Data, Methods, and Tips for Health Workforce Supply and Demand Modeling

May 14, 2014
By Tim Dall
Goals

• To describe alternative approaches to health workforce supply and demand modeling at the national, state, and local levels
• To discuss data sources
• To share tips and best practices to help ensure study success
Agenda

• Terms and definitions

• Demand modeling
  – Evolution of health workforce modeling
  – Advantages and disadvantages of alternative approaches
  – Data and methods

• Supply modeling
  – Evolution of health workforce modeling
  – Advantages and disadvantages of alternative approaches
  – Data and methods

• Tips for improving workforce study success
Terms and Definitions

• Health care services
  – Demand: amount of services that people are willing to use at different price points
  – Utilization: actual use (usually analyzed in the form of medical claims)
  – Need: an informed opinion on the level of services that would be appropriate

• Workforce “requirements”
  – Demand: number and mix of health workers to meet demand for services
  – Need: an informed opinion on the number and mix of health workers to meet the need for services
    • Minimum need
    • Best practices
Terms and Definitions, cont.

• **Supply**
  – Licensed: health workers eligible to work
  – Active: health workers employed or seeking employment in an area that requires their clinical skills or knowledge
  – Full time equivalent (FTE): “standardized” measure of active supply taking into account part time workers
    • Example 1: Full time = 1 FTE; part time = ½ FTE
    • Example 2: FTE = average patient care hours worked among providers working at least 30 hours per week

• **Adequacy of supply**
  – Shortfall: Demand exceeds supply
  – Surplus (excess supply): Supply exceeds demand
  – Equilibrium: Supply equals demand (± X%)
Terms and Definitions, cont.

• Models

“A model is a mathematical framework representing some aspects of reality at a sufficient level of detail to inform a clinical or policy decision” ¹

Demand Modeling

- Drivers of demand for services and providers
- Modeling approaches
- Data and model inputs
Drivers of Demand for Health Care Services

- Epidemiological factors (need, or perceived need)
  - Correlated with demographics (particularly age)
  - Correlated with other health risk factors (e.g., disease presence)

- Price and socioeconomic factors (ability/willingness to pay)
  - If a person has medical insurance, the correlation between use of health care services and household income largely disappears

- Health care system characteristics and economic considerations
  - Reimbursement/ what services are covered, value-based pricing
  - Provider-induced demand
  - Defensive medicine

- Technology (treatment possibilities)

- Societal norms and expectations
Drivers of Demand for Health Care Providers

• Demand for services
  – Mix of services by condition and care delivery setting
  – Complexity of services

• Provider characteristics
  – Scope of practice
  – Cost or relative value (e.g., physician assistant vs physician)
Models Differ in Approach, Complexity, and Value

**Demand Models**

- **Provider-to-population ratios (benchmarking)**
  - Examples: Weiner, HMO Model (1994)

- **Correlation analysis (econometric)**
  - Examples: Cooper, Trend Model (2002)

- ** Macrosimulation (population based)**
  - Examples: HRSA Models 1990s-2012

- **Microsimulation (person based)**
  - Examples: HRSA Models 2013+, IHS Models, SHEPS Models

**Needs-based Models**

- **Provider-to-population ratios, benchmarking**
  - Examples: HRSA HPSA designations

- **Expert Panels Need/demand hybrid**
  - Examples: GMENAC (1970s)

- **Simulation**
  - Examples: Application of HRSA, IHS, SHEPS models
FTE Practitioner Use per 100,000 Population, by Age Group (based on utilization patterns)

HRSA (2013): Projecting the Supply and Demand for Primary Care Practitioners Through 2020
Demand for FTE Primary Care Providers/10K Population

- Non-Hispanic, black, female, age 75+, insured, with diabetes, with hypertension, obese: 26 FTE/10,000 population
- Non-Hispanic, black, female, age 75+, insured, no diabetes, no hypertension, normal weight: 8.6 FTE/10,000 population
- Non-Hispanic, black, male, age 18-34, insured, with diabetes, with hypertension, obese: 5.9 FTE/10,000 population
- Non-Hispanic, black, female, age 18-34, insured, no diabetes, no hypertension, normal weight: 2.4 FTE/10,000 population
Cooper’s Economic Trend Model


- Healthcare system too complex to model, so identify few key drivers of demand
- Our demand is limited primarily by our ability to pay for services
- “The major trend affecting demand for physician services is the economy.” (income elasticity = 0.75)
- “Population growth is a second major factor that affects demand for physicians.”

![Graph showing physician supply and gross domestic product from 1929 to 2000 and projected to 2020.](image-url)
Tim’s Apple Trend Model

• Key findings
  – A major trend affecting demand for physician services is apple consumption
  – Consumption of 118,000 apples reduces physician demand by 1
  – National per capita consumption of an apple/day reduces physician demand to zero

• Key implication
  – “An apple a day keeps the doctor away”

Source: Analysis of per capita apple consumption: 1970 - 2004

\[
y = -2.557x + 284.23
\]
Limitations of Historical Approaches to Modeling Demand

- Population averages (provider-to-pop ratios) inflexible for modeling
  - Geographic variation in health risk factors other than demographics
  - Paradigm shifts in care delivery
  - Policy changes such as Health Care Reform
- Few demand drivers (demographics, income, insurance, HMOs)
- Reliance on key assumptions (e.g., economic growth, HMO growth)
- Expert panel limitations
  - Convolution of “need” versus “demand”
  - Bias: e.g., physicians and nurse practitioners likely have very different views on scope of practice and implications for provider demand
- Static models
  - Utilization is independent of supply
  - Provider demand is independent of other “factors of production”
Healthcare Demand Microsimulation Model: Overview

**Utilization Patterns**
Relationship between patient characteristics and health care use

**Population Database**
Demographic, socioeconomic, & health risk factors

**External Factors**
Trends or changes in policy, prices, economic conditions, technology

**Service and Product Demand**

- **Hospital**
  - Inpatient Days
    - By diagnosis category
  - Emergency Visits
    - By diagnosis category

- **Ambulatory**
  - Provider Office Visits
    - By occupation/specialty
  - Outpatient Clinic Visits
    - By occupation/specialty
  - Dentist Office Visits
    - By occupation/specialty

- **Post-acute/Long Term**
  - Nursing Facilities
  - Residential Care
  - Home & Hospice Visits
    - By occupation

**Staffing Patterns**
By occupation/specialty & setting

**Health Workforce Demand**
By occupation/specialty and setting

**Other Employment**
Public health
School health
Academia
Other
Develop Representative Sample of Current and Future Population to Model Demand

Combines:
Behavioral Risk Factor Surveillance System (BRFSS)
American Community Survey (ACS)
National Nursing Home Survey (NNHS)
Create Population Database

• ACS-BRFSS match based on same state, age group, gender, race/ethnicity, income level, insurance status

• ACS-NNHS match based on same age group, gender, race/ethnicity
Project Demand for Services: Chronic Disease Example

Source: Dall et al., 2013, Health Affairs
Example: Healthcare Utilization for Cardiologist and Cardiology-Related Services

<table>
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<tr>
<th>Race-Ethnicity</th>
<th>Parameter</th>
<th>Office Visits(^1)</th>
<th>Outpatient Visits(^1)</th>
<th>Emergency Visits(^2)</th>
<th>Hospitalization(^2)</th>
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<td>0.67**</td>
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<td>0.12**</td>
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<td>35-44 years</td>
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<td>0.59**</td>
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<td>45-64 years</td>
<td>0.53**</td>
<td>0.72**</td>
<td>0.83**</td>
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<td>65-74 years</td>
<td>0.88**</td>
<td>1.35**</td>
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<td>0.90**</td>
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<td>75+ years</td>
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<td>Smoker</td>
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<td>0.62**</td>
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<th>Emergency Visits(^2)</th>
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<td>Hypertension</td>
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<td>Coronary heart disease</td>
<td>7.03**</td>
<td>6.37**</td>
<td>2.60**</td>
<td>3.39**</td>
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<td>History of heart attack</td>
<td>1.61**</td>
<td>1.90**</td>
<td>2.50**</td>
<td>2.58**</td>
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<td>History of stroke</td>
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<td>0.80**</td>
<td>2.38**</td>
<td>2.53**</td>
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<td>Diabetes</td>
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<td>1.51**</td>
<td>1.08**</td>
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<td>Arthritis</td>
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<td>1.32**</td>
<td>0.94**</td>
<td>0.89**</td>
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<td>Asthma</td>
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<td>1.05**</td>
<td>1.09**</td>
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<td>Insured</td>
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<td>1.14**</td>
<td>0.76**</td>
<td>0.99</td>
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<td>History of cancer</td>
<td>1.15**</td>
<td>0.83**</td>
<td>0.93**</td>
<td>0.91**</td>
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<th>Household Income</th>
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<th>Office Visits(^1)</th>
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<td>&lt; $10,000</td>
<td>0.89**</td>
<td>0.64</td>
<td>1.66**</td>
<td>1.53**</td>
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<td>$10,000 to &lt; $15,000</td>
<td>0.83**</td>
<td>0.64**</td>
<td>1.36**</td>
<td>1.51**</td>
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<td>$15,000 to &lt; $20,000</td>
<td>0.85**</td>
<td>0.86**</td>
<td>1.10**</td>
<td>1.28</td>
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<td>$20,000 to &lt; $25,000</td>
<td>0.93**</td>
<td>0.39**</td>
<td>1.35**</td>
<td>1.32</td>
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<tr>
<td>$25,000 to &lt; $35,000</td>
<td>0.88**</td>
<td>0.78**</td>
<td>1.56**</td>
<td>1.36**</td>
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<td>$35,000 to &lt; $50,000</td>
<td>1.05**</td>
<td>0.69**</td>
<td>1.17**</td>
<td>1.16**</td>
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<tr>
<td>$50,000 to &lt; $75,000</td>
<td>0.99</td>
<td>0.80**</td>
<td>1.06**</td>
<td>1.09**</td>
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<td>$75,000 or higher</td>
<td>1.00</td>
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<th>Body Weight</th>
<th>Parameter</th>
<th>Office Visits(^1)</th>
<th>Outpatient Visits(^1)</th>
<th>Emergency Visits(^2)</th>
<th>Hospitalization(^2)</th>
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<tr>
<td>Not available</td>
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<td>0.89**</td>
<td>2.26**</td>
<td>1.98</td>
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<tr>
<td>Normal</td>
<td>0.97**</td>
<td>0.97</td>
<td>1.14**</td>
<td>1.02</td>
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<td>Overweight</td>
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<tr>
<td>Obese</td>
<td>1.04**</td>
<td>0.69**</td>
<td>1.09**</td>
<td>1.12</td>
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<td>Metro area</td>
<td>1.35**</td>
<td>0.94**</td>
<td>1.04</td>
<td>0.93</td>
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1 Rate ratios from Poisson regression analysis using 2006-2010 Medical Expenditure Panel Survey (MEPS).
2 Odds ratios from logistic regression analysis using 2006-2010 MEPS.
Statistically significant at the 0.05 (*) or 0.01 (**) level.
# Distribution (%) of Nurses Across Employment Settings

<table>
<thead>
<tr>
<th>Work Setting</th>
<th>RNs</th>
<th>LPNs</th>
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<tr>
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<tr>
<td></td>
<td>OES</td>
<td>2008-10 ACS</td>
</tr>
<tr>
<td></td>
<td>2012</td>
<td>2010</td>
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<td>Hospitals</td>
<td>62.0</td>
<td>60.4</td>
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<tr>
<td>Inpatient</td>
<td>55.6</td>
<td>54.1</td>
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<tr>
<td>Emergency</td>
<td>6.4</td>
<td>6.3</td>
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<tr>
<td>Offices</td>
<td>7.4</td>
<td>9.8</td>
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<td>Outpatient</td>
<td>4.0</td>
<td>4.5</td>
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<tr>
<td>Home health</td>
<td>6.2</td>
<td>5.5</td>
</tr>
<tr>
<td>Government</td>
<td>5.6</td>
<td>5.8</td>
</tr>
<tr>
<td>Nursing care facilities</td>
<td>5.3</td>
<td>5.1</td>
</tr>
<tr>
<td>(skilled/long term)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential care facilities</td>
<td>1.7</td>
<td>1.6</td>
</tr>
<tr>
<td>Nurse education</td>
<td>3.1</td>
<td>1.2</td>
</tr>
<tr>
<td>School health</td>
<td>1.9</td>
<td></td>
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<tr>
<td>Social work</td>
<td>0.7</td>
<td>0.7</td>
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<tr>
<td>Public/community health</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>2.2</td>
<td>5.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
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</table>

Sources and notes:  

- Occupational Employment Statistics.  
- 2008-2010 pooled files of the American Community Survey, reported in HRSA 2013 nursing report.  
- 2008 National Sample Survey of Registered Nurses.  
- Nurses in teaching positions might be recorded in the ACS under teaching rather than under nursing.  
- Estimated based on estimate that 89.6% of hospital nurses are working in inpatient settings and 10.4% are working in emergency settings, with nurses in administration allocated proportionately across settings (from the 2008 NSSRN).  
- Numbers might not sum to 100% because of rounding.
Care Delivery Patterns: Converting Service Demand to Health Profession FTEs

• Translate demand for health care services into full time equivalent (FTE) providers
  – Example: 1,000 ambulatory visits to a pediatrician equates to approximately 0.23 FTE pediatrician; 1,000 hospital rounds equates to approximately 0.48 FTE pediatrician

• Data sources
  – Occupation/specialty/setting specific surveys and studies
  – National organizations (e.g., Medical Group Management Association’s Physician Compensation and Production Survey)
  – National ratios (e.g., home health aides to home health visits)
  – Reported statistics (e.g., nurse staffing ratios in nursing homes)
Conceptual Model for Health Workforce Supply

Current Active Supply + New Entrants - Attrition = Future Active Supply

Workforce Participation
- Hours Worked
- Change in Occupation, Specialty, or Education Level
Modeling Health Care Supply: Traditional Approach

• “Cohort” or “Inventory” model
  – By profession, age, gender, location (e.g., state), other (e.g., education level)
  – Estimate supply components (by provider characteristics)
    • # current providers
    • # new entrants to the health workforce each year
    • # retirements each year
    • Average hours worked

• Framework
  – Supply generally modeled separate from demand; static versus dynamic
  – Cohort averages applied (e.g., retirement probability, hours worked)
  – Cohort approach usually works fine for general forecasting
Microsimulation Approach to Supply Modeling

- Individual providers are unit of analysis
- Start with database of providers
  - Characteristics similar to cohort approach: age, gender, specialty/occupation, location
- Simulate provider choices (e.g., specialty, location, hours, retirement) over career
  - Estimate choice probability as function of provider characteristics and external factors
  - Example: work location choice is function of
    - Provider characteristics (age, gender, specialty, IMG)
    - Location characteristics (shortfall/surplus, earnings potential, other)
    - Policies (e.g., state scope of practice regulations for NPs/PAs)
  - Compare probability to random number generator to simulate choices
- New graduates: “create” new individuals
  - Characteristics reflect distribution of current/future graduates in terms of age, gender, specialty/occupation
# Strengths and Limitations of Alternative Supply Approaches

<table>
<thead>
<tr>
<th>Features</th>
<th>Traditional (Cohort) Approach</th>
<th>Microsimulation Approach</th>
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<tbody>
<tr>
<td>Simplicity</td>
<td>Simpler</td>
<td>More complex</td>
</tr>
<tr>
<td>Data needs</td>
<td>Fewer data needs</td>
<td>Greater data needs</td>
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<tr>
<td>Flexibility for modeling policies and trends in supply determinants</td>
<td>Less flexible</td>
<td>More flexible</td>
</tr>
<tr>
<td>Static versus dynamic:</td>
<td>Less flexible</td>
<td>More flexible</td>
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<tr>
<td>• Integrate supply &amp; demand</td>
<td></td>
<td></td>
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<tr>
<td>• Integrate economic factors</td>
<td></td>
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<tr>
<td>Research needs</td>
<td>Compute averages</td>
<td>Regression analysis or other approaches to calculate model parameters</td>
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<tr>
<td>Accessibility</td>
<td>Can be developed in MS Excel spreadsheet</td>
<td>Requires more powerful software (e.g., SAS)</td>
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Supply-Related Data Sources

- State licensure files
  - Many states collect valuable information via survey at relicensure

- National and profession surveys
  - American Community Survey
  - HRSA Nurse Practitioner survey
  - AAMC Physician Workforce Survey
  - Individual profession surveys

- Association/licensure databases
  - American Medical Association Masterfile
  - American Dental Association Masterfile
  - National Commission on Certification of Physician Assistants Masterfile

- Integrated Postsecondary Education Data System (IPEDS)
Prediction Equations for Supply Decisions

- Supply data analyzed
  - American Community Survey for non-physicians
  - Profession-specific data (e.g., AMA Masterfile, ADA Masterfile)

- Modeling approach
  - Linear/non-linear regression models
  - Potential hourly earnings
    - Estimated using data on average earnings of employed people in same profession and geographic area, and person’s characteristics
  - Hours worked, probability active, separation rates
    - Estimated using data on age group, gender, unemployment rate, and potential hourly earnings
      - Working to incorporate local estimates of adequacy of supply (PUMA level, Public Use Micro Area)
Average Weekly Patient Care Hours Across Primary Care Physician Specialties

Source: FL Physician Survey, 2012-1013
Physician Retirement Rates

Source: Analysis of the 2006 AAMC Survey of Physicians Over Age 50, combined with CDC mortality rates.
Workforce Attrition for General & Family Practice Doctors in FL

Sources: CDC mortality rates combined with FL survey data (intention to retire in next 5 years)
RESOURCES AND TIPS FOR SUCCESSFUL WORKFORCE STUDY
Resource: State/Researcher Access to Nursing Component of Web-Based Workforce Model

- Web-based version of model currently being developed by HRSA and will be beta tested with select states
  - States have access to more accurate nurse workforce data through licensure process
  - States will have ability to upload their minimum data sets for nursing
  - States will have ability to run supply and demand scenarios related to nursing
Tips for Successful Study

• Up front, clearly define goals of the study
  – Primarily interested in forecasting? Interest in policy analysis?
• Use an advisory committee that includes clinicians
• Beware of small specialties (small sample size issues)
• Give the supply data a thorough cleaning
  – Some licensed providers might not be actively practicing even if their records indicate they are active
  – New licenses to the state workforce might include physicians in GME who do not intend to practice in the state, locum tenens, retirees
• Conduct sensitivity analyses and stress tests with the model
• Use the peer review process to check your proposed approach and findings
• Models and projections need periodic updating and refinement
  – Consider future data availability