Veterinary workforce planning is the process of helping ensure that the nation has the right number and mix of veterinary service providers in the right places to provide access to veterinary services at affordable prices that support economically viable veterinary practices. Over the past several decades, numerous reports and articles have been published on the topic of whether the United States has the right number and mix of veterinarians to meet the country's current and future needs. Multiple studies have suggested that there currently is or will be excess capacity in the veterinary workforce. Other studies have suggested that there is inadequate supply capacity in select employment sectors (eg, food animal production, public health, and research) and geographic (mainly rural) areas. The recent National Research Council report found little evidence of workforce shortages in most fields of veterinary medicine and expressed concern that the profession is confronted with an unsustainable economic future owing to the large number of veterinarians being trained and the high debt levels of new graduates.

The 2013 US Veterinary Workforce Study was commissioned by the AVMA to estimate the current and future supply of and demand for veterinarians and veterinary services; results are expected to help inform strategies that will ensure the economic viability of veterinary medicine as the profession works to attract and retain highly qualified professionals. The study identifies and quantifies the implications of key trends and factors related to veterinary workforce decisions, demand for veterinary services, economic viability of practice, and care delivery; estimates the degree to which there is a deficit or excess in the capacity to provide veterinary services; and identifies gaps in current knowledge regarding the veterinary workforce and areas requiring further research. The present article summarizes the methods used and major findings. A companion article prepared by the AVMA Workforce Executive summary

of the 2013 US Veterinary Workforce Study

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Executive summary

Advisory Group, which helped oversee the study, discusses the implications of the study and provides recommendations for future actions.

In this article and the Veterinary Workforce Study itself, supply and demand estimates are presented in terms of FTE veterinarians, with 1 FTE defined as 2,313 hours worked/yr, or the mean number of hours worked annually across all active veterinarians. Reporting supply and demand estimates on the basis of FTEs allows use of a standardized unit to compare current and future supply and demand.

In this article, the term demand reflects consumer willingness to pay for veterinary services at the given price of services or the willingness to hire veterinarians at the given salaries, while the term need refers to an assessment of services that are warranted but not necessarily supported by a willingness of consumers to pay for those services at the current prices. Finally, the term supply represents the capacity to provide veterinary services in a specific geographic area and employment sector regardless of whether such services are provided by veterinarians, veterinary technicians, or other veterinary staff. Excess capacity refers to the ability to provide services in excess of the quantity demanded at a price that consumers are willing to pay. Excess capacity typically means that veterinarians in a particular geographic area or employment sector are underutilized, often because of insufficient demand for services to keep all veterinarians busy or because veterinarians are keeping busy by performing activities that could instead be provided by a technician or other staff member with less training.

Market indicators often signal whether a health profession is experiencing imbalances between workforce supply and demand. Typical indicators of excess capacity are decreasing incomes, short wait times to access services, difficulties experienced by new graduates in finding employment, and declining productivity relative to historical trends. Most indicators suggest that there currently is excess veterinary capacity at the national level:

- In the AVMA's 2012 pet demographics study, most pet owners reported that for their last visit to a veterinarian, they were able to obtain a visit that same day or the next day, with 85% of owners able to obtain an appointment within 3 days. In contrast, average wait time
Methods

Economic data from the AVMA suggest that mean incomes for veterinarians in clinical practice is decreasing, with the decrease especially pronounced for veterinarians in equine practice. Across all veterinarians, mean income decreased 10% from $112,488 in 2006 to $101,671 in 2012 (in 2012 dollars; mean incomes have not been adjusted for changes in the demographics of the profession).

In its 2012 survey of fourth-year veterinary medical students in the United States actively seeking employment or an advanced education position after graduation who had not received at least 1 offer by approximately 1 month prior to graduation, as a function of graduation year, and mean numbers of offers received for all fourth-year students overall and for fourth-year students who had received at least 1 offer.

Figure 1—Percentages of fourth-year veterinary medical students in the United States actively seeking employment or an advanced education position after graduation, as a function of graduation year, and mean numbers of offers received for all fourth-year students overall and for fourth-year students who had received at least 1 offer.

is 35 business days for a new patient to obtain an appointment with an adult neurologist and 30 days for an existing patient to obtain an appointment for a follow-up visit, with long average wait times to obtain a clinic visit with a pediatric neurologist (45 days), neurosurgeon (24 days), family practitioner (20 days), orthopedic surgeon (17 days), or cardiologist (13 days).

Economic data from the AVMA suggest that mean income for veterinarians in clinical practice is decreasing, with the decrease especially pronounced for veterinarians in equine practice. Across all veterinarians, mean income decreased 10% from $112,488 in 2006 to $101,671 in 2012 (in 2012 dollars; mean incomes have not been adjusted for changes in the demographics of the profession).

In its 2012 survey of fourth-year veterinary medical students in the United States, the AVMA found that 38.5% of respondents actively seeking employment or an advanced education position (eg, internship or residency) had not received an offer at the time of the survey, approximately 1 month prior to graduation (Figure 1). In contrast, percentages of respondents to earlier surveys without an offer ranged from 8.3% to 10.4% between 2003 and 2008, but increased to 20.5% in 2009. In addition, there was a consistent decrease, other than a slight uptick in 2008, in the mean number of offers received, both for all respondents and for those respondents with at least 1 offer. However, in a study of 2011 and 2012 graduates of US veterinary colleges, 98% reported being employed in the veterinary profession a minimum of 6 months after graduation.

Methods

In the 2013 US Veterinary Workforce Study, the effort to model the US veterinary workforce was separated into analyses of current capacity and current demand; results therefore reflect the marketplace at current prices for services and the current socioeconomic characteristics of the consumers of those services. An integral part of the study was an Internet-based survey of veterinarians performed between September and October 2012 to collect information on workforce behavior. A total of 3,497 individuals responded (adjusted response rate, 34.8%). Pertinent information from the survey included information on retirement patterns and intentions, perceptions of local adequacy of veterinary supply capacity, and other workforce-related information. A key component of the study was the development of a veterinary workforce computer simulation model that can be used to project future supply and demand and that allows projections to be refined and updated as new information becomes available.

Modeling supply—Projections of the future supply of active veterinarians were based on a microsimulation model that simulated career choices of individual veterinarians. This microsimulation approach was recently adapted for use by the federal government and its health workforce projections and has been used to model workforce supply for other health professions. Projections were developed by starting with data on individual veterinarians in the AVMA member database, which includes information on association members and nonmembers. At the time of the workforce study, the member database contained information on an estimated 90,705 veterinarians who were active in veterinary medicine during 2012. This starting-year supply estimate was derived from the approximately 98,900 veterinarians listed in the member database whose status suggested they were located in the United States and active in the profession, after removal of a portion (n = 8,195) of those veterinarians > 65 years of age to adjust for overestimates of active veterinarians in the older age groups.

Projections of the future supply of veterinary services took into consideration the growing portion of the workforce that is female and expected shifts in the age distribution of the workforce. The mean number of hours worked by 5-year age group and gender determined from the AVMA’s 2012 biennial economic survey was used to simulate how work patterns would change over a veterinarian’s career.

New veterinarians were added to the supply each year on the basis of estimates of the number of new graduates entering the veterinary workforce from accredited and nonaccredited colleges of veterinary medicine in the United States and internationally. Each new veterinarian was assigned an age and gender on the basis of recent distributions. The geographic distribution of new veterinarians was determined on the basis of projected growth in demand for veterinarians in each state and estimates of the number of veterinarians
retiring from each state, under the assumption that veterinarians would locate in states with the most employment opportunities. Multiple supply scenarios were developed, taking into account expected growth in the number of seats at existing and planned new colleges of veterinary medicine as well as historical patterns in the growth of the number of new veterinary graduates.

**Modeling demand**—The demand component of the veterinary workforce computer simulation model was designed to forecast changes in pet ownership and food animal populations, demand for veterinary services, and derived demand for veterinarians through 2025 by employment sector. Demand was projected at the state level for the small animal, equine, and food animal sectors, but calculated at the national level for the industry, academia, government, and other employment sectors owing to a lack of state-level data and the regional nature of these employment sectors.

Major data sources used to model demand for veterinary services and animal populations included results of previous AVMA economic and pet demographic surveys as well as data from the US Census Bureau. In particular, the American Community Survey, which contains demographic, employment, location, income, and other information on 1,283,700 households representative of the approximately 100 million households in the United States in 2010, was used. Household sample weights for 2011 through 2025 that reflect Census Bureau population projections were developed.

Projections of future pet ownership were used to calculate the demand for small animal veterinarians and small animal veterinary services. To forecast demand for small animals (separately for dogs, cats, birds, and all other small animals), regression analysis of data from the 2007 and 2012 AVMA pet demographic surveys, representing data for 98,200 households, was performed to develop forecasting equations that related propensity to own pets as a function of household characteristics. Poisson regression was then used to predict the likely number of each pet type as a function of household characteristics.

Current and projected uses of veterinary services by pet type were calculated and, along with proportions of time that veterinarians currently spend providing care to each pet type, were used to calculate FTE-to-service ratios. For these calculations, self-reported data from the AVMA’s 2012 biennial economic survey of the amount of time spent providing care to various types of animals were used. This includes enforcing meat and poultry inspection procedures, regulating animal medications, and researching animal diseases. Because many of these veterinarians provide services related to food supply animals, demand for veterinarians in these other government agencies was modeled separately. Veterinarians working for these other government agencies provide many services centered around, but not limited to, the US food animal population. This includes enforcing meat and poultry inspection procedures, regulating animal medications, and researching animal diseases. Because many of these veterinarians provide services related to food supply animals, demand for veterinarians in these other government agencies was modeled separately.

From these calculations, it was estimated that veterinarians in private clinical practice spent 47% of their total time providing care to dogs. Most of this care was provided by veterinarians in small animal practice, followed by veterinarians in mixed animal practices. A tiny proportion of the total time spent caring for dogs was provided by veterinarians in food animal or equine practices. Approximately 28% of veterinarian time was spent providing care to cats.

**Table 1**—Estimated percentages of amounts of time veterinarians in the United States spent providing care to various types of animals, as a function of practice type.

<table>
<thead>
<tr>
<th>Animal</th>
<th>Small animal</th>
<th>Food animal</th>
<th>Equine</th>
<th>Mixed animal</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dogs</td>
<td>43.97</td>
<td>0.62</td>
<td>0.11</td>
<td>1.91</td>
<td>46.61</td>
</tr>
<tr>
<td>Cats</td>
<td>26.30</td>
<td>0.53</td>
<td>0.86</td>
<td>1.05</td>
<td>27.74</td>
</tr>
<tr>
<td>Birds</td>
<td>0.58</td>
<td>0.01</td>
<td>0.00</td>
<td>0.02</td>
<td>0.60</td>
</tr>
<tr>
<td>Other pets</td>
<td>1.13</td>
<td>0.02</td>
<td>0.00</td>
<td>0.04</td>
<td>1.19</td>
</tr>
<tr>
<td>Dairy cows</td>
<td>0.65</td>
<td>5.41</td>
<td>0.07</td>
<td>0.51</td>
<td>6.64</td>
</tr>
<tr>
<td>Beef cows</td>
<td>1.39</td>
<td>3.01</td>
<td>0.07</td>
<td>0.88</td>
<td>5.35</td>
</tr>
<tr>
<td>Swine</td>
<td>0.22</td>
<td>0.88</td>
<td>0.01</td>
<td>0.09</td>
<td>1.20</td>
</tr>
<tr>
<td>Poultry</td>
<td>0.05</td>
<td>0.06</td>
<td>0.00</td>
<td>0.01</td>
<td>0.12</td>
</tr>
<tr>
<td>Horses</td>
<td>2.06</td>
<td>0.51</td>
<td>0.42</td>
<td>1.23</td>
<td>9.22</td>
</tr>
<tr>
<td>Sheep and other livestock*</td>
<td>0.64</td>
<td>0.37</td>
<td>0.07</td>
<td>0.25</td>
<td>1.33</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>77</strong></td>
<td><strong>11</strong></td>
<td><strong>6</strong></td>
<td><strong>6</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

*Includes other small ruminants.
baseline demand scenario, it was assumed that this ratio would continue. With regard to veterinarians working for the Department of Defense, it was assumed that future demand for veterinarians in the military would grow at the same rate as the projected size of the military. The Congressional Budget Office has projected the size of the armed forces to decrease by approximately 1.3% per year between 2012 and 2017. From 2012 through 2025, therefore, the size of the armed forces was assumed to decrease by 17%, and demand for veterinarians in the Department of Defense was assumed to decrease accordingly.

Finally, demand for veterinarians working in academia was modeled as a function of the number of new graduates entering veterinary medicine. Given the number of veterinarians currently working in academia (n = 6,800) and the estimated number of new graduates in 2012, it was calculated that there were approximately 2.08 veterinarians working in academia for every new graduate. Because the amounts of time devoted to teaching, research, and administration could be expected to remain relatively constant over time, it was assumed that this ratio of veterinarians to graduates would remain constant.

**Results**

Respondents to the Internet-based survey performed as part of the Veterinary Workforce Study who indicated that they were engaged in clinical practice were asked to characterize their local markets and their practices' capacity and productivity. Overall, 44% of respondents reported a perception that there were too many veterinarians in their area, and 46% reported a perception of too many veterinary practices. Similar percentages reported perceptions of just the right number of veterinarians (43%) and the right number of veterinary practices (45%); the remainder indicated perceptions of too few veterinarians (13%) or too few practices (9%).

Over half of the respondents indicated their practices were not working at full capacity, and follow-up questions were posed to these respondents to determine the extent of potential productivity available under 2 scenarios. For the first scenario, respondents were asked to assume that there were no changes in the way the practice is organized and no changes in the number of veterinarians or support staff, but an unlimited supply of clients and patients. For the second scenario, respondents were asked to assume that there was an unlimited supply of clients and patients, that additional veterinary technicians and support staff were hired as needed given the supply of clients and patients, and that new staff members were well trained in providing medical care.

For the first scenario, 34% of respondents reported that they could potentially increase productivity by > 25% (Figure 2). For the second scenario, 70% reported they could potentially increase productivity by > 25%, indicating a potential to expand the provision of veterinary services through greater use of support staff.

Through the use of ordered logistic regression analysis, it was estimated that nationally under scenario 1, there was 17% excess capacity for veterinary services were highest for equine practice (23% excess capacity), followed by small animal (18%), food animal (15%), and mixed animal (13%) practice. Importantly, these numbers reflected the fact that 42% of veterinarians who reported on the capacity status of their practice (ie, did not respond “don't know/not sure”) reported that their practice was already working at full capacity.

**Supply projections**—A baseline projection of future supply was calculated under the assumption that current patterns of retirement and hours worked would remain unchanged for the various demographic groups defined by age and gender. Also, for this baseline scenario, current veterinary college enrollment and outcomes of the North American Veterinary Licensing Examination were used to project that the number of new veterinarians entering the US veterinary work-
Demand projections—For 2012, national demand for veterinarians (expressed as FTEs) was calculated as 78,940. Demand for small animal veterinarians (n = 48,800) constituted 62% of estimated total demand, with food animal veterinarians (9,550), veterinarians in academia (6,800), and equine veterinarians (5,640) the next largest sectors (Table 2). By 2025, demand for small animal veterinarians was projected to grow to 54,640 (remaining at 62% of total veterinarian demand).

Demand for food animal veterinarians was expected to grow by 12% (approx 450 FTEs/y) between 2012 and 2025 as a function of population growth and changing household characteristics (including modest growth in average household income). This projected growth rate over the 13-year period (0.9% annual growth, on average) is substantially lower than the 1.3% average annual growth rate projected by Brown and Silverman1 for the period from 1997 to 2015.

Demand for food animal veterinarians was projected to grow only 1% between 2012 and 2025, reflecting slow growth in national populations of dairy cows and beef cattle, which together account for 83% of veterinarians involved in food animal practice. Furthermore, it was considered possible that industry consolidation and improved productivity could contribute to an actual decline in demand for food animal veterinarians. These findings are similar to findings of Brown and Silverman, who estimated a 1.7% decrease between 1997 and 2015 in the number of veterinarians (expressed as FTEs) working in large animal practice.

Comparison of national supply and demand projections (2012 through 2025)—On the basis of the microsimulation model, the ability of veterinarians in the United States to provide services (90,200 FTEs) during 2012 exceeded demand for those services (78,950 FTEs) by approximately 11,250 FTEs. Thus, there exists an excess capacity of approximately 12.5% at current prices for services. Because a large proportion of veterinarians are self-employed and unemployment rates for veterinarians are low, this excess capacity likely took the form of underemployment rather than unemployment. For the baseline scenario, both supply and demand were projected to grow by about 11% between 2012 and 2025 (reaching demand of 88,100 and supply of 100,400 by 2025). Comparison of the baseline supply and demand scenarios, which assume that current trends in supply and demand continue, suggests that the magnitude of the excess capacity will remain between 11% and 14% through 2025 (equivalent to 9,300 to 12,300 FTEs). If veterinary practices were to use a greater proportion of veterinary technicians and other staff to provide services, then the excess capacity for the veterinarian workforce could be even higher.

Alternative scenarios—Five scenarios with alternative assumptions of key supply inputs were used to illustrate the sensitivity of supply projections to the number of new entrants to the US workforce, the number of hours worked, and delayed or earlier retirement (Figure 3).

- Flat growth in number of new veterinary graduates—This scenario modeled the implications of keeping the number of new entrants constant starting in 2016 (the last class for which enrollment data were available).
- Flat growth scenario plus known expansions—This scenario modeled the implications of keeping the number of new entrants constant starting in 2016, but also accounting for known expansions as a result of new veterinary colleges at Utah State University (25 additional students starting in 2016), Lincoln Memorial University (100 additional students starting in 2017), and Midwestern University (100 additional students starting in 2018). Although plans for potential veterinary colleges at the University of Arizona and in Buffalo, NY, have been publicly announced, enrollment and first-year graduation information was unknown, so these potential programs could not be considered for this scenario. Likewise, additional enrollment growth in international schools was unknown and therefore not included in this scenario.
- High-growth-rate scenario (4% annual growth)—The annual rate of growth in the number of US citizens graduating from veterinary colleges in the United States and other countries has been approximately 4% over the past 4 years. This scenario modeled the implications if this recent growth trend were to continue. Whereas the baseline scenario assumed that the number of graduates increased by 80 to 95 each year between 2016 and 2025, this high-growth-rate scenario assumed that the number of new graduates would increase by 160 to 220 each year between 2016 and 2025.
- Delayed- and earlier-retirement scenarios—Over time, veterinarians could delay retirement to reflect, for example, changes in the Medicare eligibility age or prolonged careers as a result of improved health. Alternatively, veterinarians might decide to retire earlier because of work-life balance choices. This
scenario modeled the implications of veterinarians delaying or accelerating retirement by 2 years.

- Change-in-total-hours-worked scenarios—Baseline projections reflected the changing demographics of the veterinarian workforce. However, mean total number of hours worked could change to reflect differences in desired work-life balance or the need to work more hours because of high educational debt.

Under every scenario, supply projections exceeded demand through 2025 (Figure 3). Given the high educational debt load of new graduates and the stagnating incomes seen in recent years among veterinarians, it seemed unlikely that veterinarians would reduce the mean number of hours worked because of economic pressures to maintain practice and household income. Likewise, it would seem unlikely that veterinarians would retire earlier than in historical patterns because of a combination of economic pressures, changes in federal policies (eg, an increase in the age of eligibility for Medicare), and the general overall improvement in population health that allows people to live longer and remain healthier. However, as veterinarians work more hours or retire later, fewer veterinarians are required to provide the same quantity of services. Consequently, analysis of the alternative scenarios revealed greater potential for supply projections to exceed baseline estimates rather than fall short of baseline estimates.

Discussion

In summary, results of the Veterinary Workforce Study suggest that at the national level, there is an excess capacity in the provision of veterinary clinical services. Results further suggest that this excess capacity is likely to persist for the foreseeable future in the absence of reduced growth in the number of new veterinarians trained or efforts to expand the use of veterinary services. In fact, the results suggest that, all things being equal, excess capacity is more likely to become more severe rather than less severe.

Although at the national level there appears to be excess capacity in veterinary clinical practice, in certain geographic areas and employment sectors (eg, research), there may be pockets where there is insufficient capacity to meet the demand for services. Despite the increased difficulty that new veterinary graduates are having finding employment, the large number of employment offers made to some new graduates and the perception by some practitioners that they are operating at full capacity demonstrate that excellent markets for veterinary services do exist and suggest that top students at well-regarded colleges of veterinary medicine will have little difficulty finding employment.

Why is it important to have supply and demand in balance? From a societal perspective, the nation’s resources should be put to their most efficient use. Training too many veterinarians uses educational and financial resources that could have been put to other uses, but more importantly, it reduces the average productivity of veterinarians over the course of their 30- to 40-year career. Excess capacity reduces the financial viability of veterinary medicine, placing a financial burden on veterinarians and their families, especially new veterinarians entering the workforce with high levels of educational debt. As articulated by Getz,3 “As long as the excess supply continues…a number of persons trained to be veterinarians seem likely to be disappointed in their economic circumstance.”

Training too few veterinarians also has costs. With too few veterinarians, services needed by animals may not be provided, even when the owners of these animals are able and willing to pay prevailing prices for those services. National shortages tend to exacerbate geographic inequalities in supply, with the available workforce gravitating toward metropolitan and higher-income areas. However, while there may be a rationale to refocus the training of some veterinarians (eg, away from clinical practice and toward research), the indica-

Figure 3—Baseline projections of the supply of and demand for veterinarians (expressed as FTEs, with 1 FTE defined as 2,313 hours worked/y) in the United States from 2012 through 2025 and projected supply under various alternative scenarios for number of new entrants to the veterinary workforce, number of hours worked by veterinarians, and delayed or earlier retirement of veterinarians.
tors are that the nation is producing more veterinarians than are required to meet the overall demand for veterinary services at prevailing prices.

There exists in every industry an optimal level of excess capacity to provide the ability to react to increasing demands of society while providing adequate remuneration for services. The optimum level of excess capacity in the veterinary profession has not been identified; however, market indicators suggest that the current level of excess capacity is higher than optimal.

**Study Strengths and Limitations and Areas for Future Research**

The main strengths of the Veterinary Workforce Study are the use of recent data sources and state-of-the-art projection methods to simulate the current and future supply of and demand for veterinary services and veterinarians. Whereas traditional workforce models often start with the assumption that supply and demand are in equilibrium in the base year, this study used recent observations of the local adequacy of supply to quantify the current relationship between supply and demand. Data challenges identified during the study included the following concerns:

- Estimates of excess capacity during 2012 were based on the self-reported perceptions of veterinarians as to whether their local supply was adequate and the degree of excess capacity within their practices. Still, the perceptions of excess capacity were consistent with market indicators (eg, decreasing incomes, short wait times to access services, difficulties experienced by new graduates in finding employment, and declining productivity relative to historical trends).

- Modeling of demand for veterinary services was complicated by the large variation in the types of work provided by veterinarians. A more detailed analysis of how much time is spent providing specific veterinary services would improve the estimate of the demand for veterinary services, especially given the mix of services will likely change over time.

- Little information to model trends in the demand for veterinarians in industry is available.

- Additional research is needed to better understand trends in horse ownership by type of owner and horse use.

- The demand analysis took into consideration changes in the racial and ethnic composition of the US population. However, there may be additional diversity or cultural differences that warrant additional research.

These data limitations highlight potential areas for future research:

- Develop more objective measures of the demand for veterinary services.
- Develop early warning indicators of imbalances between supply and demand (similar to the Aggregate Demand Index developed by the Pharmacy Manpower Project).
- Conduct research on the price sensitivities of animal owners. Research is needed to better understand the degree to which changing the price of services will increase or decrease the volume of veterinary services used.

- Monitor the careers of new veterinarians by selecting a sample of new graduates each year to participate in a long-term study exploring the career trajectories of individuals who become veterinarians in the current workforce environment.

- Acquire additional information on the average amount of time veterinarians spend providing specific types of services. Such information could improve the ability to simulate the demand implications of changes in the mix of services demanded and the implementation of alternative care-delivery models, such as greater use of nonveterinarian staff.

- Continue to update the computer simulation model inputs and refine model components, parameters, and assumptions.

**References**


18. Merritt Hawkins and Associates. 2009 survey of physician ap-


