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PHARMACEUTICAL MANAGEMENT SCIENCE ASSOCIATION

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An Evidence-driven Approach to Accurate Attribution of HCP Specialization: Focus on PCPs/NPs/PAs

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PMSA PHARMACEUTICAL MANAGEMENT SCIENCE ASSOCIATION

Agenda

- **Introduction**
- Approach
- Results
- Conclusions & Discussion
- Q/A

Current HCP specialty classification is flawed and can lead to ineffective commercial efforts and other risks for Pharma

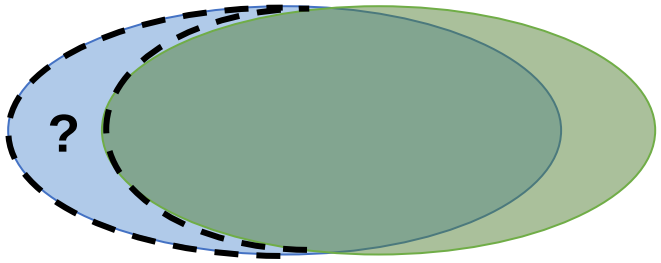
Target specialty HCPs as dictated by actual prescribing behavior will often overlap with the same NPPES specialty, but could also come from other specialties / generalists

HCP specialty designation by National Plan and Provider Enumeration System (NPPES) and other similar associations can be flawed because:

- Specialty fields are **self-reported** by providers
- Classified Generalists (FM, IM, EM, NP, PA) may work in specific TAs
- HCPs can change specialization without updating their designation

Inaccurate specialty classification can lead to negative outcomes for pharma, including ineffective targeting and call planning, potential regulatory / reputational risk, and more.

Potential negative outcomes of targeting an HCP with unrelated specialty



Don't dismiss the importance of a doctor's specialty in your marketing - it can greatly affect your impact

Ineffective targeting
1. Poor marketing ROI 2. Resource misallocation 3. Missed opportunity 4. Incorrect feedback from HCPs 5. Impacts IC & call planning

Potential Reputational risk
1. Ethical concerns 2. Negative brand perception 3. Impact on regulatory compliance 4. Risk of off-label promotion 5. Adverse effect on patient health

Our data-driven approach to HCP specialty classification can improve data accuracy by 10-25%

Our analysis hinged on three critical success factors

All Products All Markets	• Enables triangulation of data across multiple sources (diagnoses, procedures, drug claims) • Pulls like with like data despite inaccurate classifications, and captures all fringe cases
Real World Data	• Reflects real world practice based on actual patient encounters • Data available in real time, enabling rapid response and timely interventions / adjustments • Aggregated data can be de-identified while maintaining broader trends, ensuring confidentiality and privacy
Machine Learning	• ML model trained to mimic thought process of an expert • Scalable across large datasets with less processing time and increased accuracy

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We utilized the comprehensive, detailed & up-to-date Compile EPD & Provider 360 for the analysis

	Compile Enhanced Patient Data	Compile Provider 360
About	High capture open claims dataset	Comprehensive affiliations, hierarchy & other provider details
Overall coverage	• **>90% MDs & NP/PAs** • 300M+ total & 220M+ annual patients • No discernable geo, payer bias	• **~100% HCP/HCOs Covered** • 5.9M+ Total HCPs, 2M+ HCPs with affiliations • 7K+ Hospitals, 600K HCOs & 1K IDNs
Data granularity	• Provider-based capture • Transaction-level details • Dx, Px, Rx details • Prescribing providers	• Scored HCP-HCO affiliations & meta • HCO Hierarchy (Facility-HCO-Regional Parent -Parent IDN) • HCP-HCP networks
Update frequency	• Weekly data updates (Jan. 2017 - last week)	• Refreshed monthly for the most up-to-date information

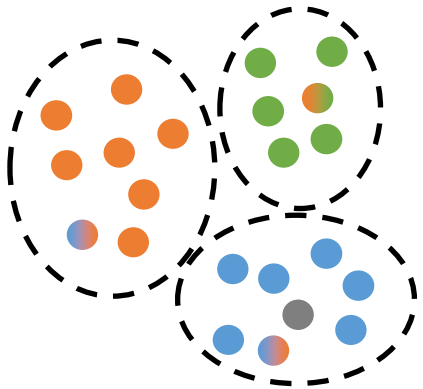
We propose a 4-step approach to accurate attribution of HCP specialization

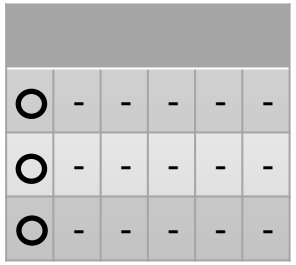
Step 1:
Pre-defining HCP groups

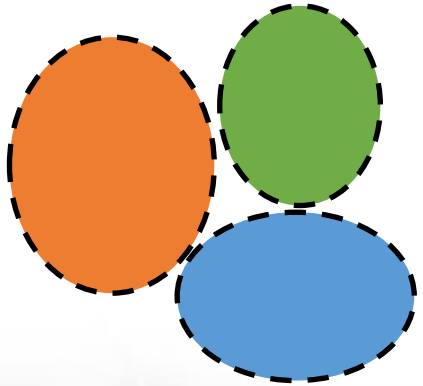
Step 2:
Data preparation at HCP-level

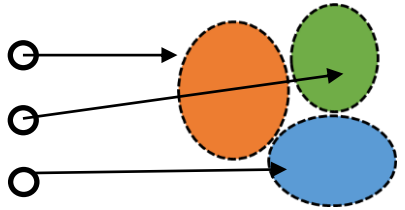
Step 3:
Learning patterns from each group

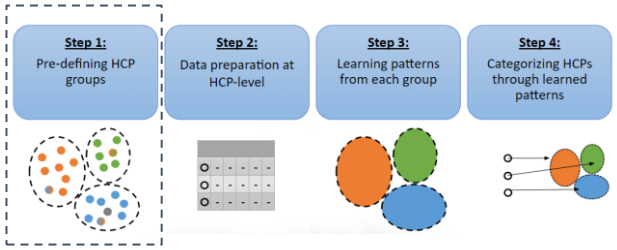
Step 4:
Categorizing HCPs through learned patterns











Step 1: Pre-defining HCP groups

- We picked nine different specialty categories using NPPES Classification & Specialization columns
- We also identified HCPs who as per NPPES are classified as generalists

Specialties considered for POC

- Cardiology
- Oncology
- Ophthalmology
- Pulmonology
- Urology
- Dermatology
- Nephrology
- Rheumatology
- Allergy & Immunology

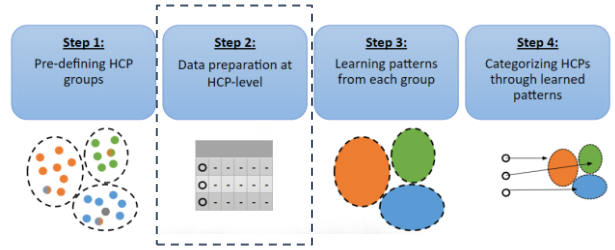
Considered Generalists

- Family medicine (FM)
- Internal medicine (IM)
- Emergency medicine (EM)
- Nurse practitioner (NP)
- Physician Assistant (PA)

(PCP)

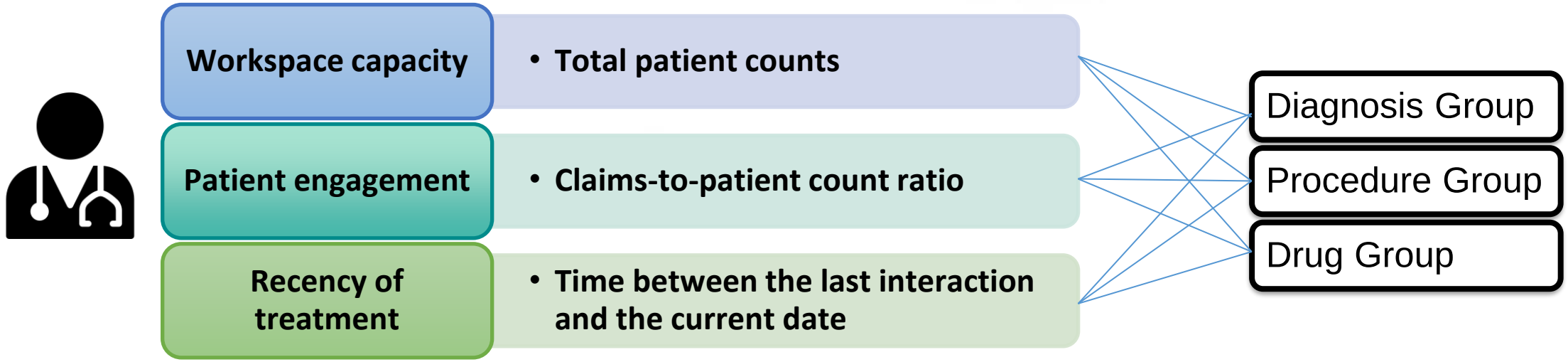
PCPs may develop an interest in a specific medical specialty. However, they generally do not switch their practice specialty frequently.

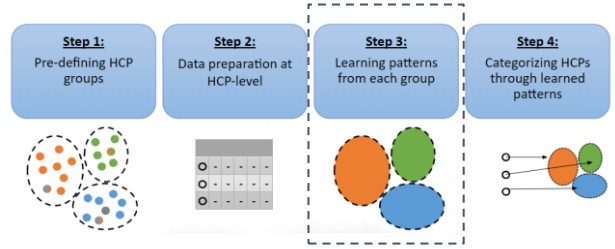
NP/PAs typically have a more flexible educational and training path than physicians and may be able to switch specialties more easily



Step 2: Data preparation at HCP-level

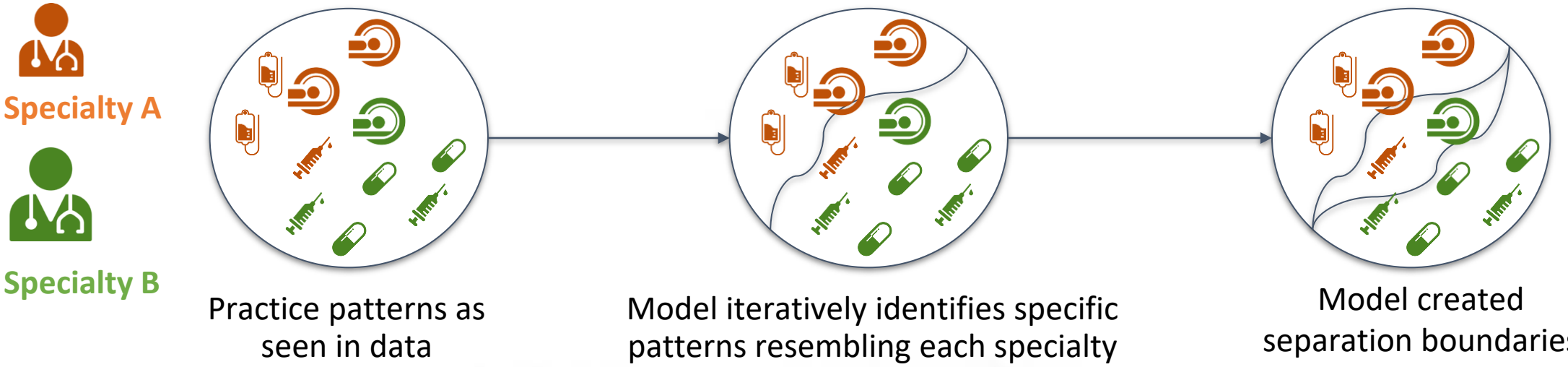
- Data required to train the ML model includes physician-level summaries of claims, where the summary contains:

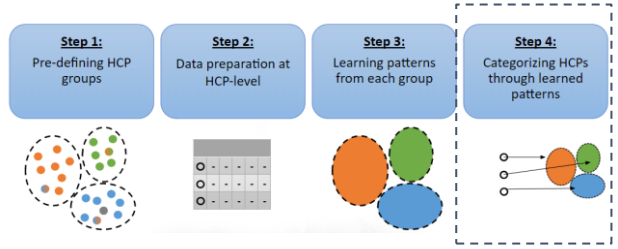




Step 3: Learning patterns from each group

- HCP Level data is used to train a XGBoost “Multi-class Classifier '' where:
  - The classes are the different specialties/specialists
  - The trained classifier learns patterns that resemble each specialty





Step 4: Categorizing HCPs through learned patterns

- After the multiclass XGBoost classifier has been trained to recognize different specialties, the learned patterns can be used to assign a **"likelihood score of being a specialist"** to generalists who were not part of the training data.
- This likelihood score is based on the generalist's HCP level data and how closely it matches the patterns associated with each specialty that the classifier has learned during training.

Likelihood score	Oncology	Dermatology	Pulmonology	...	Final assignment
1	**99.0%**	0.9%	0.1%	...	Oncology
2	20.1%	30.4%	29.5%	...	Not assigned
3	0.0%	**99.5%**	0.4%	...	Dermatology

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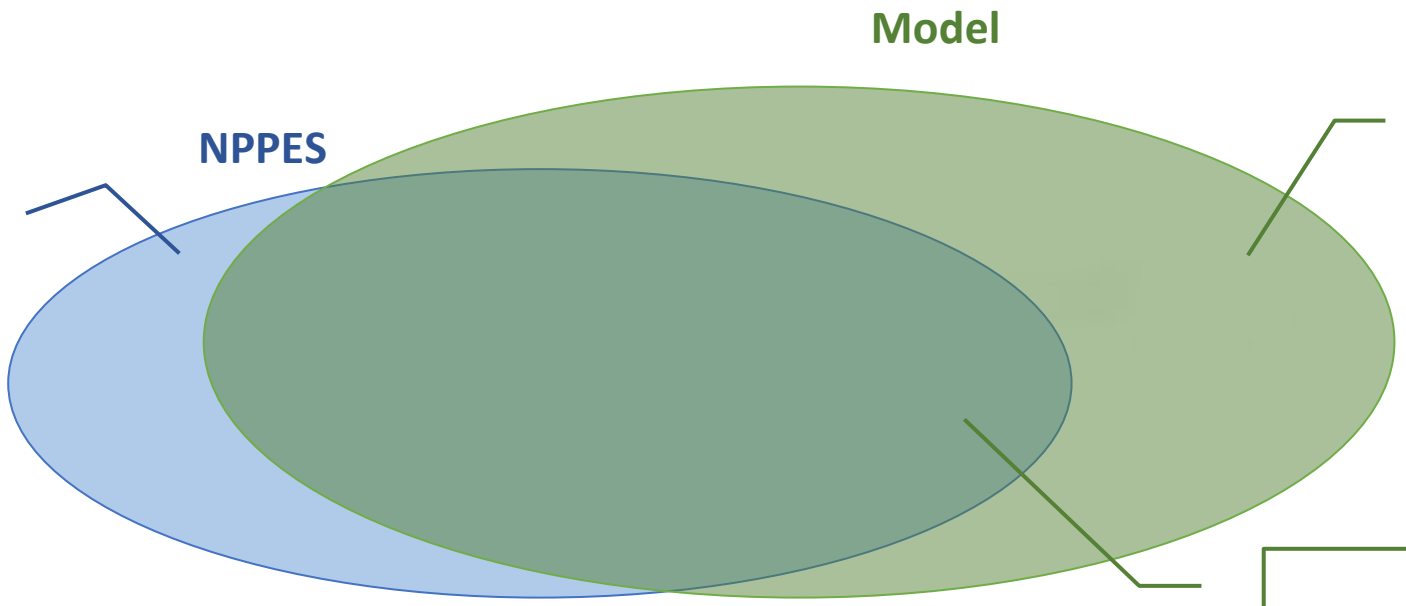
Model prediction expanded the specialist pool by 80%



HCPs exhibiting dissimilar behavior in relation to their NPPES assigned specialty (16%)

NPPES Generalists who exhibit specialist behavior (additional 80% on top of the initial 164K)

Verified specialist (84%)

N size: Total 164k specialists from 9 specialties

Note:

- Model output is shown for 99% likelihood score
- A reduction in confidence level increases the percentage of movement from NPPES-entered specialty to evidence-driven specialty and will identify more generalists acting as specialists

Heterogenous specialties have higher need for better specialty tagging

Specialty (NPPES)	# HCPs in NPPES (A)	% of A exhibiting dissimilar behavior w.r.t. their NPPES assigned specialty
Dermatology	16,526	11%
Ophthalmology	22,494	11%
Cardiology	38,623	15%
Rheumatology	7,780	17%
Urology	12,235	17%
Oncology	31,049	18%
Pulmonology	16,820	20%
Nephrology	14,053	23%
Allergy and Immunology	5,263	24%

More Homogenous

Less Homogenous

Note:

- Model output is shown for 99% likelihood score
- A reduction in confidence level increases the percentage of movement from NPPES-entered specialty to evidence-driven specialty and will identify more generalists acting as specialists

#PCP/NP/PAs gravitate towards specialties that are more prevalent, easier to train for, or are less complex

Specialty (NPPES)	# HCPs in NPPES (A)	NPPES Generalists who exhibit specialist behaviour as a % of (A)
Pulmonology	16,820	64% 44% 16%
Oncology	31,049	18% 67% 37%
Cardiology	38,623	39% 49% 20%
Dermatology	16,526	6% 23% 38%
Allergy and Immunology	5,263	4% 38% 14%
Nephrology	14,053	30% 20% 4%
Urology	12,235	25% 19%
Rheumatology	7,780	6% 17% 12%
Ophthalmology	22,494	3%

PCP
NP
PA

Note:

- Model output is shown for 99% likelihood score
- A reduction in confidence level increases the percentage of movement from NPPES-entered specialty to evidence-driven specialty and will identify more generalists acting as specialists

Case study:
Sales force estimation in ophthalmology

BACKGROUND

Novartis conducted a market landscape exercise in ophthalmology, specifically a rare back-of-eye disease with significant unmet need and limited treatment options

PROBLEM

- Defining the HCP universe diagnosis code yielded 1,600 retina specialists, 17,000 ophthalmologists, and 170,000 other physicians
- Some ophthas could be operating as retina specialists, but did not have the correct sub-specialty recorded
- Many physicians could have patients with the relevant diagnosis code, but play no role in treatment decisions

SOLUTION

- Identified relevant diagnosis codes, diagnostic procedures, and pharmacy / medical claims
- Leveraged k-means clustering and ML methodologies to predict physician specialty based on real world behavior
- Identified total of 3,600 retina specialists and developed high level call plan to inform sales force sizing, marketing and sales

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Resulting implications for pharma industry

Case	Example
1. Targeting and messaging based on activity	e.g., a gastroenterologist with expertise on proton pump inhibitors may need to be targeted differently than one who sees patients with Crohn's & other autoimmune diseases
2. Targeting and messaging based on sub-specialty	e.g., a dermatologist who spends most of her time as a plastic surgeon may need to be messaged differently than someone who is treating patients with psoriasis or eczema
3. Targeting new HCPs based on activity	e.g., NPs and PAs in specialty offices who refill prescriptions can be messaged with adherence campaigns since they are often responsible for helping to keep patients on a drug
4. Targeting and messaging based on the impact on a patient's treatment journey	e.g., generalists who are treatment decision-makers may need to be targeted differently than those who largely refill existing prescriptions
5. Targeting HCPs with inaccurate specialty exclusion flags	e.g., a pediatric cardiologist by specialty practicing as an adult cardiologist should be included in a targeting database

Key conclusions from the analysis

An evidence-driven approach powered by real-world data & a machine learning model is better than relying on the accuracy of documented specialties.

It enables segmenting generalists into true generalists and those practicing as specialists, and identifies which specialization is appropriate when a health care practitioner has more than one.

This more accurate characterization can improve the targeting, segmentation, call planning, and sales incentive compensation exercises in accordance with HCP's practicing behavior within a compliant framework.

What's Next?

Thank you

Questions?

Things to consider while targeting NP/PAs

1. Variability in prescribing authority across states
2. Cost implications of NPs' ordering and referral practices
3. NPs/PAs must work under doctors' guidance for patient safety
4. Importance of specialist-led care for patient education, training, and expertise
5. Alternating between NPs/PAs and specialists for patient care
6. Utilizing NPs/PAs and telemedicine in rural healthcare settings