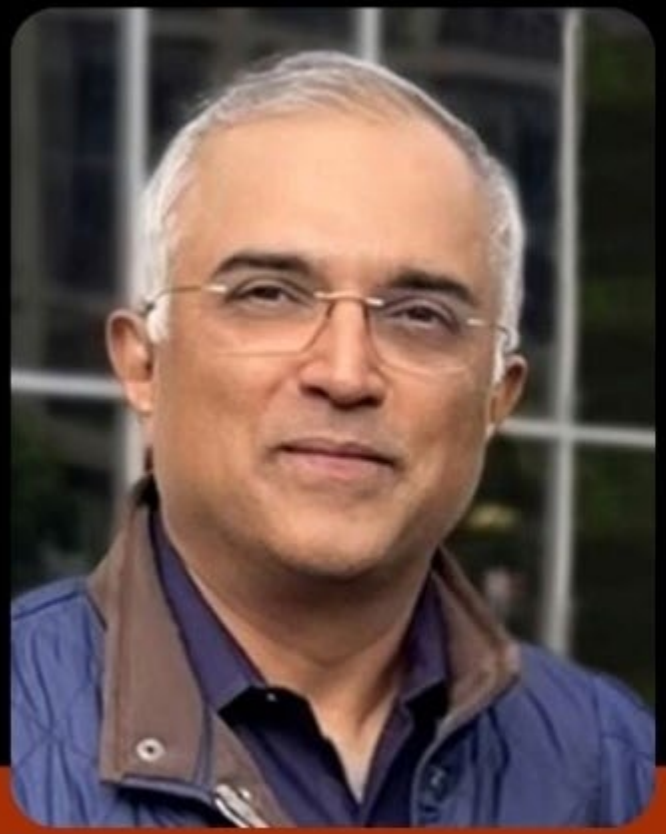


THE ROLE OF DIGITAL HEALTH & AI IN OPTIMIZING PATIENT COMPLIANCE TO THEIR PRESCRIBED MEDICATION REGIMEN

by

Dr. Deepak Sirdeshmukh

Sensal Health, Chapel Hill, USA

Key Topics I Will Cover

1. Understanding compliance and reasons for noncompliance.
2. Extent of noncompliance in clinical care and trials.
3. Digital health interventions and examples.
4. AI’s role in dealing with noncompliance.
5. Risks of AI

What is Patient Compliance? Also called Adherence?

- ***Adherence*** is defined as *the* ***extent to which a person's behavior – taking medication, following a diet, and/or executing lifestyle changes – corresponds with agreed recommendations from a healthcare provider*****.**

- Adherence is measured over a specified period of time and reported as the percentage of the prescribed doses of medication actually taken by the patient.

- In clinical trials, an adherent patient is one who takes at least a predefined percentage (typically 80%) of the treatment, considered to be sufficient for obtaining measurable benefit.

MEDCITY INFLUENCERS, BIOPHARMA

Let's focus on patient compliance as the problem, not adherence

The change in terminology from "compliance" to "adherence" is based on unfounded and untenable foundations. It conflates cause and effect, and a shift in language and mindsets can help reframe and better tackle the core problem: patient failure to take medications as prescribed.

By Deepak Sirdeshmukh on December 20, 2021 11:22 am Share

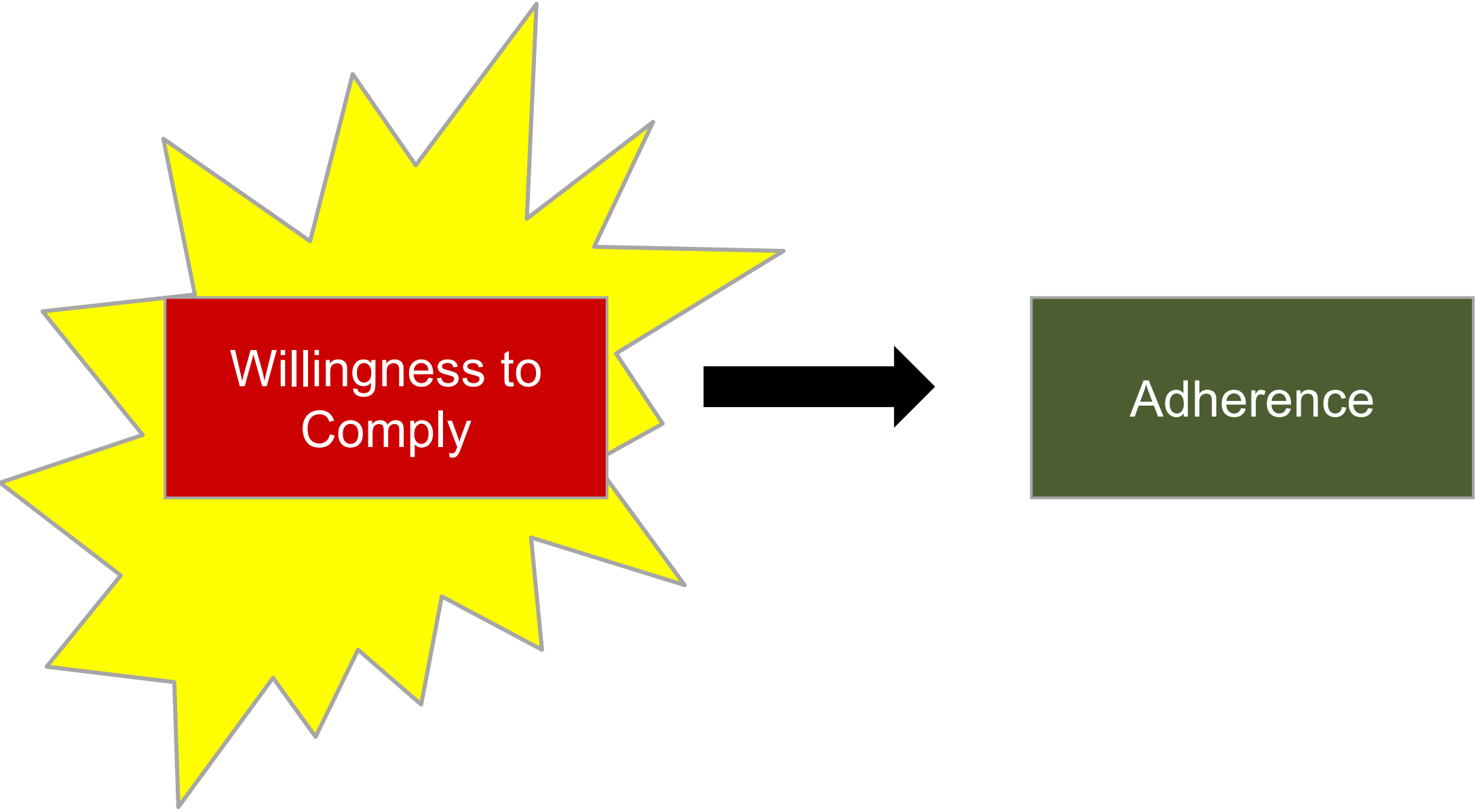
As young pharmacists, my colleagues and I wrestled with the thorny and puzzling phenomenon of why people refused to take medications as prescribed—acting ostensibly against their self-interest, and considered how we could get them back

Recommended

7 HLTH Announcements You Don't Want to Miss

Centene CEO: ICHRA Is the Future of Individual Health Insurance

Ventyx Bio Cardiovascular Drug's Phase 2 Results Set Up Talks With a Big Pharma Firm


Willingness to Comply
Adherence

How Big is the Compliance Problem?

Among adults with diagnosed diabetes in the United States, about 80% use medications other than insulin to treat and control diabetes.

An adult with diagnosed diabetes uses an average of 5.9 prescription medications.

Diabetes in America, National Institute of Diabetes and Digestive and Kidney Diseases, 2024

2022 Consensus Report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD)

"Suboptimal medication-taking behavior and low rates of continued medication use, or what is termed "persistence to therapy plans," affects almost half of people with type 2 diabetes, leading to suboptimal glycemic and CVD risk factor control."

Key Nonadherence Statistics by Disease Condition

via Claude, October 2025

Disease Condition	Nonadherence Rate	Notes
Hypertension	31–61%	31% national weighted rate (2015); varies by insurance type (25–55%); 49% don't continue medications at 12 months
Diabetes	40–50%	Nearly 50% struggle to reach glycemic goals; 27% persistent at 6 months, only 39% at 2 years; primary non-initiation: 10%
Hyperlipidemia/High Cholesterol	66.7% low adherence	Primary non-initiation rate: 25%; 25–50% discontinue statins within 6–12 months
Asthma	28–43%	28% for maintenance therapy; 43% for acute treatments; primary non-initiation: ~12–15%
COPD	Variable	Similar patterns to asthma; limited specific data
HIV/AIDS	37–83%	Wide variation depending on monitoring method and follow-up period; highly variable across studies
Depression	40–70%	Primary non-initiation: 12% (lowest among chronic conditions)
Arthritis	Higher adherence observed	One of the conditions with better adherence rates overall
Cancer	25–33%	Chronic myeloid leukemia: 25–33% nonadherent; endocrine therapy nonadherence associated with increased mortality
Parkinson's Disease	61%	61% took less than 80% of medication over 7 years
Cardiovascular Disease (General)	30–50%	Varies; cardiovascular and oral diabetic medications show particularly poor adherence
Heart Transplant (Immunosuppressants)	37.9%	26.2% took medication at wrong times; 17.3% missed doses
Osteoporosis	25%	Primary non-initiation rate (highest among conditions studied)
Gout	56%	56% non-persistence within 12 months of initiation
Kidney Disease	High	Limited specific data but associated with higher comorbidity burden
Liver Problems	63%	Highest diabetes-related CRN when comorbid with diabetes
Overall Average (Chronic Diseases)	~25–50%	Meta-analysis of 569 studies found 25% average nonadherence

Outcomes of Nonadherence in Clinical Settings

Poor clinical outcomes, increased risk of relapse and rehospitalization.

For cardiovascular conditions, nonadherent patients had a 35% higher chance of having a stroke in 5 years, 40% increased risk of hospitalization, and 50% - 80% higher risk of death

(Archives of Internal Medicine, 2021).

Assessing the Impact of Medication Adherence on Long-Term Cardiovascular Outcomes

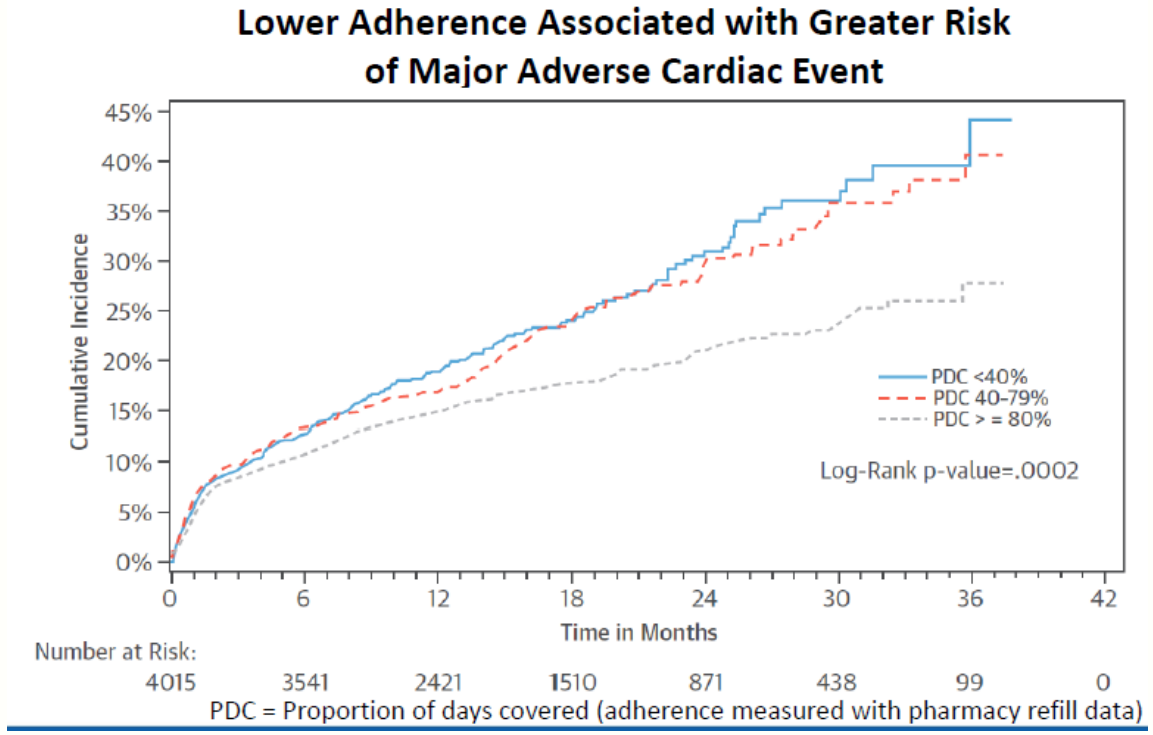
Bansilal et. al. 2016, Journal of the American College of Cardiology

Patients: Post myocardial infarction (MI).

Stratification: Stratified as fully adherent (≥80%), partially adherent (≥40% to ≤79%), or nonadherent (<40%)

Outcome Measure 1 : Major adverse cardiovascular events (MACE) (All-cause death, MI, stroke, or coronary revascularization)

Outcome Measure 2: Per-patient annual direct medical (ADM) costs.



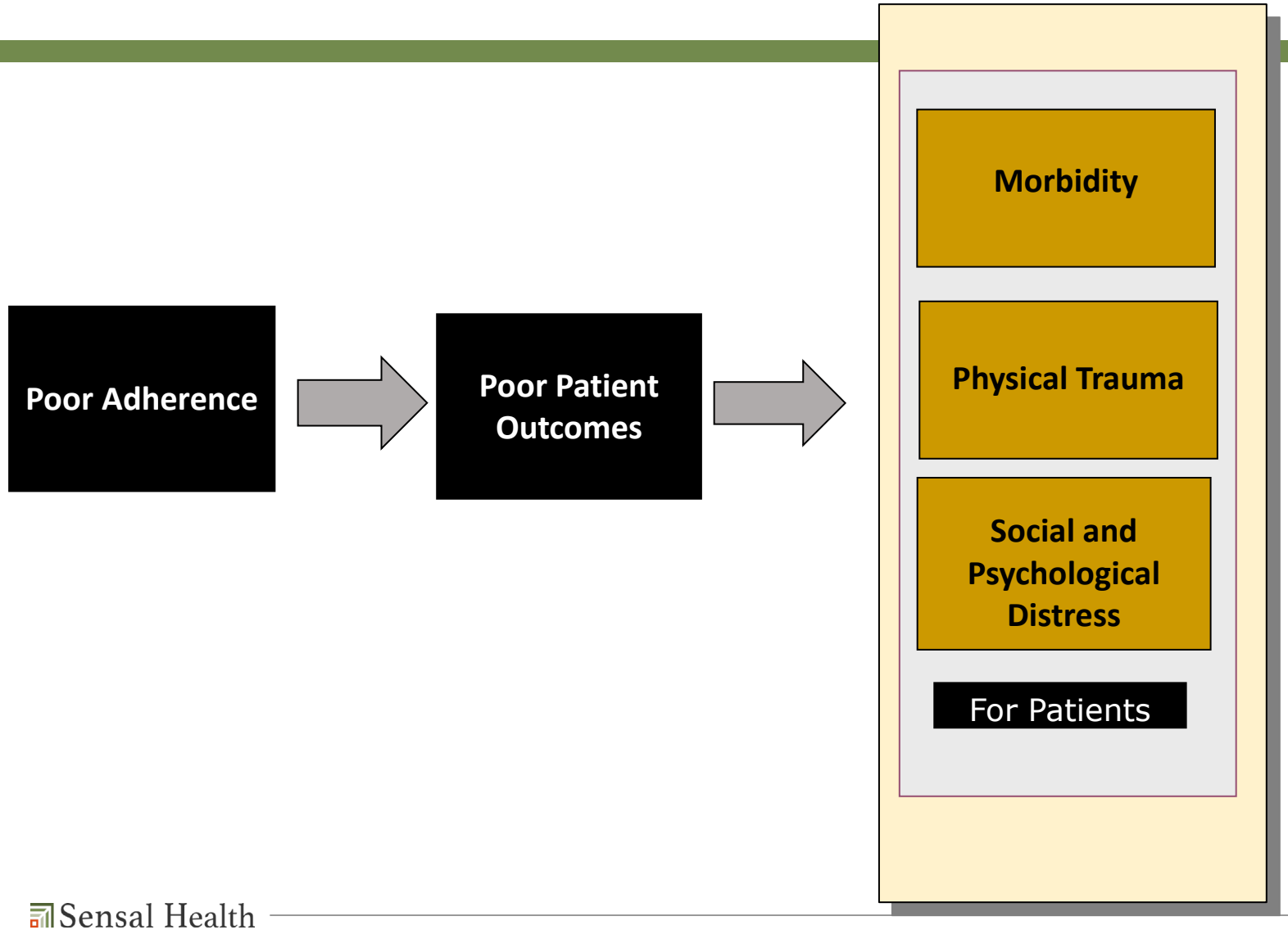
RESULTS

Bansilal et. al. 2016, Journal of the American College of Cardiology

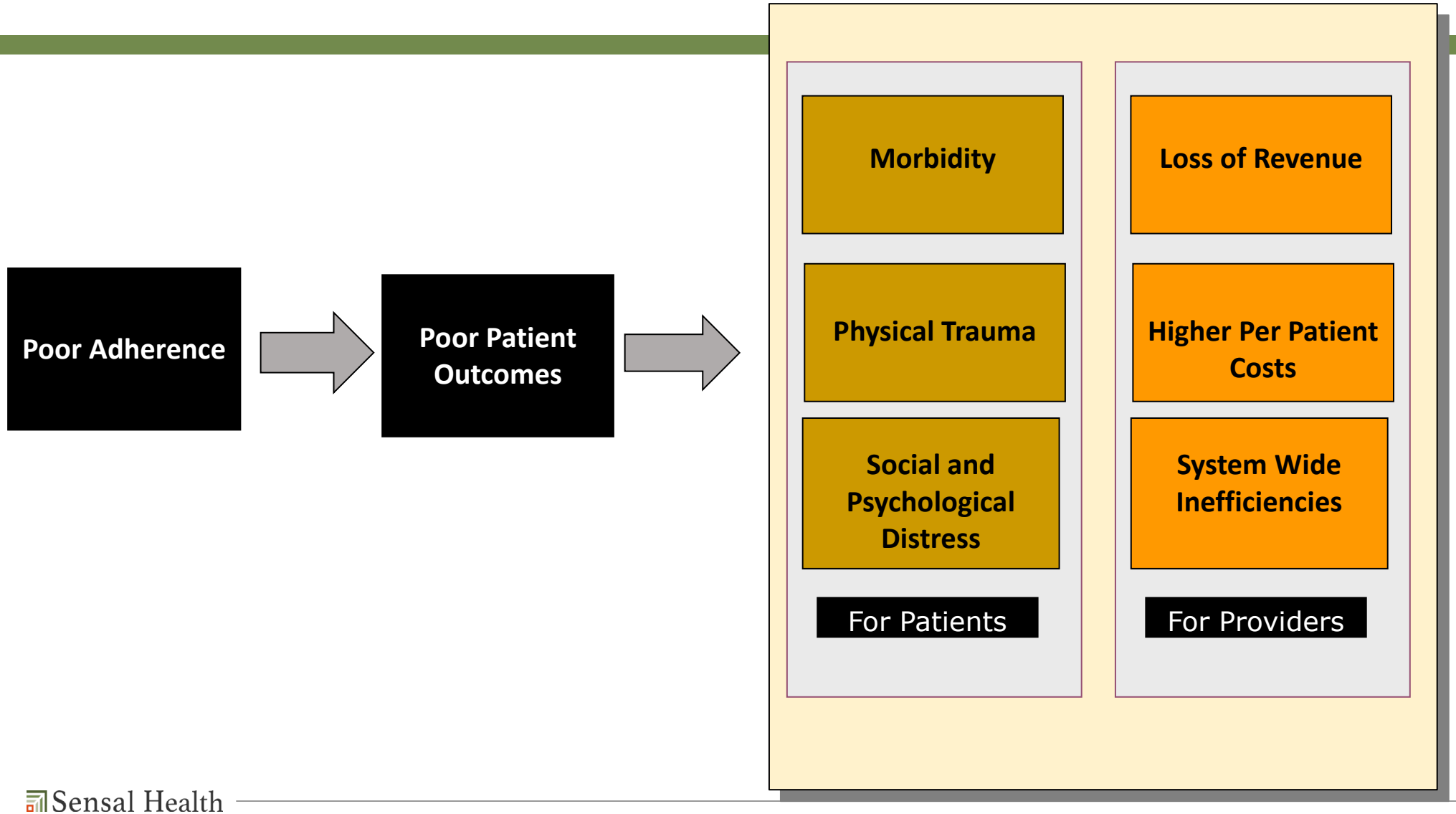
1. The fully adherent group had a significantly **lower rate of MACE** than the nonadherent (18.9% vs. 26.3%; hazard ratio [HR]: 0.73; p = 0.0004) and partially adherent (18.9% vs. 24.7%; HR: 0.81; p = 0.02) groups at 2 years.

2. The fully adherent group had **per-patient cost savings** in ADM costs of $369 and $440 compared with the partially adherent and nonadherent groups, respectively.

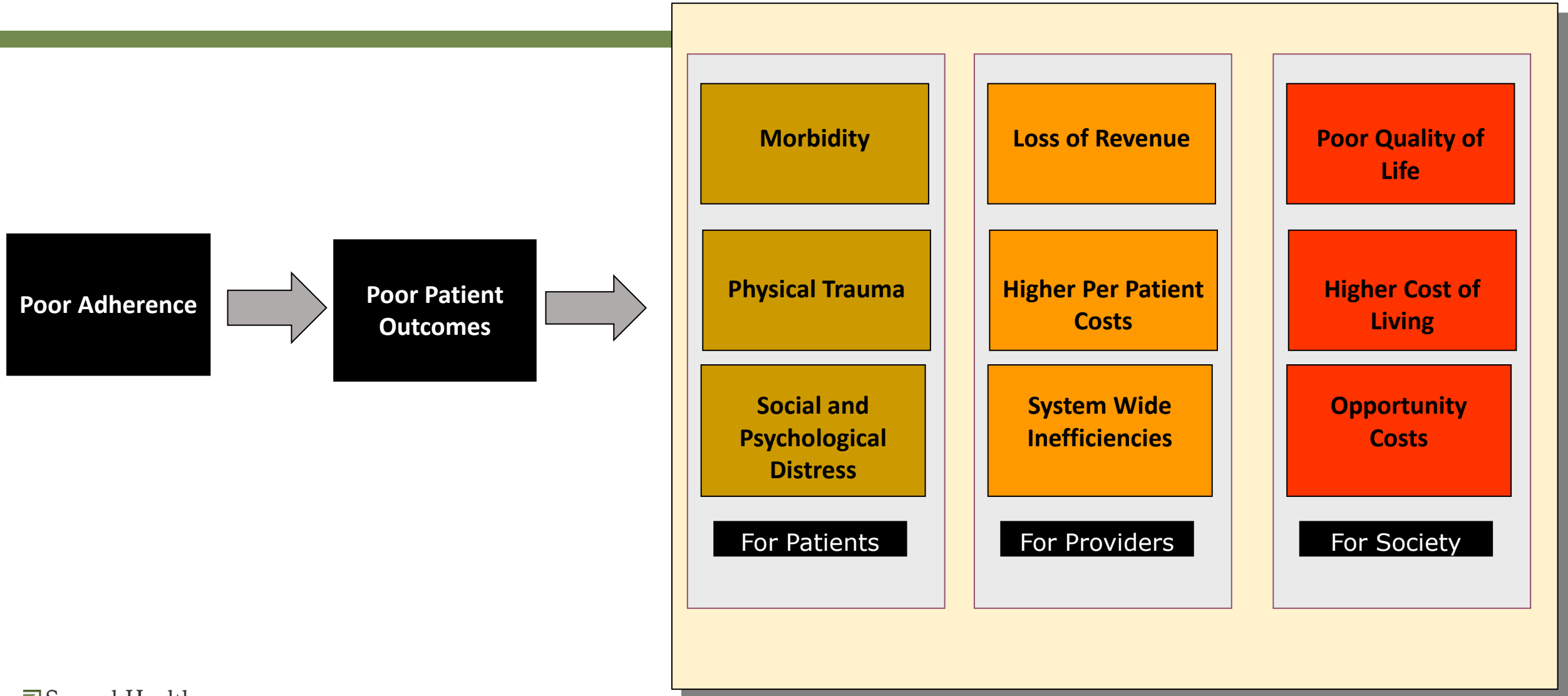
Significant Negative Outcomes



Causal Stream of Effects



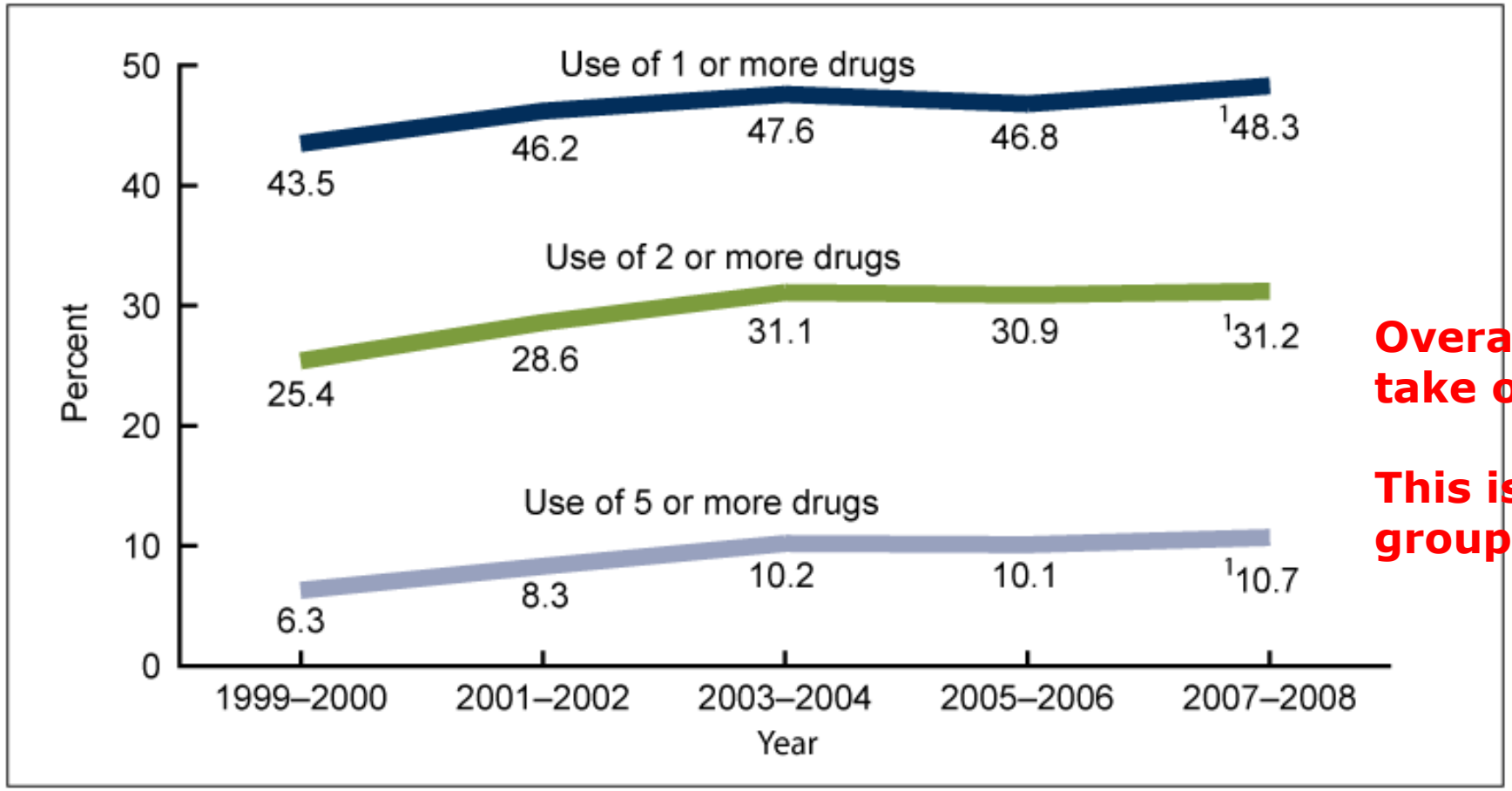
Causal Stream of Effects



Polypharmacy: Makes The Adherence Problem Even Worse


NITIN A GOKHALE

Figure 1. Trends in the percentage of persons using prescription drugs: United States, 1999–2008



[1]Significant linear trend from 1999–2000 through 2007–2008.
NOTE: Age adjusted by direct method to the year 2000 projected U.S. population.
SOURCE: CDC/NCHS, National Health and Nutrition Examination Survey.

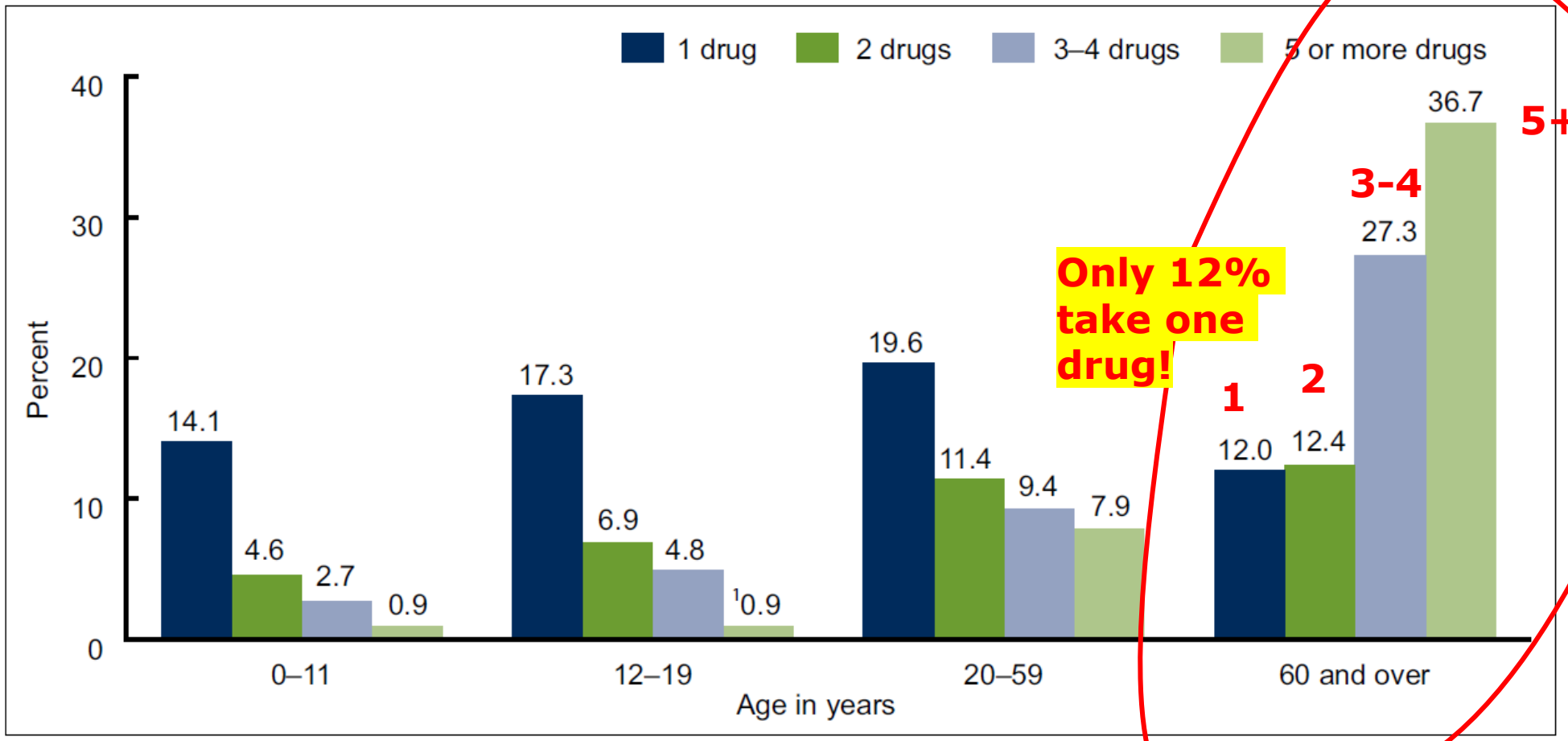
Overall, about 50% take one drug.

This is across age groups.

Polypharmacy And Patient Age

The use of multiple prescription drugs in the past month varied by age (Figure 2).

Figure 2. Percentage of prescription drugs used in the past month, by age: United States, 2007–2008



Only 12% take one drug!

1

2

3-4

5+

64% take 3 or more drugs

[1]Estimate is unstable; the relative standard error is greater than 30%.
SOURCE: CDC/NCHS, National Health and Nutrition Examination Survey.

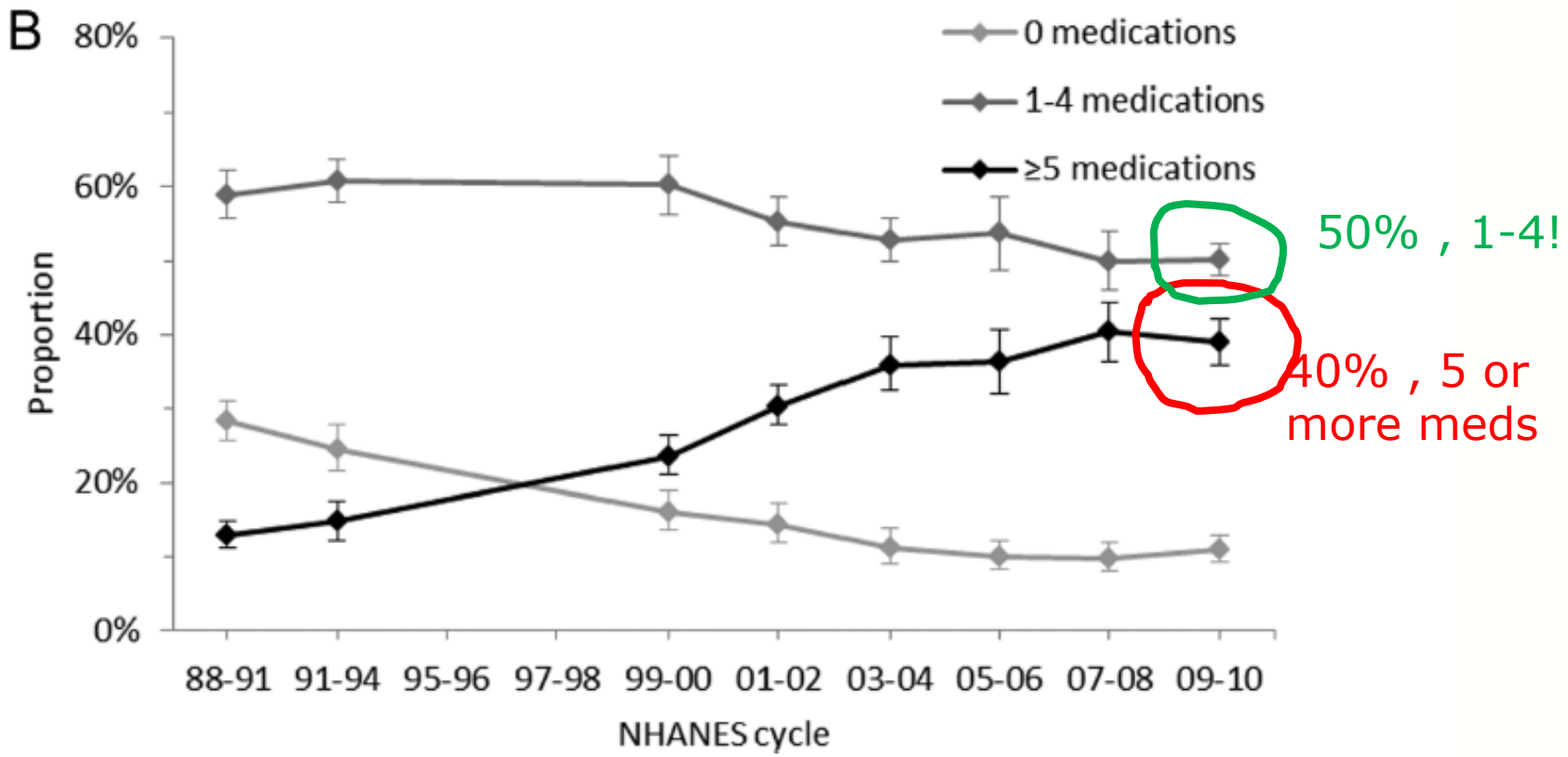


Figure 1. Serial cross-sectional estimates of prescription medication use among U.S. noninstitutionalized adults aged 65 and older (1988–2010) including (A) mean, median, and interquartile range for total number of prescription medications used, and (B) proportion taking 0, 1–4, and ≥5 prescription medications, with 95% confidence intervals.

Polypharmacy & Depression

WILEY Open Access Collection

Acta Psychiatr Scand. 2022 Apr 29;146(1):85–97. doi: 10.1111/acps.13435

Determinants and consequences of polypharmacy in patients with a depressive disorder in later life

Carlijn Wiersema [1], Richard C Oude Voshaar [1], Rob H S van den Brink [1], Hans Wouters [2], Peter Verhaak [2,3], Hannie C Comijs [4], Hans W Jeuring [1,✉]

Author information · Article notes · Copyright and License information

PMCID: PMC9321061 PMID: 35435249

Results

Polypharmacy was more prevalent among patients with depression (46.9%) versus non-depressed comparisons (19.7%). A lower level of education, lower cognitive functioning, and more chronic diseases were independently associated with polypharmacy. Adjusted for these determinants, polypharmacy was associated with a higher level of motivational problems, anxiety, pain, and an earlier age of onset. A higher number of drugs was associated with a worse course of late-life depression (OR = 1.24 [95% CI: 1.03–1.49], $p = 0.022$).

Why would polypharmacy be associated with (or cause) higher levels of depression among patients?

Non Adherence in Clinical Trials

Adherence during clinical trials

- Estimates of the costs per patient for clinical trials range from approximately $2000 - $19,000 (Emanuel 2003).
- The average costs of trials have been estimated at $1.4-$6.6 million (Phase 1), $7.0-$19 million (Phase 2), and $11.5-$52.9 million (Phase 3).
- Eye for Pharma (2018) reports average adherence rates of **43%-78% in clinical trials**.

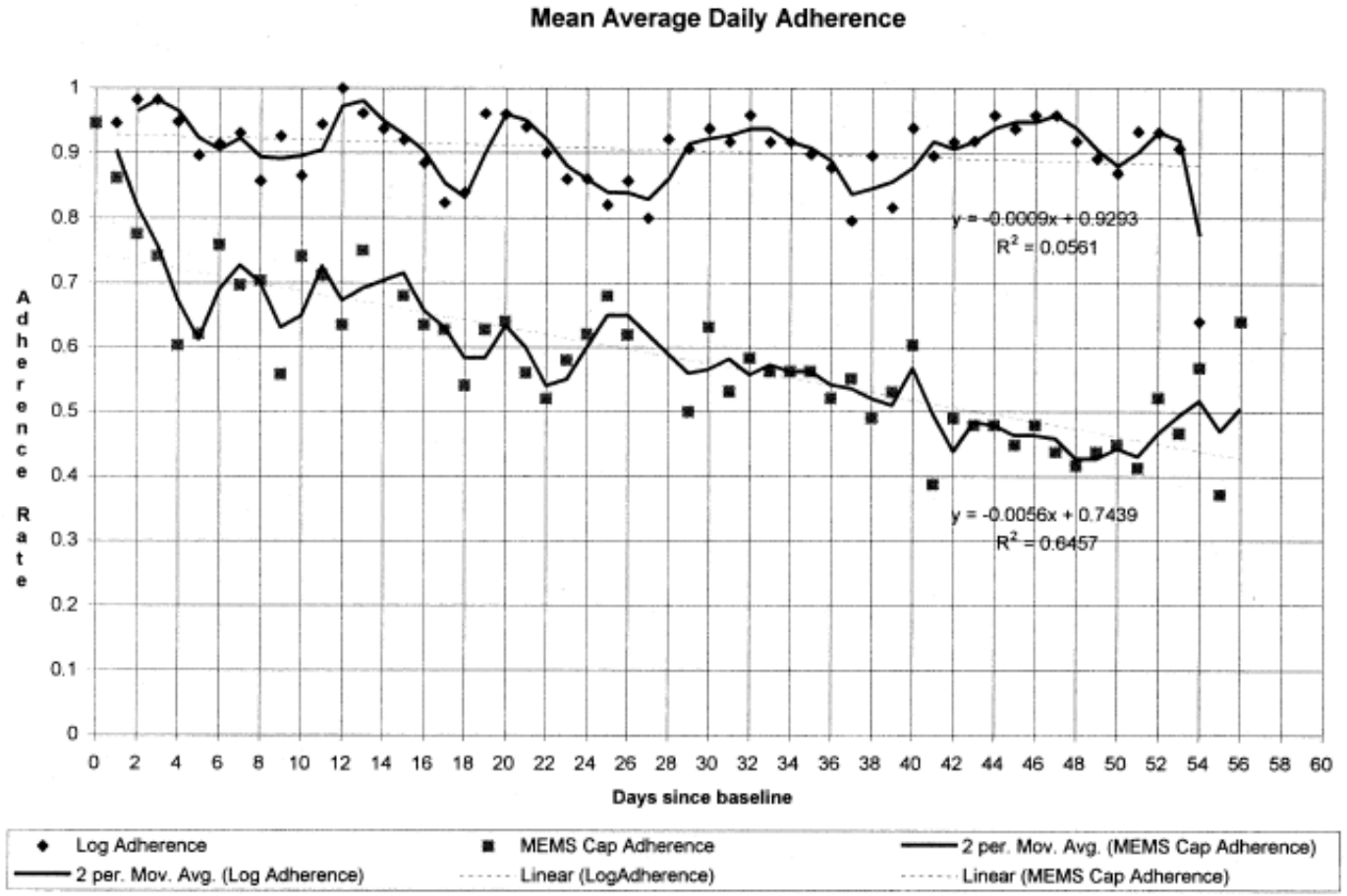


Fig 1. Overall adherence rates for both electronic and log data were calculated on daily basis as actual daily applications/expected applications (two). Adherence rates were then averaged and plotted over time. Resulting trends compared with linear regression show slopes that are significantly different ($P < .0001$). *MEMS*, Medication event monitoring system; *Mov. Avg*, Moving average.

Topical Medication Trial
Mean daily adherence went from 84.6% to 51% in 8 weeks (Feldman, 2004)

Why Are Patients Noncompliant?

Main Drivers of Medication Nonadherence

Patient Related

- Higher order beliefs about medication/efficacy.
- Poor knowledge of dosing regimens.
- Inability to perceive causal outcomes.
- Not convinced about the necessity of the medication.
- Concerned about negative outcomes.
- Not aware of consequences of nonadherence.
- Forgetting.
- Weak economic condition/willingness to pay.

From multiple sources.

Main Drivers of Medication Nonadherence

Medication Related

- High costs
- Concern about (or experienced) side effects.
- Inconvenient dosage form/vehicles.
- Multiple medications.
- Storage and organizing challenges.
- Too many doses per day.

From multiple sources.

Main Drivers of Medication Nonadherence

Provider and System Related

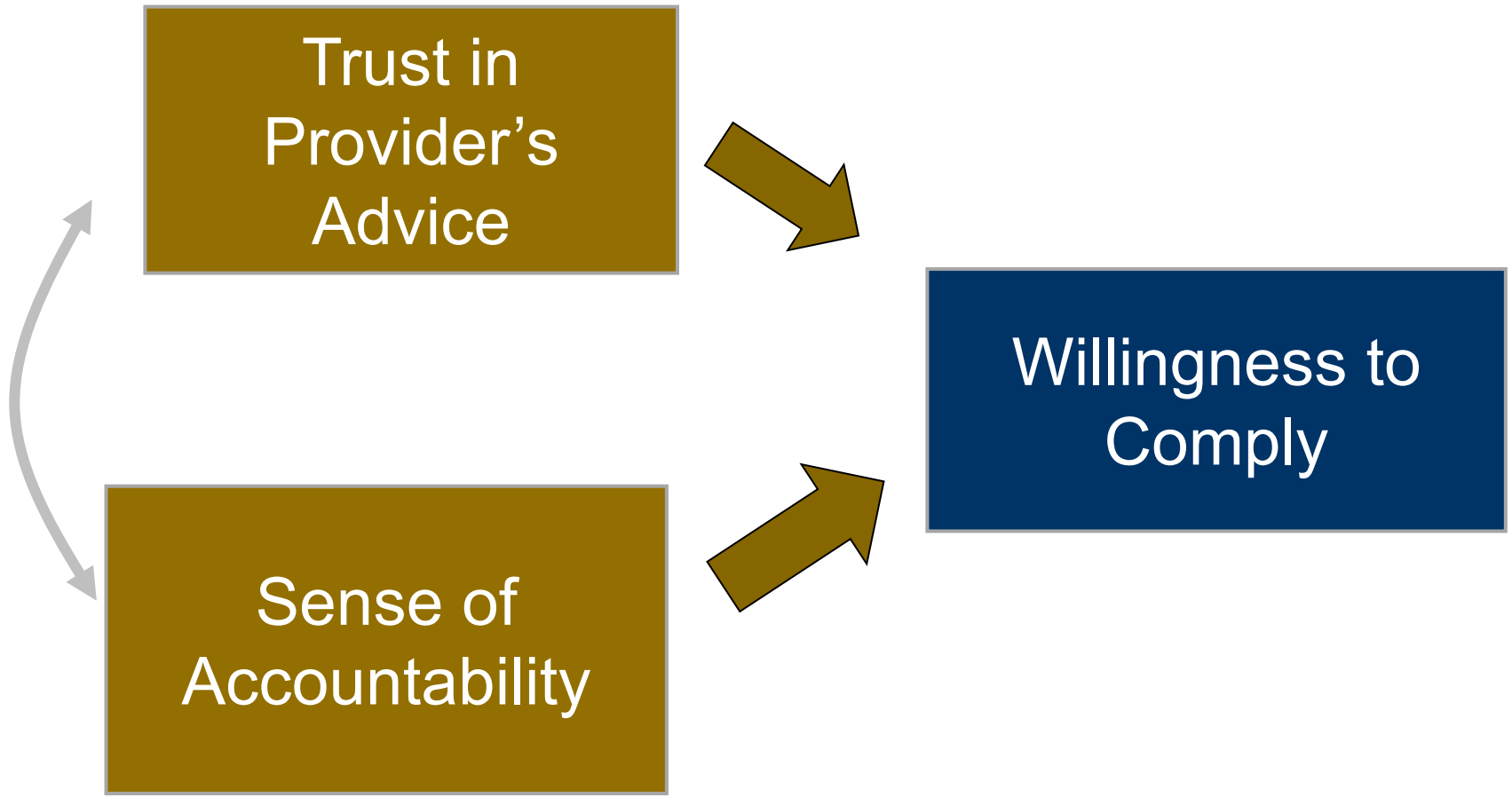
- Lack of trust in physicians/other providers.
- Lack of sufficient explanation about drug regimens from providers.
- Lack of relationship (normative, social, informational) with provider.
- Negative opinion of health system.

From multiple sources.

The Challenge and Opportunity: Monitoring & Improving Patient Medication Adherence

The Sirdeshmukh, Singh, and Sabol Trust Model

This is a foundational framework from their influential 2002 *Journal of Marketing* paper titled "Consumer Trust, Value, and Loyalty in Relational Exchanges" Consumer Trust, Value, and… . The model has become a cornerstone in relationship marketing and consumer behavior research.


Trust in Provider's Advice
Sense of Accountability
Willingness to Comply

DIGITAL HEALTH TECHNOLOGIES (DHT)

- **Digital health refers to the *use of information and communications technologies in medicine and other health professions to manage illnesses and health risks and to promote wellness*.**
- Digital health has a broad scope and includes the use of wearable devices, mobile health, telehealth, health information technology, and telemedicine.

Ronquillo Y, Meyers A, Korvek SJ. Digital Health. [Updated 2023 May 1]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK470260/

SOME MAJOR TYPES OF DHT

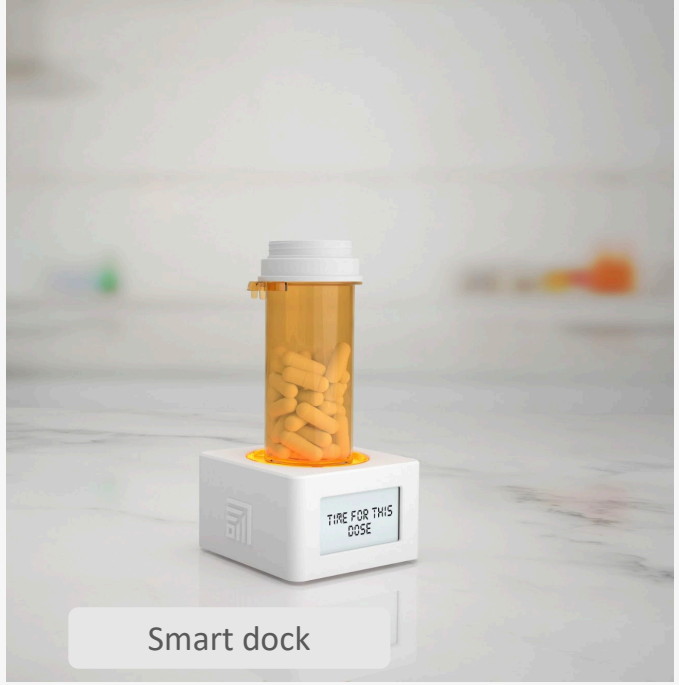
- Remote sensing and wearables
- Telemedicine and health information
- Data analytics and intelligence, predictive modeling
- Health and wellness behavior modification tools
- IOT Health Technologies for various purposes including medication management
- Digital therapeutics
- Digitized health record platforms
- DIY diagnostics, compliance, and treatments

Complete & Integrated Platform

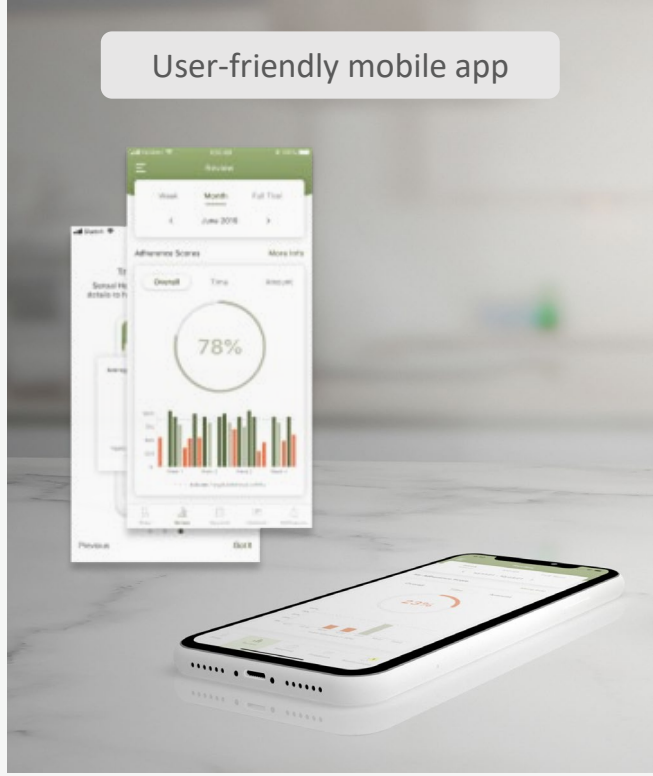
Smart Technology | Patient Apps | Clinician Dashboard | Administrative Portal

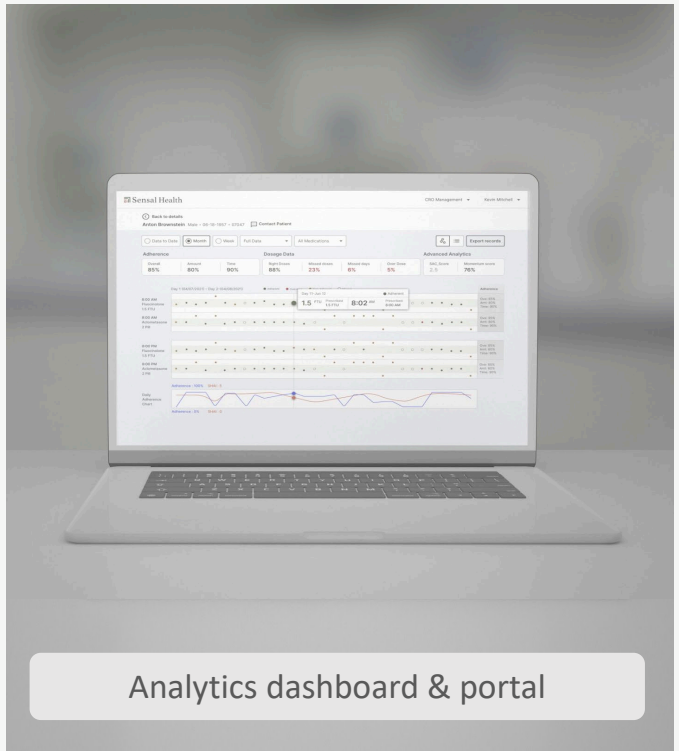
Advanced, user-friendly and comprehensive technology that works in sync to capture dosage data without interrupting patients' normal routines, while keeping clinicians and care-givers in the loop.

Sensal Health®



Smart dock




Analytics dashboard & portal

AI in Pharmacy

Artificial Intelligence

- Artificial intelligence (AI) is the capability of computer systems to perform tasks that typically require human intelligence, such as learning, problem-solving, and decision-making.
- It involves machines simulating human cognitive (and affective?) processes to understand their environment, recognize patterns, and take actions to achieve goals.

Major AI Techniques

- **Machine learning**: It is the subfield of AI aimed to focus on development of algorithms who could learn from the data to further timely improve their performance.
- **Neural networks and Deep learning**: It refers to those algorithms type of machine learning that imitate the structural aspect and functionality of the human brain. Deep learning is a subset of neural networks concentrated on developing algorithms with multiple layers of artificial neurons.
- **Data Mining, Knowledge Discovery and Advanced Analytics**: These techniques involve extracting useful information from large datasets and using it to make predictions or decisions.
- **Rule-Based Modeling and Decision-Making**: The set of systems that use a set of predefined rules aimed to make decisions for the input data are termed the Rule based systems.
- **Fuzzy Logic-Based Approach**: An approach of logic in the mathematical system that deals with uncertainty and imprecision in data.
- **Text Mining and Natural Language Processing**: These techniques involve analyzing and understanding natural language data, such as text and speech.
- **Visual Analytics, Computer Vision and Pattern Recognition**: These techniques involve analyzing and understanding visual data, such as images and videos.

LLMs: The Most Common AI We Hear Of

- **LLMs**, or large language models, are advanced artificial intelligence systems trained on vast amounts of text to understand and generate human-like language.

- They are used for tasks such as text generation, translation, summarization, and question answering. LLMs are built on deep learning architectures, most commonly the transformer architecture, and can be either proprietary or open-source.

Sensal Health: AI Use Cases

AI Copilot for Clinician Adherence

An AI Copilot that integrates seamlessly into the provider dashboard, allowing clinicians to interact with patient data using natural language

Predictive Non-Adherence Risk Scoring & Preemptive Intervention

An AI-driven ML algorithm that can detect irregularities in medication adherence

Our Role

SoluteLabs brings AI-driven intelligence that turns Sensal's adherence data into *foresight.*

Our experience building predictive copilots for U.S. health systems and pharma ensures the right balance of data sensitivity and clinical value.

HIPAA/HITECH • BAA-ready • FHIR/SMART-on-FHIR • HIPAA-aware SDLC • US presence

AI Copilot for Sensal Adherence Dashboard

Challenge and Opportunity

Currently, clinicians using Sensal's Adherence Analytics Dashboard must:

- Manually filter through patient adherence data
- Click through multiple screens to understand patterns
- Spend time identifying which patients need intervention
- Analyze trends across individual patients and cohorts

AI-Generated Smart Summaries

- **Pre-visit summaries:** Before a provider sees a patient, the AI automatically generates: "Patient Sarah has taken 18 of 21 prescribed doses (85.7% adherence). Missed doses clustered on weekends. Temperature sensors detected 2 instances of room-temperature storage vs. refrigeration requirement."
- **Anomaly detection alerts:** "Patient #4523's adherence dropped from 92% to 45% over the past 5 days - this is a 3-sigma deviation. Recommend immediate outreach."

Natural Language Querying

Clinician: "Which patients missed more than 3 doses this week?"
Sensal AI: [Filtered list with patient names, medications, exact missed doses]

Clinician: "Show me John Doe's adherence trend over 30 days"
Sensal AI: [Visualization + natural language summary: "John's adherence declined from 95% to 62% starting Jan 15, coinciding with weekend patterns"]

Clinician: "Summarize all dermatology patients with <50% adherence"
Sensal AI: [List + insights about common patterns, suggested interventions]

Predict Non-Adherence Before It Happens, Not After

Challenge and Opportunity

Sensal Health helps providers monitor patient adherence through SmartCap and SmartDock. But clinicians still react *after* patients miss doses.

By the time a missed dose shows up on the dashboard, the opportunity for intervention has passed. This reactive model limits both patient outcomes and trial reliability.

Sensal collects unprecedented granular data:

- Exact dosage amounts, times, temperatures
- Multi-month longitudinal data per patient
- Device usage patterns (shaking, tilting via accelerometer)
- Environmental factors (temperature storage violations)

This data is currently underutilized, it's being displayed but not predicted.

Our Approach

1. **Map adherence patterns** across device data and user interactions.
2. **Train AI models** to forecast "risk of non-adherence."
3. Embed **early-warning alerts and summaries** into the clinician dashboard.

AI Can Cause Mistakes & Damage Trust

Deepak Sirdeshmukh M.S., Ph.D.

Patient Trust Matters

ARTIFICIAL INTELLIGENCE

Trust in Healthcare AI Can Be Hurt Intentionally or Innocuously

6 key factors can affect trust among AI providers' buyers and clinical users.

Posted September 22, 2025 | Reviewed by Michelle Quirk

KEY POINTS

- **Health AI customers and users rely heavily on their trust in the provider to dampen risk.**
- **Contrary to common belief, trust in companies is not only depleted through wanton and Machiavellian actions.**
- **Trust in health AI firms can be damaged through innocuous acts.**

The race for supremacy among major artificial intelligence (AI) providers, including OpenAI, Anthropic, and Google, is approaching peak intensity. Alongside this growth, concerns about customer trust and distrust have become paramount. These concerns are appropriate—our own work suggests that in the face of the ambiguity and uncertainty typically accompanying a new technology such as healthcare AI, customers and users rely heavily on their trust in the provider to dampen risk and obtain peace of mind.

Healthcare buyers and users' trust in their AI providers will likely drive their

How Companies Damage Trust

- Uncontrollable factors
- Good intentions gone wrong
- Poor insight, cluelessness
- Hubris and complacency
- Pressure and expediency
- Greed and malintent

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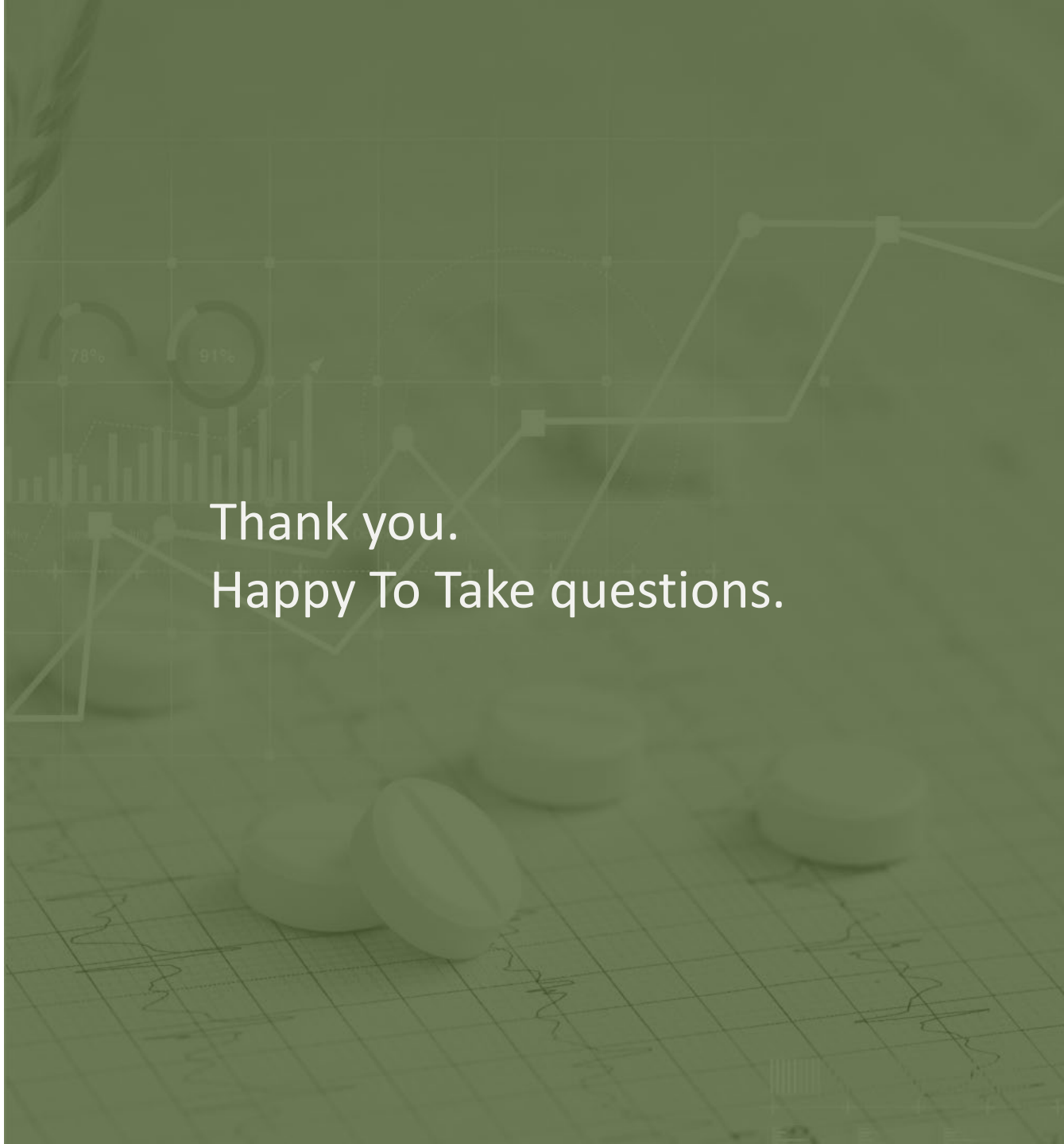

Thank you.
Happy To Take questions.