Health Workforce Modeling Using a Microsimulation Approach

International Health Workforce Collaborative

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Background

- Workforce study sponsors in the US
  - Federal government
    - Bureau of Health Professions (BHPr), Health Resources and Services Administration (HRSA)
    - Department of Labor (DOL)
    - Assistant Secretary for Planning and Eval.(ASPE), Dept of Health and Human Services (HHS)
    - Others (e.g,. Department of Defense)
  - State governments
  - Professional associations
  - Hospital systems
  - Health plans
- Historically, wide variability in methods, data, assumptions, conclusions
  - Most medical specialties or health professions modeled in isolation
  - Demand generally modeled using historical care use/delivery patterns

Model Design Criteria To Consider

- Address key policy or research questions
  - Have flexibility to project S&D under wide range of scenarios—reflecting uncertainties in future trends and to simulate implications of new policies
- Provide the most accurate projections possible
- Build on solid theoretical underpinnings
- Build dynamic model
  - Integrate professions and specialties
  - Link supply and demand
- Take into consideration both current and future availability of data
- Be user friendly for adaptation at the state or local level
- Be easy to maintain/update with new information
- Provide platform for continued improvement

Choice of Microsimulation for Workforce Modeling

- This approach can take better advantage of rich data sources
- Made available by increasingly powerful computers
- Intuitively appealing
  - Supply: career decisions made by individuals and households (not cohorts)
  - Demand: demand for services determined at the individual level (and will vary substantially by individuals); there is no “average” person
- Substantial flexibility to model paradigm shifts in care use and delivery

Dynamic microsimulation models allow construction of appropriate behavioral models at the level on which the relevant decisions are made.

Bacon and Pennec (2009, p. 27)

Recent US Applications of Microsimulation Modeling

- Sheps Center, open source physician workforce model
- IHS Global Inc., Healthcare Demand Microsimulation Model & Health Workforce Supply Model
  - Dall TM, Storm MV, et al. Neurologist Workforce Analysis: Estimating and Forecasting Supply and Demand through 2025. *Neurology*. April 17, 2013 (online ahead of print) http://www.neurology.org/content/early/2013/04/17/WNL.0b013e318294b1cf.short
  - Dall TM, Forte GJ, et al. US Veterinary Workforce Study. *Journal of the American Veterinary Medical Association*. (June 2013).
  - Dall TM, Chakrabarti R, Storm MV, and Rayburn WF. Supply and Demand for Obstetrician Gynecologists, 2010-2020. *Journal of Women's Health*. (forthcoming 2013).
- Health Resources and Services Administration
  - Being developed by IHS Global Inc. and Albany Center for Health Workforce Studies, with Erin Fraher, PhD as a consultant
- Microsimulation modeling also used extensively by US government and other organizations for wide variety of policy/research applications (e.g., military, health, taxes, social policies)

HRSA Health Workforce Simulation Model (HWSM): Professions and Specialties Included

Approx. 50 Health Professions

- Physicians, APRNs and PAs by specialty
- Nurses (RN by education level, LPN)
- Oral health professions
- Non-physician clinicians
- Pharmacy-related professions
- Auditory, visual, and orthotic devices professions
- Therapy-related professions
- Non-physician behavioral health professions
- Other technicians and technologists
- Other health care assistants and aides

40 Specialties (some by child vs adult)

Allergy & Immunology
Anesthesiology
Cardiology
Colon & Rectal Surgery
Critical Care Medicine
Dermatology
Emergency Medicine
Endocrinology
Gastroenterology
General & Family Practice
General Internal Medicine
General Surgery
Geriatrics
Hematology & Oncology
Infectious Diseases
Neonatal-Perinatal Medicine
Nephrology
Neurological Surgery
Neurology
Obstetrics & Gynecology
Occupational Medicine
Ophthalmology
Orthopedic Surgery
Other Specialties
Other Surgical Specialties
Otolaryngology
Pathology
Physical Medicine & Rehabilitation
Plastic Surgery
Preventive Medicine
Psychiatry
Pulmonology
Radiation Oncology
Radiology
Rheumatology
Thoracic Surgery
Urology
Vascular Surgery

Conceptual Model for Supply

- Simulate likely career choices of individual clinicians
  - Microsimulation—modeling workforce decisions of individual clinicians, rather than inventory models that simulate groups of clinicians
- Dynamic modeling
  - Agent-based modeling—actions of one clinician affect the actions of other clinicians
  - Environmental and market factors—clinicians respond to changes in the economy, healthcare operating environment, and policy
- Workforce activities: what, where, how, when
  - What type of work will I do (e.g., choice of physician assistants to specialize)
  - Where will I work (e.g., state of practice)
  - How much will I work?
  - When will I retire?

Supply-Related Data Sources

- American Community Survey (ACS)
  - Used for starting supply estimate for many non-physician specialties
- Association Masterfiles
  - American Medical Association Masterfile
  - American Dental Association Masterfile
- HRSA Surveys
  - Nurse Practitioner Survey
- Integrated Postsecondary Education Data System (IPEDS)
- Association web sites
  - Data on number trained, age/gender distribution of new graduates, other population data for benchmarking and model validation
- State minimum data sets (for nursing)

Prediction Equations

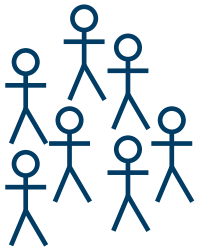
- Data
  - Medical Expenditure Panel Survey for non-physicians
  - Profession-specific data (eg., AMA Masterfile, ADA Masterfile)
- Modeling approach
  - Hierarchical linear/non-linear regression models
    - Individual and state as two levels of analysis
- Equations
  - Potential hourly earnings
    - 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 (and earnings squared for hours worked)

Example: Hours Worked Regressions from ACS

			Age									
SOC Title	Intercept	Unemployed	< 35	35-44	55-59	60-64	65-69	70-74	Male	Year	Wage	Wage^2
Audiologists	37.061	-0.132	2.505	-2.456	0.008	2.415	-2.633	-5.714	7.281	-1.103	1.427	-0.017
Chiropractors	39.462	-0.971	5.937	-1.073	-3.697	-1.656	-9.868	-14.423	5.336	1.878	0.465	0.000
Dental Assistants	34.230	-0.145	-0.457	-0.249	-1.521	-2.065	-6.736	-13.217	0.898	-0.070	8.822	-0.198
Dental Hygienists	30.165	0.008	1.567	0.018	-0.539	-2.829	-4.828	-7.913	4.969	0.201	-0.911	0.007
Dentists	37.904	0.021	0.483	0.632	-1.728	-4.401	-8.496	-11.085	3.914	-0.339	0.501	-0.003
Emergency Medical Technicians and Paramedics	46.485	0.163	-6.840	-1.173	-3.459	-6.784	-19.611	-23.224	6.678	-1.003	0.074	-0.018
Health Technologists and Technicians, All Other	38.615	-0.148	-2.568	-0.043	-0.346	-3.695	-7.549	-10.220	4.188	0.145	0.175	-0.007
Home Health Aides	35.934	0.196	-3.395	-0.609	-0.217	-1.736	-6.371	-9.326	2.366	-0.479	-6.311	0.136
Medical and Clinical Laboratory Technicians	37.929	0.149	-3.079	-0.467	0.151	-1.661	-5.244	-10.942	2.291	-0.169	-1.342	0.020
Medical Assistants	36.912	-0.517	-1.821	-0.878	-2.062	-3.738	-8.634	-10.087	1.439	0.000	4.078	-0.161
Occupational Therapists	35.553	-0.225	1.593	-1.461	0.923	-2.319	-5.107	-12.864	6.912	0.220	2.687	-0.027
Occupational Therapy Aides	35.753	0.658	2.070	0.973	-0.350	-3.462	-5.222	-5.222	0.383	0.248	1.764	0.000
Occupational Therapy Assistants	35.753	0.658	2.070	0.973	-0.350	-3.462	-5.222	-5.222	0.383	0.248	1.764	0.000
Opticians, Dispensing	37.181	-0.050	-3.130	-0.849	0.342	-2.268	-4.673	-8.025	3.876	0.008	-1.917	0.053
Optometrists	38.815	-1.209	7.369	0.470	0.863	-6.062	-10.826	-1.824	-0.670	0.000	2.096	0.000
Pharmacists	37.869	0.059	-3.622	-1.204	-0.265	-2.292	-9.272	-13.329	5.019	-0.565	11.701	-0.073
Pharmacy Aides	32.597	1.053	-9.789	-2.547	0.851	-5.780	-11.292	-10.975	3.371	0.000	-1.344	0.000
Physical Therapist Aides	34.595	-0.112	-2.927	-0.622	1.619	0.562	-7.020	-2.532	2.520	0.061	0.485	0.000
Physical Therapist Assistants	34.595	-0.112	-2.927	-0.622	1.619	0.562	-7.020	-2.532	2.520	0.061	0.485	0.000
Physical Therapists	37.462	-0.209	1.033	-2.200	-0.787	-2.000	-8.579	-12.627	7.117	-0.024	-8.294	0.093
Physician Assistants	40.645	0.089	-0.267	-0.903	-0.804	-4.079	-12.602	-20.081	5.613	0.772	-3.377	0.037
Podiatrists	43.153	-0.992	5.467	2.140	1.615	-7.286	-12.144	-10.046	11.500	2.252	-0.655	0.002
Psychiatrists	36.686	0.170	-2.621	-2.192	-0.325	-3.037	-10.390	-15.287	6.593	-0.242	-1.426	0.010
Registered Nurses	36.755	0.208	-1.627	-1.254	-0.090	-1.815	-7.560	-11.931	3.946	-0.070	0.036	-0.001
Respiratory Therapists	37.716	0.277	-1.841	-0.524	-0.290	-0.562	-6.313	-9.083	3.163	0.170	0.039	-0.002
Social Workers	39.068	0.129	-1.260	-0.956	-0.517	-2.407	-7.332	-8.325	2.876	-0.078	-0.044	-0.003
Speech-Language Pathologists	35.456	0.574	-3.110	-3.824	0.131	-3.117	-7.400	-16.858	4.314	-0.022	0.999	-0.014

Conceptual Model for Demand

Population Characteristics



Healthcare Workload Drivers

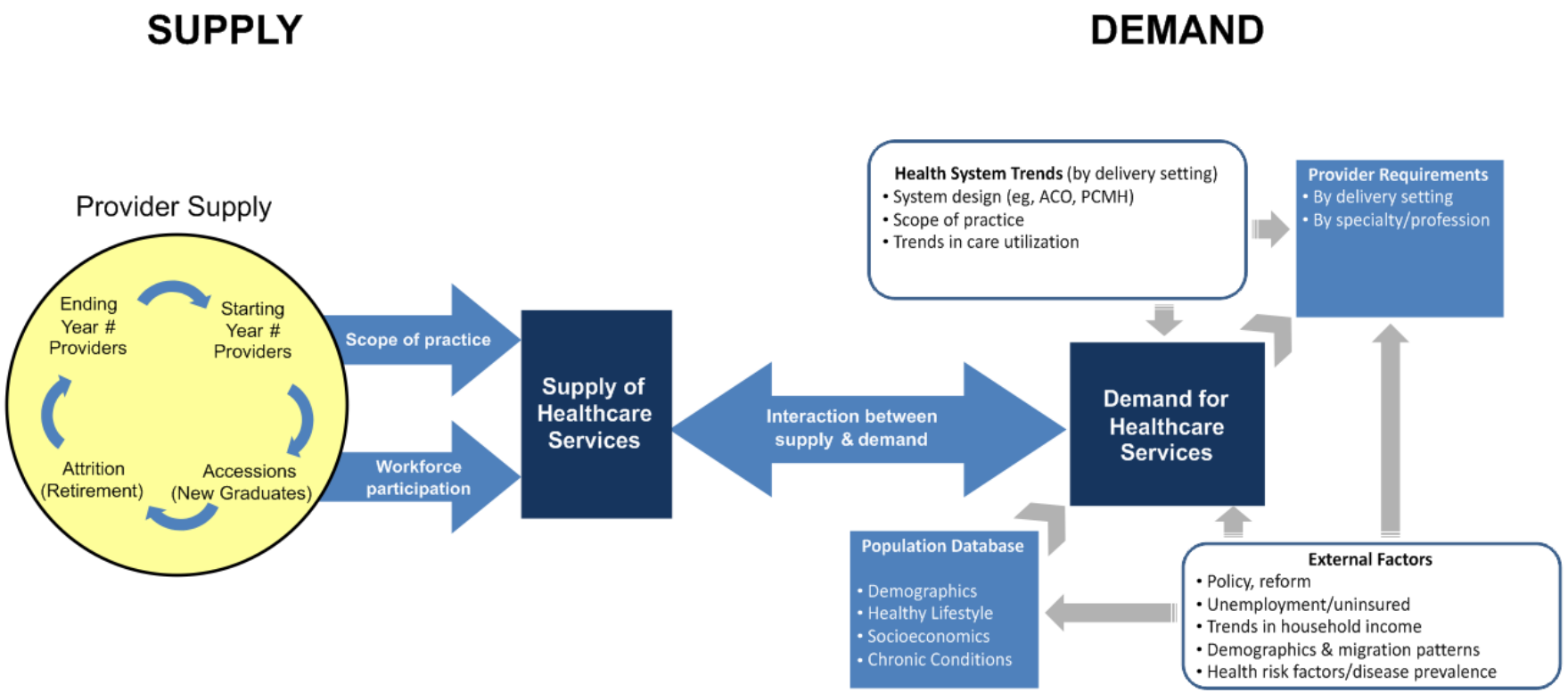
- **Office visits**
- **Outpatient visits**
- **Emergency visits**
- **Inpatient days**
- **Home/hospice visits**
- **Nursing facility residents**
- **Oral health visits**
- **Other services/purchases (eg, glasses, contact lens)**
- **Receipt of care in workplace, school, or non-traditional settings**

Care Delivery

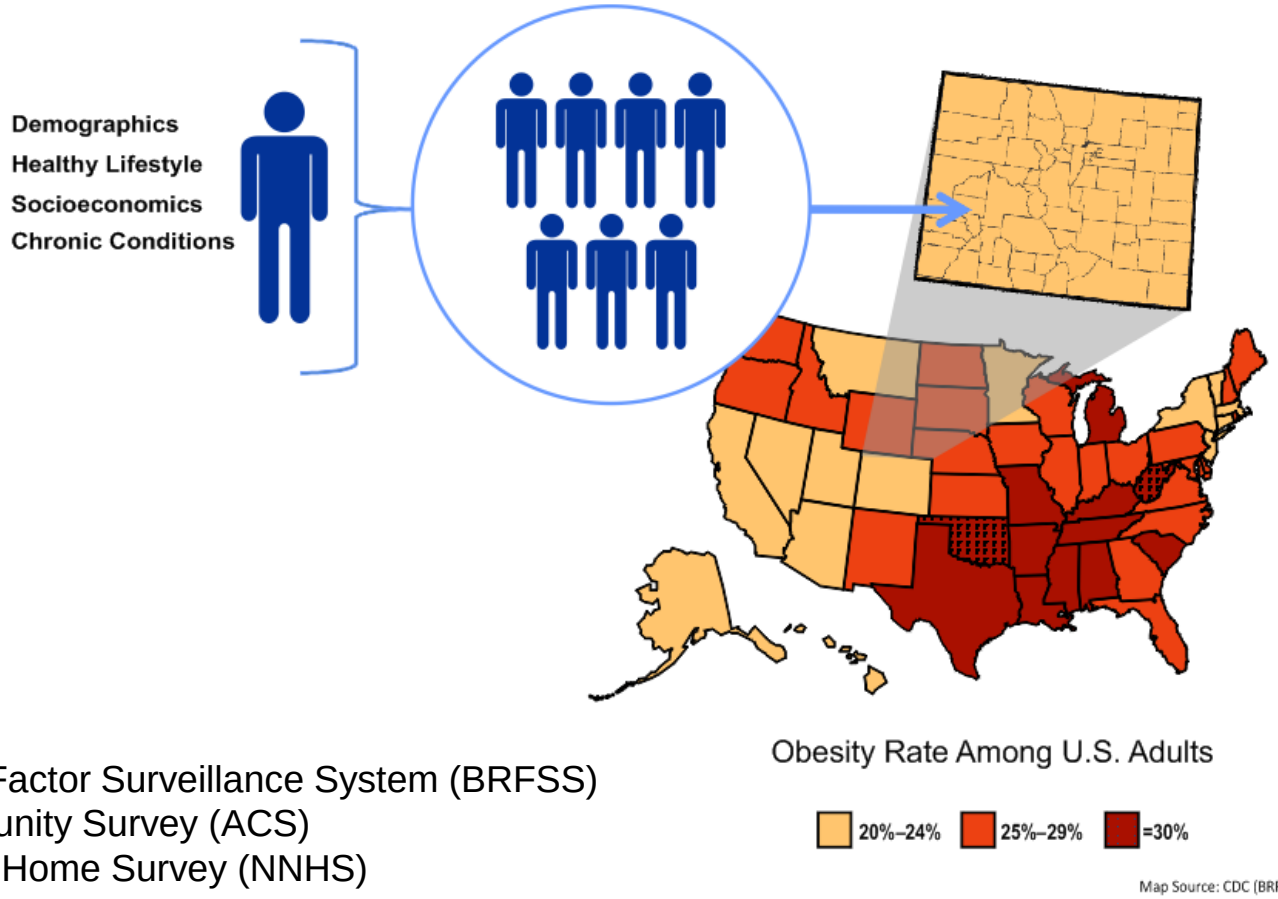
Visit characteristics

- What profession/specialty?
- Was patient seen by APRN/PA?
- What tests or procedures provided?
- Number of prescriptions?
- What is the probability this visit could have been avoided or care provided in other setting or by other provider type?

Health Workforce Simulation Model: Overview

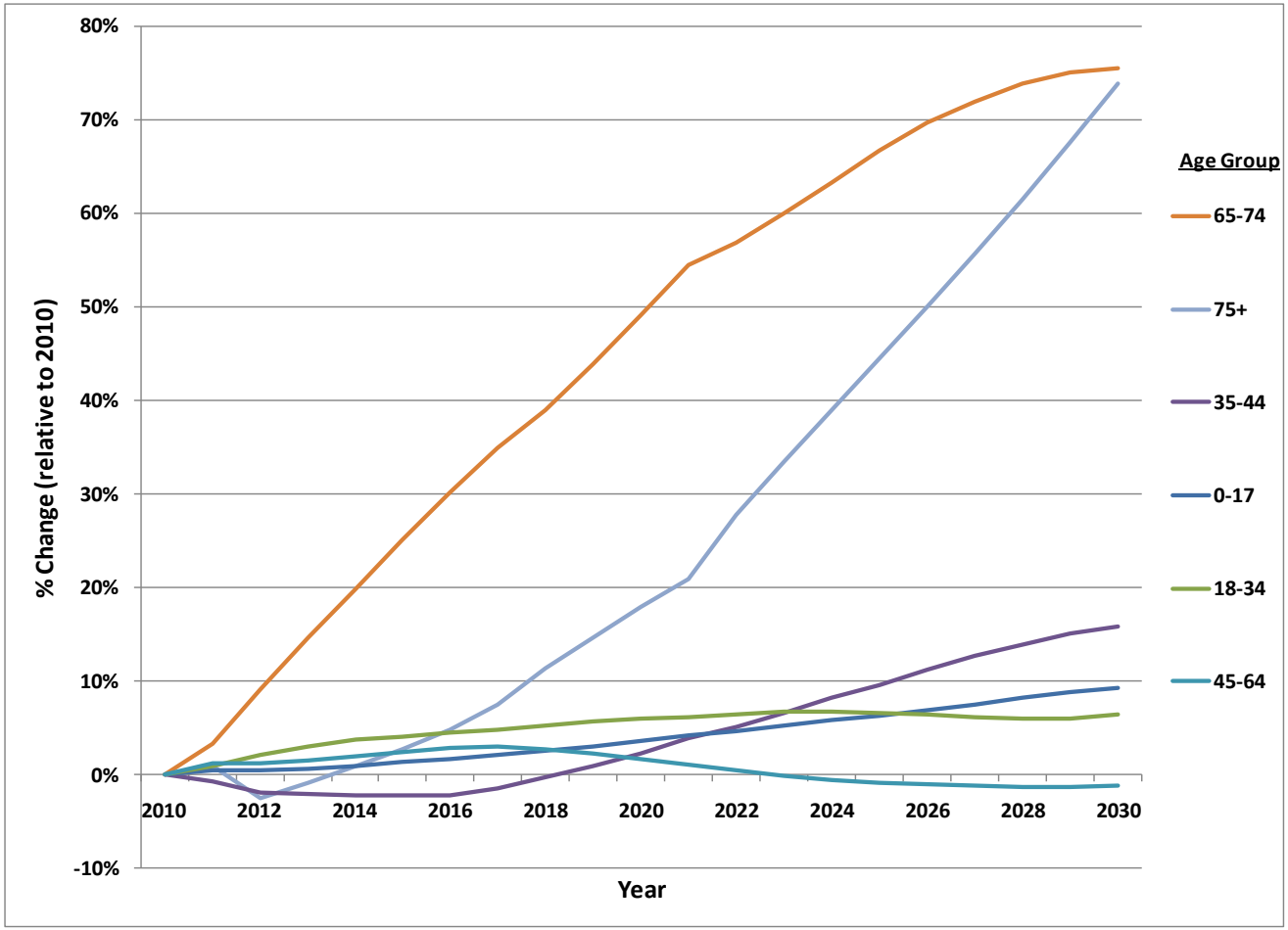


Developed Representative Sample of Current and Future Population to Model Demand

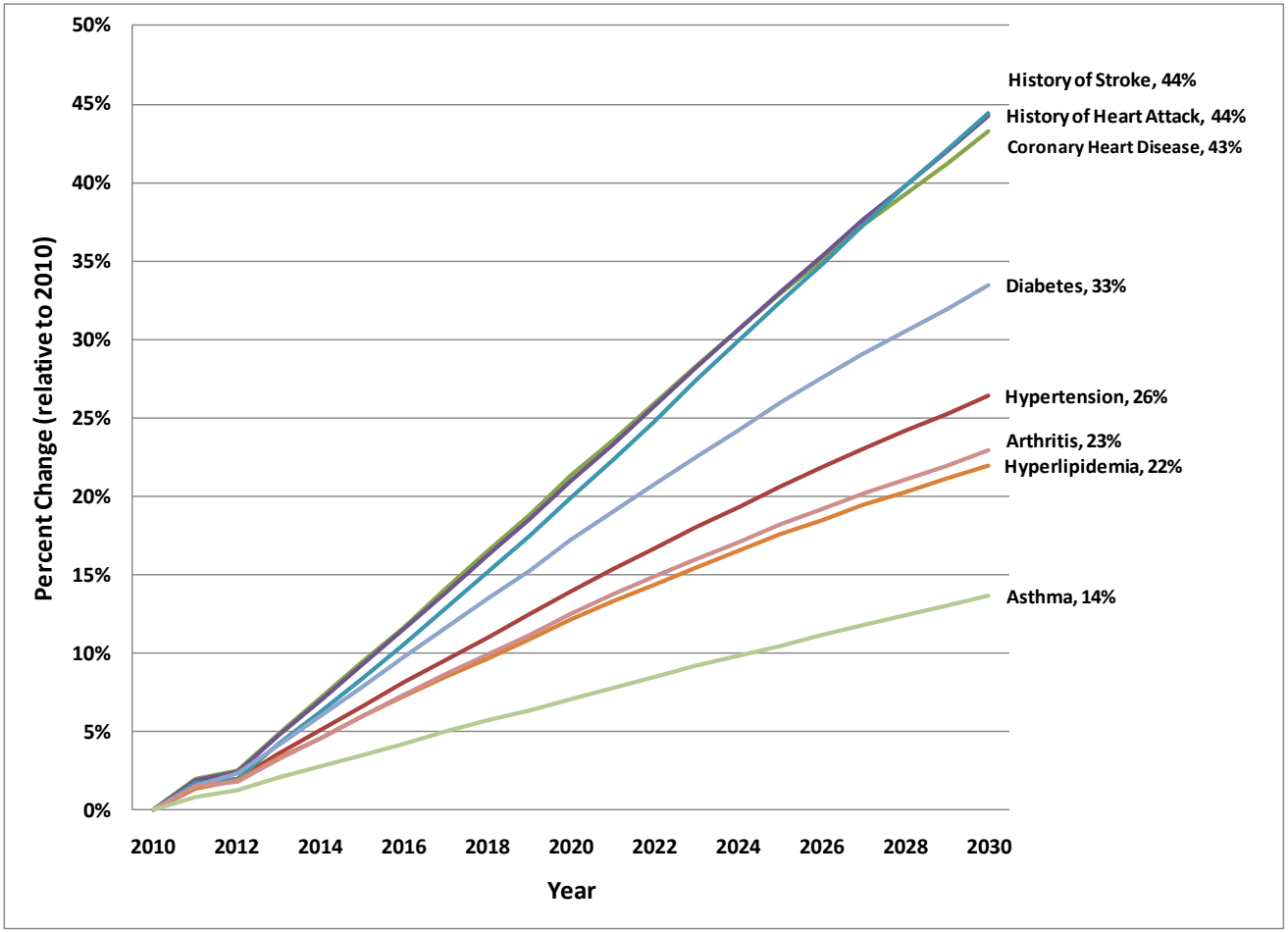


Combines:
Behavioral Risk Factor Surveillance System (BRFSS)
American Community Survey (ACS)
National Nursing Home Survey (NNHS)

Population Growth (%)



Disease Prevalence Growth (%)



Example: Not for citation

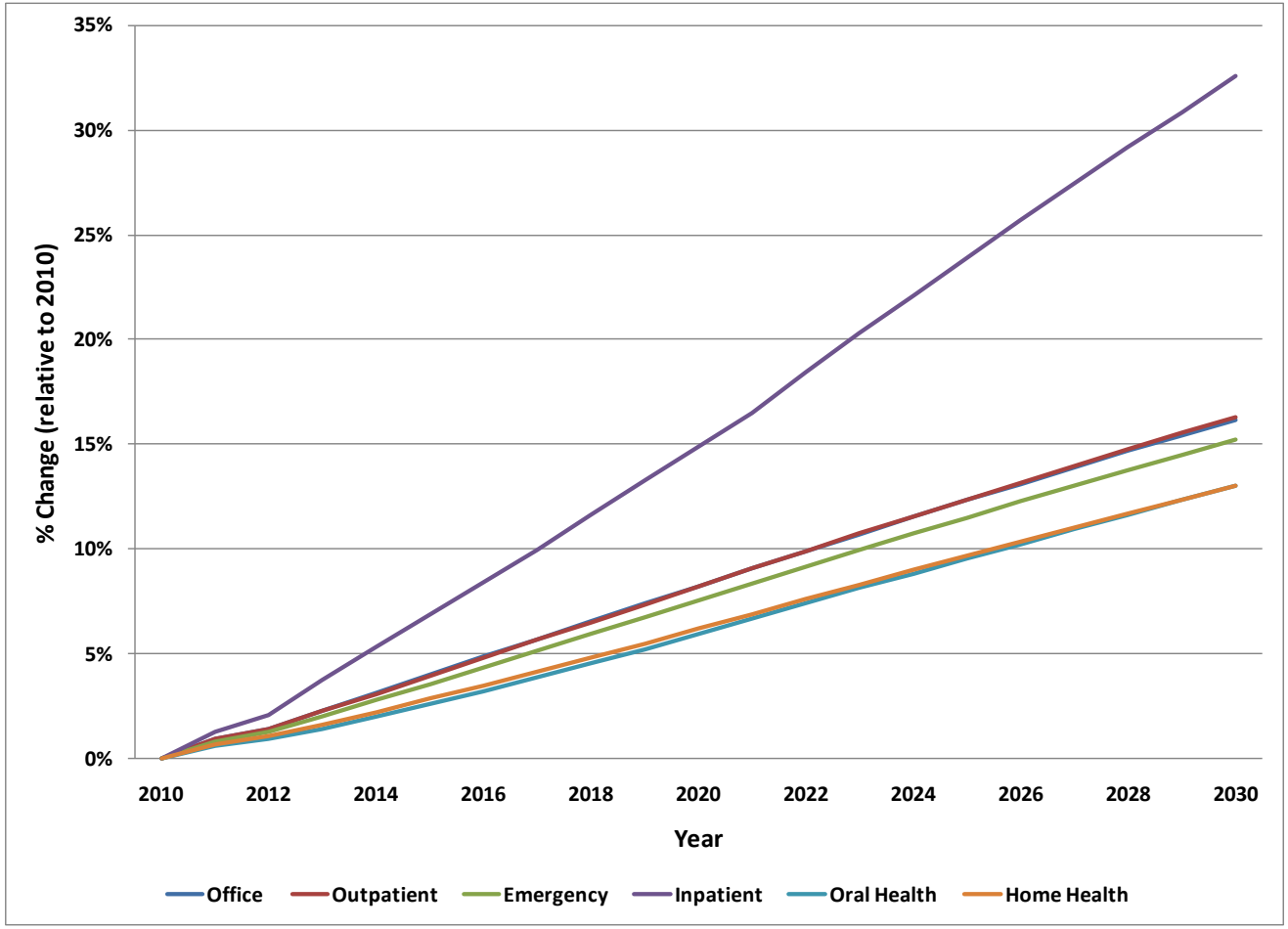
Example: Healthcare Utilization for Cardiologist and Cardiology-Related Services

	Parameter	Office Visits[1]	Outpatient Visits[1]	Emergency Visits[2]	Hospitalization[2]
Race-Ethnicity	Hispanic	0.78**	0.67**	1.02**	0.86**
	Non-Hispanic black	0.73**	2.15**	1.41**	1.34**
	Non-Hispanic white	0.93**	1.31**	0.96**	0.97**
	Non-Hispanic other race	1.00	1.00	1.00	1.00
	Male	1.13**	1.62**	0.92**	0.99
Age	18-34 years	0.13**	0.12**	0.45**	0.25**
	35-44 years	0.32**	0.59**	0.84**	0.53**
	45-64 years	0.53**	0.72**	0.83**	0.69**
	65-74 years	0.88**	1.35**	0.91**	0.90**
	75+ years	1.00	1.00	1.00	1.00
	Smoker	0.77**	0.62**	0.97	0.95
Diagnosed With	Hypertension	1.34**	1.31**	2.50**	1.91**
	Coronary heart disease	7.03**	6.37**	2.60**	3.39**
	History of heart attack	1.61**	1.90**	2.59**	2.58**
	History of stroke	1.07**	0.80**	2.38**	2.53**
	Diabetes	1.18**	1.51**	1.08**	1.25**
	Arthritis	1.02**	1.32**	0.94**	0.89**
	Asthma	1.04**	1.06**	1.05*	1.09**
	History of cancer	1.15**	0.83**	0.93**	0.91**
	Insured	1.56**	1.14**	0.76**	0.99
	Medicaid	1.29**	1.59**	1.57**	1.42**
Household Income	< $10,000	0.89**	0.64	1.66**	1.53**
	$10,000 to < $15,000	0.83**	0.64**	1.36**	1.51**
	$15,000 to < $20,000	0.85**	0.86**	1.10**	1.28
	$20,000 to < $25,000	0.93**	0.39**	1.35*	1.32
	$25,000 to < $35,000	0.88**	0.78**	1.56**	1.36**
	$35,000 to < $50,000	1.03**	0.69**	1.17**	1.16**
	$50,000 to < $75,000	0.99	0.80**	1.06**	1.09**
	$75,000 or higher	1.00	1.00	1.00	1.00
Body Weight	Not available	0.89**	0.89**	2.26**	1.98
	Normal	0.97**	0.97	1.14**	1.02
	Overweight	1.00	1.00	1.00	1.00
	Obese	1.04**	0.69**	1.09**	1.12
	Metro area	1.35**	0.94**	1.04	0.93

[1] Rate ratios from Poisson regression analysis using 2006-20010 MEPS. level.

[2] Odds ratios from logistic regression analysis using 2006-20010 MEPS. Statistically significant at the 0.05 (*) or 0.01 (**) level.

Example: Growth in Demand for Healthcare Services



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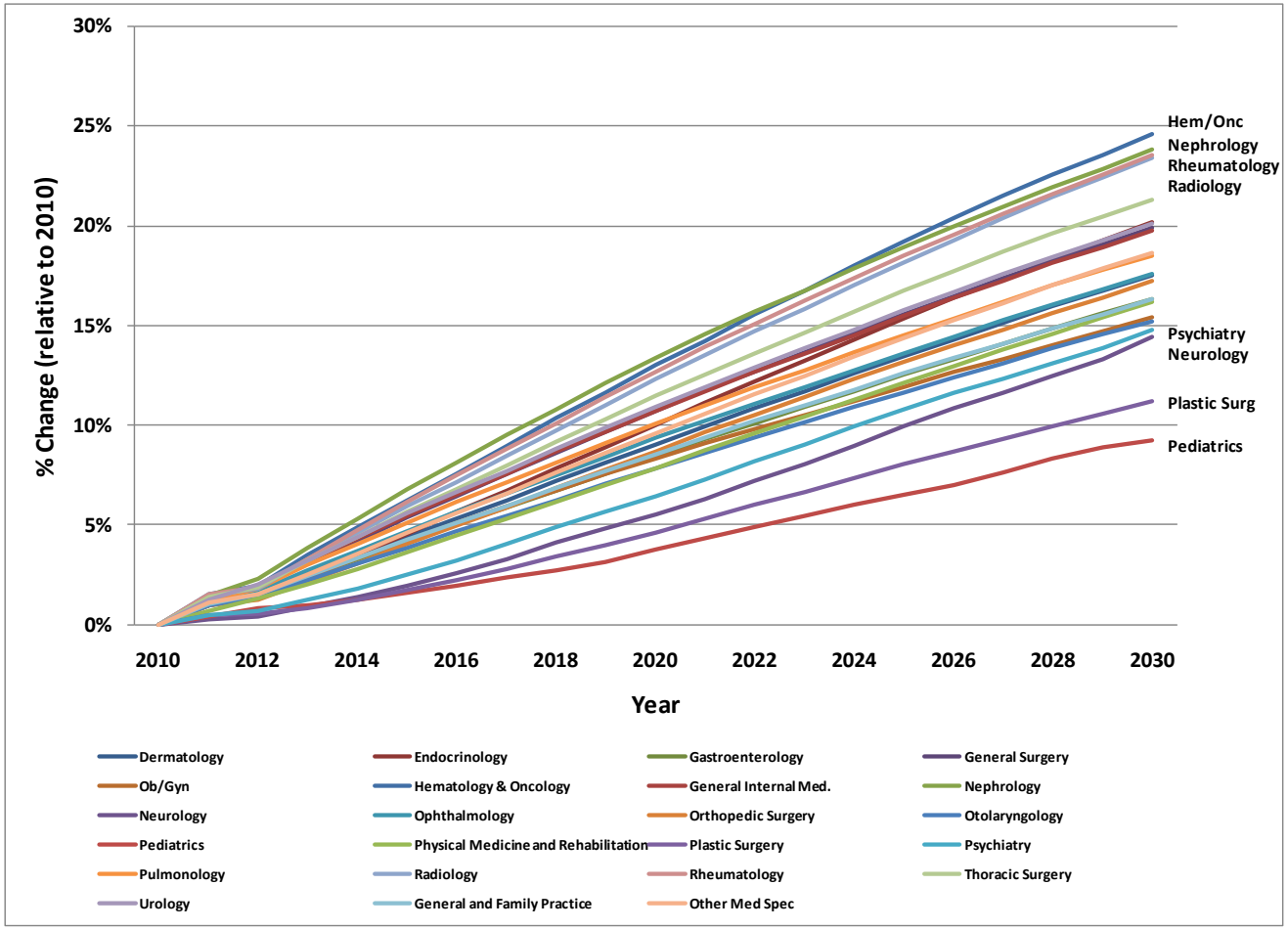
Example: Growth in Office Visits



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Care Delivery Patterns: Converting Encounters to 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)

Modeling Interaction of Supply and Demand

- How does compensation change in response to excess/shortage supply capacity?
- How do changes in compensation levels affect supply and demand?
- How does local adequacy of supply impact labor force participation (hours, retirement)?
- How do geographic differences in job opportunities influence the geographic dispersion of new health workforce graduates?
- How do healthcare facilities (eg., hospitals) change the way that care is delivered in response to excess/shortage supply capacity?

Scenarios

- Goal is to develop flexible model that can simulate healthcare use and workforce implications of
  - Paradigm shifts in care delivery
    - Eg., Accountable Care Organizations, Patient Centered Medical Home model, changes in technology, team-based care
  - New policies
    - Eg., Health care reform, expanded scope of practice
  - Interventions for specific subsets of the population
    - Eg., Disease management programs for diabetes, CHF, COPD
  - Changing economic conditions
  - Changing demographics
- Initial modeling focuses at the state level, but preliminary model has been used at the sub-state level

1991 National Academy of Sciences Assessment of Microsimulation Models Used for Social Policy Analysis

- Citro and Hanushek (p. 16) stated: “We recommend that policy analysis agencies set standards for the design of future microsimulation models that include:
  - setting clear goals and priorities for the model
  - using self-contained modules that can be readily added to (or deleted from) the model and that are constructed to facilitate documentation and validation, including the assessment of uncertainty through the use of sensitivity analysis and the application of sample reuse techniques to measure variance
  - providing for entry and exit points in the model that facilitate linkages with other models
  - attaining a high degree of computational efficiency of the model and its components consonant with other objectives such as ease of use
  - attaining a high degree of accessibility of the model to analysts and other users who are not computer systems experts