or hospital staff who serve as consultants. While the factors affecting physician ED coverage are complex,

in some regions of the country, such as Florida, the rising cost of professional liability insurance is forcing doctors to limit ED call or avoid it entirely.³ The delivery of eye care in the ED may be further compromised by changing practice patterns that shift surgery to outpatient facilities, leaving hospitals with fewer ophthalmologists to take emergency call.⁴

While data on the amount and pattern of ED eye care have been reported on national, regional, and state levels,⁵⁻⁷ there is no population-based information on how this volume of care is distributed among ophthalmologists. To determine the burden of ED eye care that ophthalmologists provide in Florida, we correlated selected material within statewide data sets on ED patient care and ED hospital admissions for 2006 with the 2007 Florida Physician Workforce Survey.

METHODS

This study combined information from 3 data sets: Florida Department of Health Workforce Survey for 2007, which was part of the 2007 relicensing process, and the 2006 Florida Agency for Health Care Administration (AHCA) hospital inpatient and ED data sets.

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Table 1. Emergency Department Eye Care and Hospital Admission Diagnoses

ICD-9-CM Code	Description
360.0-379.9	Eye and ocular adnexal problems unrelated to injury
802.6-802.7	Orbital floor fractures, blowout
870.0-870.9	Open wounds in the ocular adnexa
871.0-871.9	Open wounds in the eyeball
918.0-918.9	Superficial injury of the eye and adnexa
921.0-921.9	Contusion of the eye and adnexa
930.0-930.9	Foreign body on the external eye
940.0-940.9	Burn confined to the eye and adnexa
950.0-950.9	Injury to the optic nerve and pathways
951.0	Injury to the oculomotor nerve

Abbreviation: ICD-9-CM, *International Classification of Diseases, Ninth Edition, Clinical Modification*.

Each of these data sets belongs in the public domain and contains only deidentified health care information.

The 2007 Florida Physician Workforce Survey included approximately 50% of Florida allopathic physicians and reflects 2006 practice patterns.⁸ The survey was developed by the Florida Department of Health with input from the Florida Medical Association, medical specialty societies, the Graduate Medical Education Committee, and other health care organizations. The survey queried duration, type, and location(s) of practice; coverage of EDs; and future plans for retirement or relocation. Only physicians who answered that they had practiced for any length of time in Florida during 2006 were included in our analysis. We excluded physicians who did not self-report a minimum of 60% time devoted to their designated specialty. The overall response rate was 88.7% (22 035 of 24 840 allopathic physicians). This response rate may reflect the fact that the voluntary nature of the survey may not have been clear to relicensing physicians. Relicensing residents and physicians in fellowship who responded to the survey were identified and excluded from further analysis.

Limited deidentified ED and inpatient data sets for 2006 were obtained from the Florida AHCA on compact disc and downloaded into Microsoft Access (Redmond, Washington) for analysis as databases. Emergency department and inpatient eye care were identified through *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* codes within the Florida AHCA ED and hospital data sets. Codes were selected to identify ocular and ocular adnexal trauma and eye and ocular adnexal problems unrelated to injury. These codes are listed in **Table 1**. A flowchart (**Figure**) shows the design and general study methods.

The 2006 Florida AHCA ED data set was queried for primary (principal) eye-related diagnostic codes. Since the out-patient ED data set does not include patients admitted for hospital care through the ED, we used the Florida AHCA inpatient data set to identify those particular cases. Admission diagnosis in this situation was considered the primary diagnosis. Secondary ED and hospital discharge eye diagnoses include any diagnosis listed among the multiple diagnostic fields other than primary (ie, secondary, tertiary, quaternary, etc) in the data sets. Secondary diagnoses constitute other ocular and ocular adnexal comorbidities important enough to be included in the ED or hospital discharge record. We combined primary and secondary eye diagnoses as a measure of total ICD-9-CM code-specific diagnoses to calculate "cumulative workloads." What constitutes a primary diagnosis rested with the physician providing ED care or the admitting physician.

Florida AHCA requires all hospitals and EDs to report patient-level data for the purposes of use, disease surveillance, access

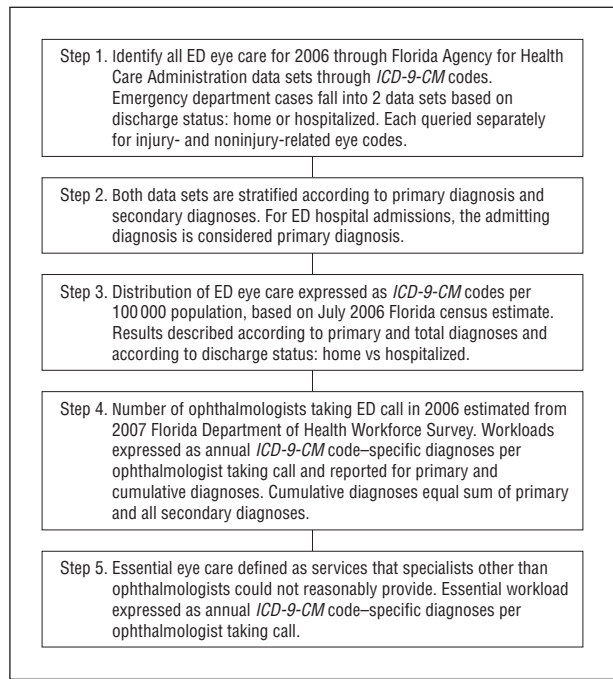


Figure. Flowchart shows the general organization of the study and how 2 Florida Agency for Health Care Administration data sets were combined with the Florida Department of Health Workforce Survey to create a workload statistic. ED indicates emergency department; ICD-9-CM, *International Classification of Diseases, Ninth Revision, Clinical Modification*.

to care, and cost trends. Failure to comply within specified time frames results in financial penalties.⁹ Reportable events, mandated by Florida statutes (§ 408.061) and Florida administrative code (chapter 59B-9), include any procedure that involves a valid Current Procedural Terminology code and, in the case of EDs, any visit in which registration occurs and the patient is not admitted for inpatient care.¹⁰ Statewide compliance is high. Hospital and ED compliance for 2006 were 100% when our limited data sets were obtained in 2008 (Patrick Kennedy, chief administrator of data collection, oral communication, March 23, 2009). Deidentified limited data sets are available to the public but are not free.

An estimate of the July 2006 Florida population (n=18 560 971) was based on the April 1, 2007, estimate of the Bureau of Economic and Business Research, Warrington College of Business Administration at the University of Florida, and proportionally extrapolated (backward) from the rate of growth between the 2000 population census and the April 1, 2007, population estimate.¹¹

Descriptive statistics of ED eye care are expressed as ICD-9-CM-coded diagnoses per 100 000 population and for ED workload, ICD-9-CM-coded diagnoses per licensed ophthalmologist taking ED call. We defined essential services as those that no specialist other than an ophthalmologist could reasonably provide. Open wounds to the eye (ICD-9-CM codes 871.0-871.9) and burns confined to the eye and ocular adnexa (ICD-9-CM codes 940.0-940.9) fell into that category. Among eye problems unrelated to injury, corneal ulcer (ICD-9-CM codes 370.00-370.07) and endophthalmitis (ICD-9-CM codes 360.00-360.4) were examined. The imperfect nature of ICD-9-CM coding does not allow for injury-related corneal ulcers and endophthalmitis to be distinguished from so-called injury codes. The nonessential category consists of injury-related and non-injury codes for which physicians other than ophthalmologists could provide services. Examples include open wounds to the ocular adnexa (ICD-9-CM codes 870.0-870.9), which

Table 2. 2007 Florida Physician Workforce Survey Results^a

Description, Licensed Physicians	No. ^a (%)
Total physicians practicing in state ^b	15 699 (100)
Total residents and fellows licensed in state	709
Total physicians taking ED call ^b	4887 (31.2)
Ophthalmologists practicing in state ^b	499 (100)
Residents and fellows licensed in state	32
Ophthalmologists taking ED call ^b	231 (46.3)
General surgeons practicing in state ^b	433 (100)
Residents and fellows licensed in state	33
General surgeons taking ED call ^b	243 (56.1)
Surgical specialists practicing in state ^{b,c}	2111 (100)
Residents and fellows licensed in state	128
Surgical specialists taking ED call ^b	1311 (62.1)

Abbreviation: ED, emergency department.

^aSurvey of 24 840 licensed physicians in 2006, which represents half of the total physicians licensed that year. Survey response rate was 88.7%.

^bExcludes licensed residents and fellows.

^cIncludes all surgical specialties except general surgery and ophthalmology.

could be managed by an ED physician, general surgeon, or plastic surgeon. Similarly, injury to the optic nerve and pathway (ICD-9-CM codes 950.0-950.9) could be evaluated and managed by a neurologist or neurosurgeon.

Two estimates of the 2006 physician workforce were used to compute a range of physician workload. The lower estimate, 462, was calculated by doubling the results of survey responders (licensed, nonresident, or fellow ophthalmologists practicing in Florida) who self-reported taking ED call that year. Since this could underestimate the actual number by 11.3% (proportion of physicians who did not return the survey), a correction factor was used that assumed nonresponders took ED call in the same proportion as responding ophthalmologists. The upper estimate also took into account the possibility that graduating residents who stayed in the state could work 6 months of the year, since they were licensed at graduation. The upper estimate for licensed ophthalmologists taking ED call for 2006 was 532.

RESULTS

A total of 24 840 physicians were eligible for relicensure in 2007, which corresponds to roughly half the physicians licensed in the state for 2006. Of these physicians, 22 035 completed the Florida Physician Workforce Survey (88.7%), with 16 802 of the responders replying that they practiced medicine at least for some time during the year in Florida. Physicians who answered that they did not practice any time during the year in Florida (n = 5151) were excluded. After excluding licensed residents and fellows in training for numerical count, 15 699 surveyed physicians were left for final analysis (**Table 2**).

In terms of specialty, there were 499 ophthalmologists and 32 residents and fellows licensed in the state who responded to the survey. Of these 499 practicing ophthalmologists, 421 were men and 77, women (sex not indicated in 1). Their average age was 54.6 years, with the mean age of men, 56 years, and women, 47.7 years. Two hundred thirty-one ophthalmologists responded that they took ED call (46.3% of those in clinical practice) in at least 1 facility during 2006. Further breakdown indicated that this was 43% of the total men (183 of 421) and 61% of the total women

Table 3. ED Outpatient Eye Care Diagnoses per 100 000 Population

Diagnosis	No. per 100 000 Population	
	Primary ED Diagnosis ^a	Cumulative Diagnoses ^b
Eye and ocular adnexal problems unrelated to injury	371.5	688.2
Orbital floor fractures, blowout	5.9	10.6
Open wounds in the ocular adnexa	26.3	35.1
Open wounds in the eyeball	4.2	5.4
Superficial injury of the eye and adnexa	107.7	135.7
Contusion of the eye and adnexa	26.1	48.1
Foreign body on the external eye	61.6	70.0
Burn confined to the eye and adnexa	8.3	10.0
Injury to the optic nerve and pathways	0.1	0.2
Injury to the oculomotor nerve	0	0.005
Total	611.7	1003.3^c

Abbreviations: ED, emergency department; ICD-9-CM, *International Classification of Diseases, Ninth Edition, Clinical Modification*.

^aPrimary diagnosis: principal reason for ED visit judged by managing physician.

^bCumulative diagnoses refers to primary and all secondary ICD-9-CM eye care diagnoses assigned on ED discharge.

^cTotal has been rounded.

(47 of 77). The average age of male ophthalmologists taking ED call was 50.8 years and female ophthalmologists taking call was 44.7 years.

By way of comparison, there were 433 general surgeons practicing in 2006 who responded to the survey, 243 of whom took ED call (56.1%). Among all surgical specialists (other than ophthalmology and general surgery), 62.1% (1311 of 2111) took ED call (**Table 2**).

The breakdown of ED diagnoses for eye care is shown in **Table 3** and expressed as number of coded diagnoses per 100 000 population. The ICD-9-CM code-specific diagnoses are divided into 2 groups: (1) primary, presumably the reason for the ED visit, and (2) cumulative, which corresponds to total eye-related workload. The rate of primary diagnosis would also correspond to the number of individual ED visits for eye care since only 1 primary diagnosis per visit was possible. In terms of primary eye diagnoses, the rate of outpatient care was approximately 612 visits per 100 000 persons living in the state for 2006.

Patients who were admitted through the ED for eye-related injuries or other eye-related conditions are not included in the Florida AHCA outpatient data set. To capture these cases, the inpatient hospital data set was used. **Table 4** shows eye-related admission diagnoses per 100 000 population and the primary discharge diagnosis. There were approximately 18 primary eye-related hospital admissions per 100 000 persons living in Florida. For the most part, rates of admission diagnosis tended to parallel discharge diagnosis. Differences in the frequencies were typically small (less than 0.1 per 100 000).

Table 4. Inpatient Hospital Admissions for Eye Care Diagnoses per 100 000 Population^a

Diagnosis	No. per 100 000 Population		
	Primary Admission Diagnosis ^b	Primary Discharge Diagnosis ^b	Discharge Diagnoses Cumulative
Eye and ocular adnexal problems unrelated to injury	13.8	13.2	534.0
Orbital floor fractures, blowout	1.6	1.9	8.8
Open wounds in the ocular adnexa	0.4	0.4	5.5
Open wounds in the eyeball	1.2	1.3	2.5
Superficial injury of the eye and adnexa	0.1	0.08	2.7
Contusion of the eye and adnexa	0.7	0.7	11.8
Foreign body on the external eye	0.01	0.02	0.3
Burn confined to the eye and adnexa	0.03	0.04	0.3
Injury to the optic nerve and pathways	0.02	0.02	0.3
Injury to the oculomotor nerve	0.005	0.005	0.05
Total^c	17.8	17.7	566.2

^aRepresents hospital admission through emergency department.
^bAdmission and discharge diagnoses represent primary or principal diagnoses.
^cTotals have been rounded.

Since these limited data sets do not contain specific information on ED consultants, another means of estimating ophthalmology workload was needed. A so-called workload statistic, or number of ICD-9-CM-coded diagnoses per ophthalmologist on-call, was derived from the earlier-mentioned data. The workload was expressed as a range, reflecting the upper and lower estimates of ophthalmologists taking ED call during 2006 (ie, 462-532). **Table 5** shows the cumulative eye-related workload according to ICD-9-CM diagnosis, expressed in diagnoses per ophthalmologist taking call. The cumulative statistic is broken down into outpatient ED and hospital admission eye care (Table 5). The workload for all open wounds to the eye ranged from 2.7 to 3.1 per ophthalmologist per year (Table 5). For burns confined to the eye and ocular adnexa, the rate ranged from 3.5 to 4.1 diagnoses per ophthalmologist annually. If the workload is examined in terms of primary injury-related eye diagnoses (which corresponds to injury-related ED outpatient eye visits), the rate jumps to 82.3 to 95 per ophthalmologist annually (**Table 6**). Primary injury-related eye diagnoses that resulted in hospital admission were relatively low, 1.2 to 1.6 per ophthalmologist on call in 2006 (Table 6).

The ED workload increased considerably for diagnostic categories in which ophthalmic care could be provided by other physicians. An example is open wounds to the ocular adnexa, where the annual cumulative rate of diagnoses ranged from 13.9 to 16.1 per ophthalmologist (Table 5). The highest single ICD-9-CM category rate was superficial injury to the eye and ocular adnexa, which consisted of 47.5 to 54.7 diagnoses per ophthalmologist per year (Table 5).

Table 5. Rates of ED Category-Specific Total Diagnoses per Ophthalmologist On Call 2006^a

Diagnostic Code Description	No. per Ophthalmologist		
	ED Diagnoses	Emergency Admission Diagnoses	Total ED and Emergency Admission Diagnoses
Opens wounds to the eye ^b	1.9-2.1	0.8-1.0	2.7-3.1
Wounds to the ocular adnexa	12.0-13.9	1.9-2.2	13.9-16.1
Superficial injury to the eye and adnexa	46.6-53.6	0.9-1.1	47.5-54.7
Contusion to the eye and adnexa	16.5-19.0	4.1-4.7	20.6-23.7
Foreign body external eye	24.0-27.6	>0.1	24.1-27.8
Burn confined to eye and adnexa ^b	3.4-3.9	>0.1	3.5-4.1
Orbital floor fracture, blowout	3.6-4.2	3.0-3.5	6.6-7.7
Total injury-related eye diagnoses^c	108.0-124.3	10.9-12.6	118.9-137.0

Abbreviations: ED, emergency department; ICD-9-CM, International Classification of Diseases, Ninth Edition, Clinical Modification.
^aRange of ICD-9-CM-coded diagnoses based on lower estimate of 462 ophthalmologists and upper estimate of 532 ophthalmologists taking ED call.
^bJudged as "essential" diagnostic codes because other specialists are unlikely to substitute equivalent care.
^cSee Table 1 for list of ICD-9-CM injury-related codes and descriptions.

Table 6. Rates of ED Category-Specific Primary Diagnosis per Ophthalmologist On Call 2006^a

Diagnostic Code Description	No. per Ophthalmologist		
	Primary ED Diagnosis ^b	Primary Emergency Admission Diagnoses	Total Primary ED and Emergency Admission Diagnoses
Open wounds to the eye	1.4-1.7	0.4-0.5	1.8-2.2
Wounds to the ocular adnexa	9.0-10.4	0.1-0.2	9.1-10.6
Superficial injury to the eye and adnexa	37.0-42.6	0.04-0.04	37.0-42.6 ^c
Contusion to the eye and adnexa	9.0-10.3	0.2-0.3	9.2-10.6
Foreign body external eye	21.1-24.4	0.004	21.1-24.4 ^c
Burn confined to eye and adnexa	2.8-3.3	0.009-0.01	2.8-3.3 ^c
Orbital floor fracture, blowout	2.0-2.3	0.5-0.6	2.5-2.9
Total injury-related eye diagnoses^d	82.3-95	1.2-1.6^c	83.8-96.5

Abbreviations: ED, emergency department; ICD-9-CM, International Classification of Diseases, Ninth Edition, Clinical Modification.
^aRange of ICD-9-CM-coded diagnoses based on lower estimate of 462 ophthalmologists and upper estimate of 532 ophthalmologists taking ED call.
^bPrimary diagnosis corresponds to number of ED outpatient visits, since only 1 diagnosis was recorded per patient.
^cTotals have been rounded.
^dSee Table 1 for list of ICD-9-CM injury-related codes and descriptions.

The ED workload for conditions unrelated to injury was high, ranging from 127.5 to 146.8 primary diagnoses per ophthalmologist annually and 4.7 to 5.5 pri-

Table 7. Rates of ED Diagnoses for Eye and Ocular Adnexa Unrelated to Injury per Ophthalmologists On Call 2006^a

Description	ICD-9-CM Codes	No. per Ophthalmologist			
		Primary ED Diagnosis	Cumulative ED Diagnoses	Primary Hospital Admission Diagnosis	Cumulative Hospital Discharge Diagnoses
All eye and ocular problems unrelated to injury	360.0-379.9	127.5-146.8	236.1-271.9	4.7-5.5	183.2-210.9
Corneal ulcer ^b	370.00-370.07	3.3-3.8	3.8-4.4	0.16-0.18	0.4-0.5
Endophthalmitis ^b	360.00-360.04	0.65-0.75	1.1-1.2	0.13-0.15	0.6-0.7

Abbreviations: ED, emergency department; ICD-9-CM, *International Classification of Diseases, Ninth Edition, Clinical Modification*.

^aRange of ICD-9-CM rates based on lower estimate of 462 ophthalmologists and upper estimate of 532 ophthalmologists taking ED call.

^bJudged as "essential" diagnostic codes because other specialists are unlikely to substitute equivalent care.

mary hospital admissions per ophthalmologist annually (**Table 7**). Nonophthalmologist physicians probably manage the majority of patients in the ED with these diagnoses, however. Two essential diagnostic categories were examined in greater detail: corneal ulcers and endophthalmitis. The annual cumulative rate of ED corneal ulcers was 3.8 to 4.4 per on-call ophthalmologist. In addition, there were 0.16 to 0.18 hospital admissions with this primary diagnosis per on-call ophthalmologist (Table 7). The cumulative rate of ED endophthalmitis was 1.1 to 1.2 per on-call ophthalmologist, with 0.13 to 0.15 hospital admissions per on-call ophthalmologist per year (Table 7).

COMMENT

Florida, like many other states, faces continuing problems with providing access to ED health care, particularly when it involves surgical specialties.^{3,12-15} One of the shortcomings in describing the dilemma of on-call coverage is the lack of data on the actual ED workload that specialists provide. This includes the volume of patient care delivered by a defined number of physician consultants or specialists with hospital staff privileges. To our knowledge, no such population-based estimates exist. We attempted to fill this void by linking large data sets that report ED care and hospital admissions through the ED with the number of ophthalmologists taking ED call in 2006. Although we confess no insight into what might represent an acceptable ED on-call workload, the data generated by this study provide a starting point for monitoring trends as well as developing more sophisticated methods of measuring workload.

We believe the rates of ED eye care use in this study are valid based on comparison with other ICD-9-CM-coded databases and the high rate of institutional compliance with reporting.¹⁶ Since the majority of eye care delivered through the ED is triaged and managed by ED physicians, or specialists whose expertise overlaps with ophthalmologists (eg, plastic surgery, neurology), only a minority of cases require the participation of an on-call ophthalmologist. The level of ophthalmologist involvement in ED care is highly variable and a function of multiple factors. Discussion concerning the appropriate level of ophthalmologist participation in the delivery of ED care is beyond the scope of this study, but we have introduced the concept of minimum involvement with diagnostic cat-

egories deemed "essential." We examined selected ICD-9-CM codes, such as open wounds to the eye, corneal ulceration, endophthalmitis, and burns confined to the eye and ocular adnexa, that we believe require the expertise that only an ophthalmologist can provide.

Other diagnostic codes, such as open wounds to the ocular adnexa, contribute less to the definition of minimal ophthalmology workload, since plastic surgeons or other surgeons could manage these conditions. As can be seen from the survey of primary diagnostic eye codes, the number of patient visits to the ED exceeds the capability of the ophthalmology workforce to handle alone.

Sharing of workload is a reality of ED coverage. Conditions such as injury to the optic nerve and pathway are probably managed in the ED by neurologists or neurosurgeons, as well as ophthalmologists. While ophthalmologists would undoubtedly contribute substantially to the evaluations of these conditions if called on, their expertise could be reserved for the management of disorders that they are more exclusively qualified to handle. Herein lies the difficulty in measuring the full burden of ED eye coverage, since the definition of essential ED care is variable.

Our study provides some insight into the ophthalmology workforce, which in terms of ED coverage is beginning to include a greater proportion of women. Based on the age differential of male and female ophthalmologists taking ED call, women will be assuming a greater role in ED coverage in the foreseeable future. We suspect the greater proportion of female ophthalmologists taking ED call parallels the larger percentage of women practicing ophthalmology over the last 10 to 15 years. The Florida survey also supplies some comparative data concerning on-call coverage provided by general surgeons and other surgical specialists (Table 2).

Several weaknesses in this study are acknowledged, including failure to capture patients treated at Veterans Affairs hospital EDs. Veterans who present to the civilian ED for eye care and are then transferred for admission to a Veterans Affairs hospital would be recorded as an outpatient ED visit rather than an ED admission. Licensed ophthalmologists in training (residents and fellows) were not included in the workforce analysis even though they likely participated in the delivery of ED eye care. They were excluded from analysis because malpractice insurance carriers, postgraduate training organizations, and medical insurance carriers generally do not recognize their participation as principal providers. This workload, how-

ever, would inevitably be captured through the Florida AHCA under the appropriate supervising faculty.

The burden of ED on-call coverage will likely increase if economic hardship continues to shift a greater proportion of the population from employer-based health insurance to no insurance and more ophthalmologists move away from hospital-based practice. The first step in planning for ED consultant coverage is to understand how much ED eye care was delivered by ophthalmologists in the past and, if possible, assess this in terms of essential and nonessential need. This study attempts to examine the complex nature of consultant ED call and provide some measure of population-based coverage from which to build a more effective coverage policy.

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