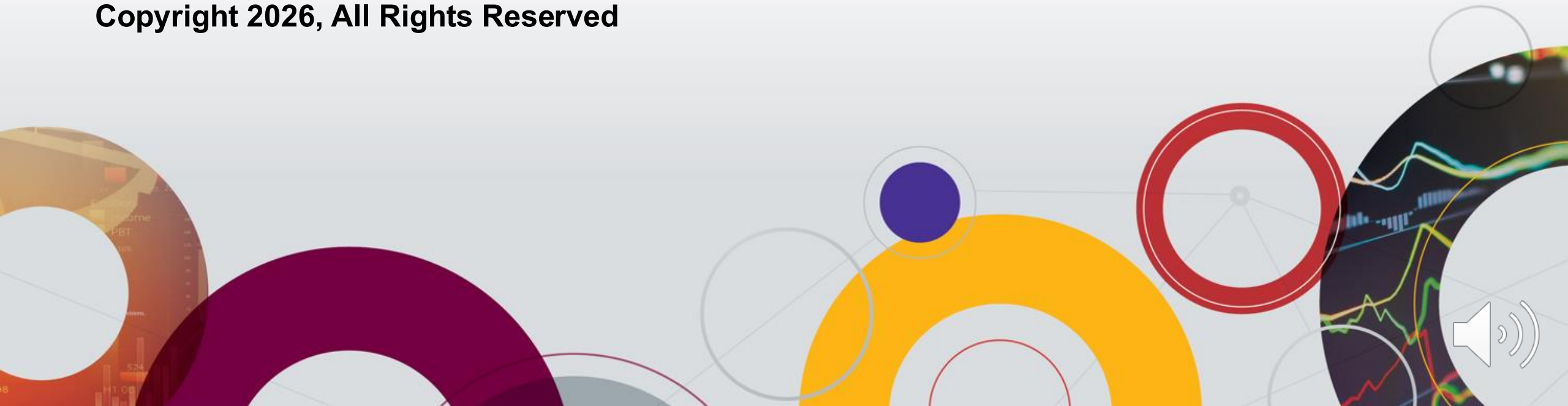


3.5b Clinical Decision Support

10x10 – Introduction to Biomedical Informatics & Artificial Intelligence
William Hersh, MD, FACMI, FAMIA, FIAHSI
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Standard approaches and tools

Another challenge for CDS is mostly local development and resulting lack of scalability, i.e., how can CDS be disseminated across institutions, different EHR systems, and other variations?

Approaches to facilitating scalability of CDS include

- Arden Syntax
- CDS Connect
- CDS Hooks

Arden Syntax (Hripcsak, 1994; Jenders, 2018; Adlassing, 2018)

Procedural language for delivering Medical Logic Modules (MLMs)

- Allows sharing of decision support rules across systems

Specifies

- Event – clinical event happens
- Condition – specific condition detected
- Action – is recommended

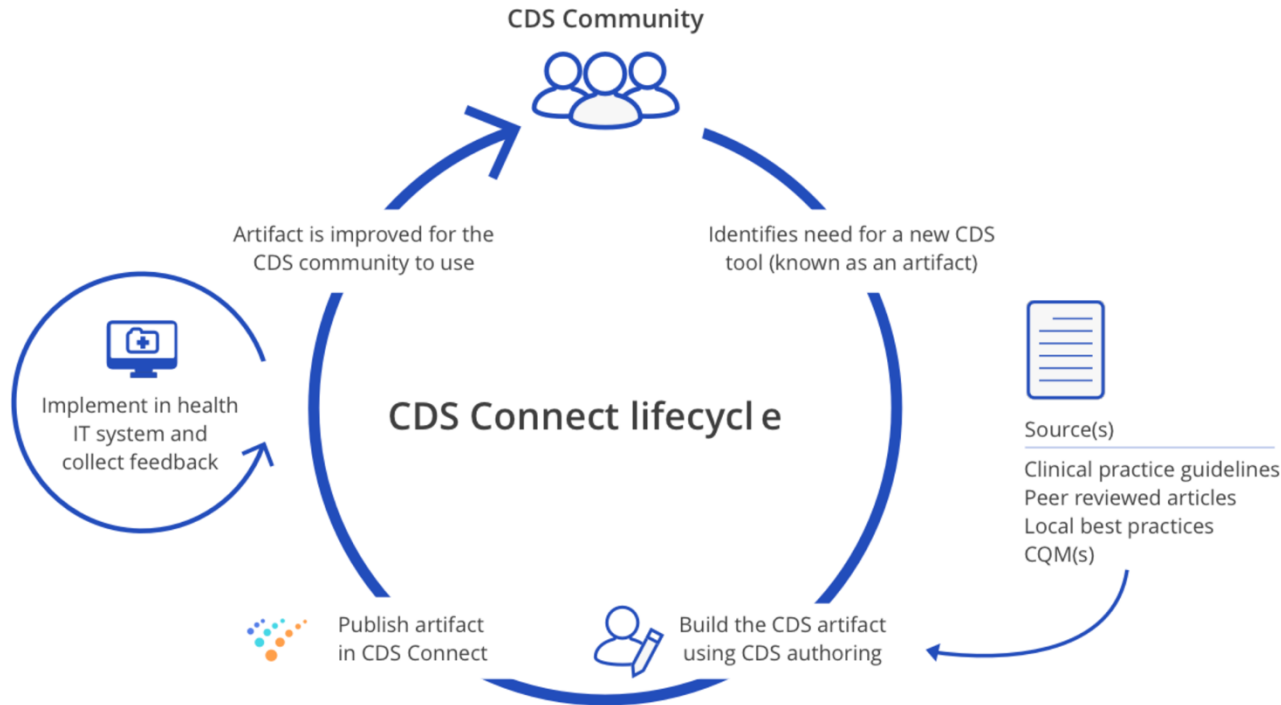
Now a standard: ASTM E1460

Major limitation has been “curly braces” problem due to local terminologies (Jenders, 1997; Samwald, 2012)

Arden syntax example

```
penicillin_order :=  
  event {medication_order  
    where class = penicillin};  
/* find allergies */  
penicillin_allergy :=  
  read last {allergy  
    where agent_class = penicillin};  
;;  
evoke: penicillin_order ;;  
logic:  
If exist (penicillin_allergy) then conclude true;  
endif;  
;;  
action:  
write  
"Caution, the patient has the following allergy to penicillin documented:"  
|| penicillin_allergy ;;
```

CDS Connect (Lomotan, 2020)



Statin Use for the Primary Prevention of CVD in Adults: Clinician-Facing CDS Intervention

Presents a United States Preventive Services Task Force (USPSTF) statin therapy recommendation for adults aged 40 to 75 years without a history of cardiovascular disease (CVD) who have 1 or more CVD risk factors (i.e., dyslipidemia, diabetes, hypertension, or smoking) and a calculated 10-year CVD event risk score of 7.5% or greater.

PROMINENT REPORTS

[Implementation Guide \(PDF 1.1 MB\)](#)

Artifact Type

Event-Condition-Action (ECA) rule

Creation Date

Mon, 07/10/2017 - 12:00

Version

1.0.0

Status

Active

Unique Identifier

CDS 009

Experimental

False

ARTIFACT CREATION AND USAGE

Steward

[Agency for Healthcare Research and Quality](#)

Contributors

This artifact was developed by MITRE software engineers and clinical informaticists, in collaboration with clinical subject matter experts and leaders from the USPSTF.

Additional information about MITRE's health expertise is available [here](#).

Additional information about the USPSTF's preventive health expertise is available [here](#).

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If you would like further information, would like to give us feedback, or have any questions about this artifact, please contact us at ClinicalDecisionSupport@ahrq.hhs.gov

Keywords

10-year ASCVD risk statin therapy preventive screening Risk assessment CVD ASCVD cholesterol primary prevention prevention

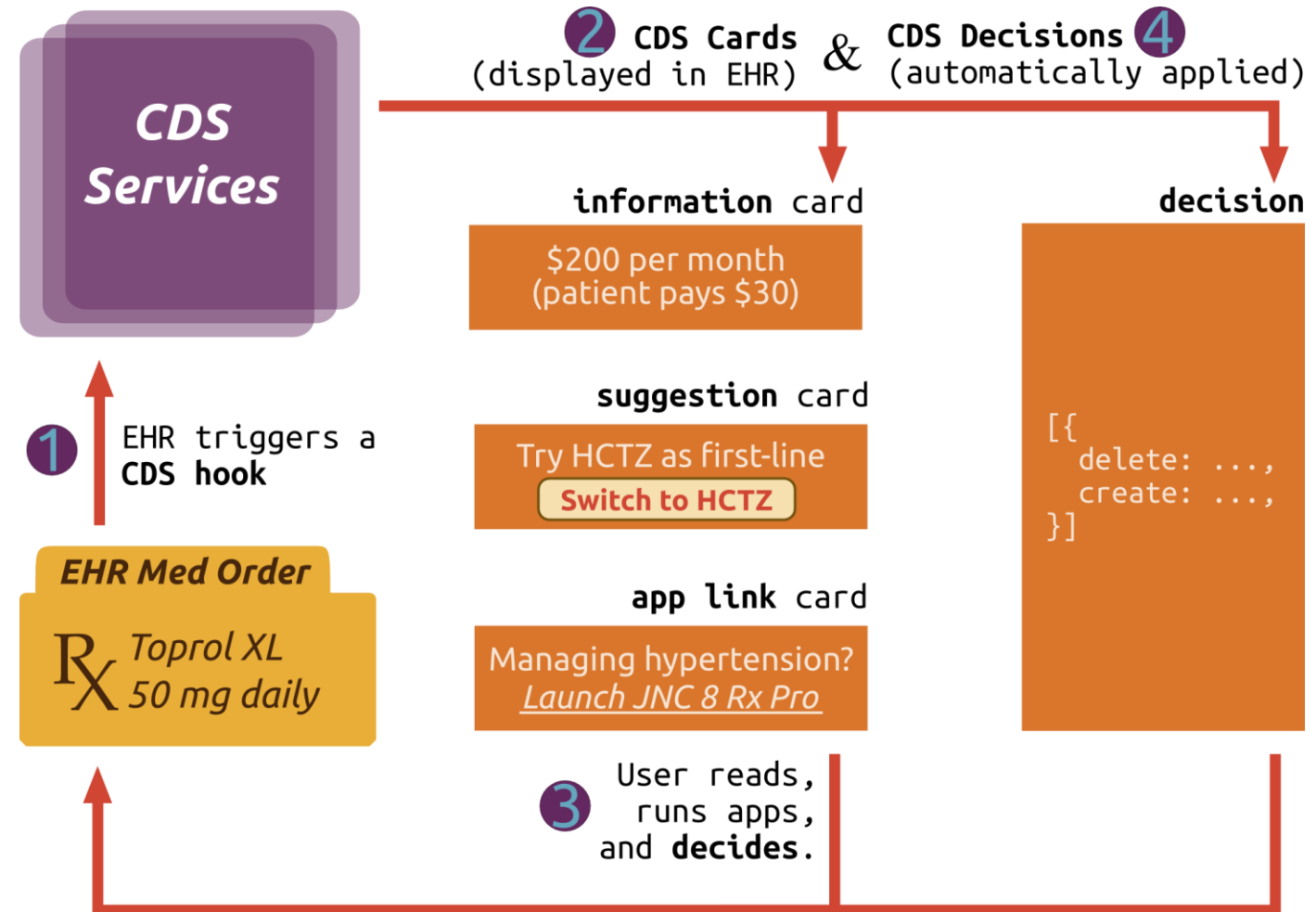
MeSH Topics

☒ Preventive Health Services ☒ Primary Prevention ☒ Cardiovascular System ☒ Statin ☒ Risk Factors ☒ CVD

CDS Hooks

HL7-supported standard

Example of use in a
pharmacogenetics medication
CDS service (Dolin, 2024)



Computerized provider order entry (CPOE)

Definition – Computerized provider order entry (CPOE) refers to the process of providers entering and sending treatment instructions – including medication, laboratory, and radiology orders – via a computer

Systematic review of usage for medication ordering found impacts at individual, technological, and organizational levels (Mogharbel, 2021)

To discuss

- Best practices
- Overrides
- Safety

Before understanding CPOE, must understand “orders”

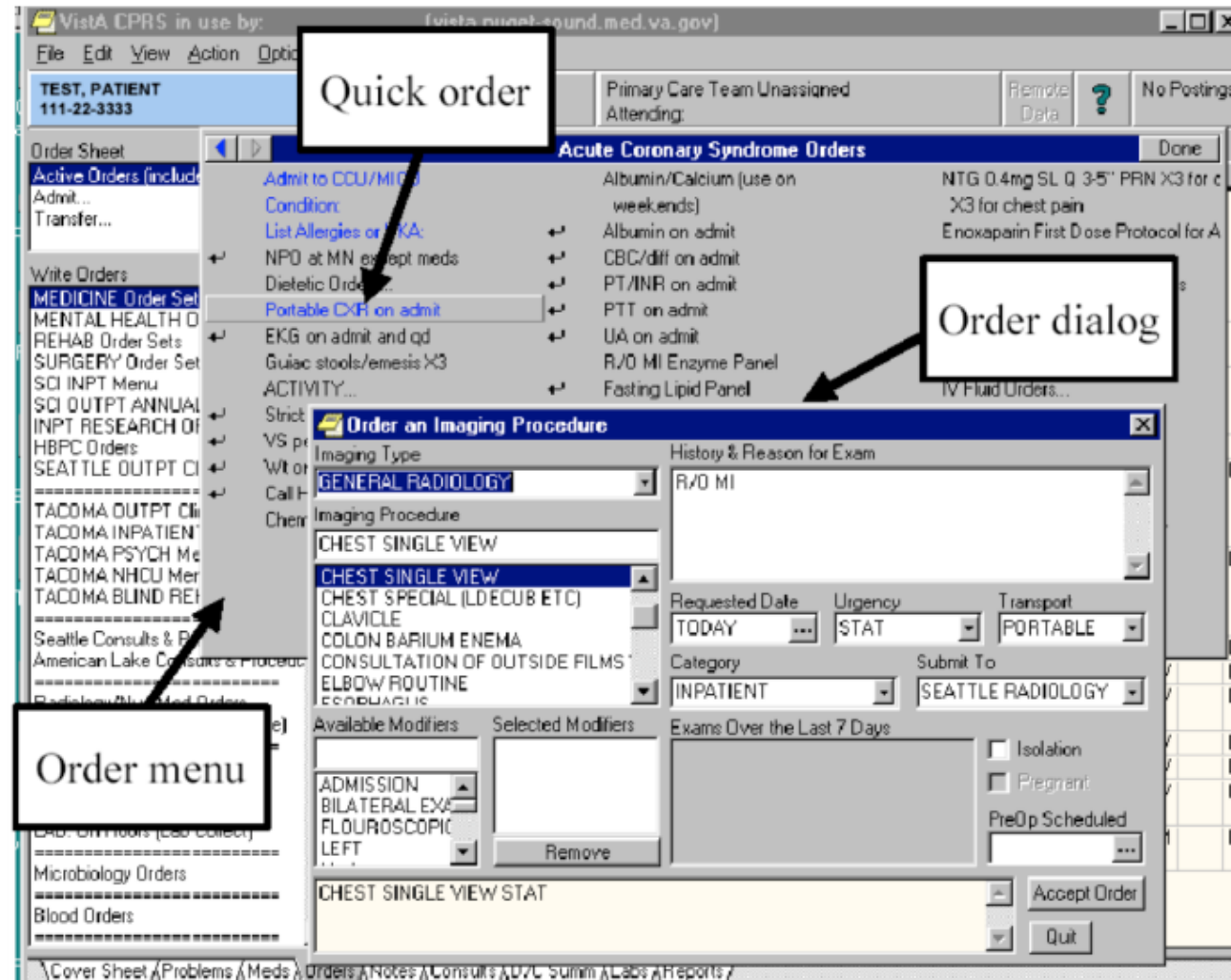
(Arcane term) describing what physicians (and sometimes other clinicians) request for patient care, e.g., tests, treatments, observations, etc.

- “The single most expensive piece of hospital equipment is the doctor’s pen.” (Rosenthal, 1984)

Most orders specified in paper or electronic chart and “signed” by physician, but there are variations

- Verbal order – order given verbally and entered later
- Telephone order – verbal order given by telephone
- Standing order – order to be repeated at interval without reordering
- Conditional order – order carried out if certain condition(s) apply
- Signed downtime order – order given during downtime

Best practices for individual orders (Payne, 2003)



Best practices for order sets

Groups of orders (directions, tests, and treatments for patient care) based on diagnosis, treatment, or medical specialty category (Payne, 2003; Bobb, 2007)

- Best managed at departmental and not institutional or individual level – can get clinicians to communicate better about consensus practices

Order sets reduce cognitive workload and order variation but do not reduce time spent, mouse clicks, or free-text entry (Avansino, 2012)

Commercially available from EHR vendors or companies, e.g., [Zynx](#)

Most common hospital use in admission and post-operative settings (Wright, 2012)

Must use care and not cause harm when evidence equivocal (Shah, 2018)

Overrides of CPOE advice

Bates (1999) study of redundant lab tests

- 31% of suggestions for cancellation overridden
- Only 41% were deemed justified by expert review

Hsieh (2004) assessment of drug-allergy overrides

- 80% of alerts overridden, usually due to “aware/will monitor” (55%) and “patient does not have this allergy” (33%)
- Still resulted in 6% rate of ADEs in patients, although all were judged clinically justifiable

Study of 2872 clinicians and 233,357 medication alerts (Isaac, 2009)

- 6.6% of all prescriptions generated alerts
- Clinicians only accepted 9.2% of drug-interaction and 23.0% of allergy alerts
- Most interaction alerts were “high-severity” (61%), which were slightly more likely to be accepted

Overrides (cont.)

Higher in commercial EHR systems (Bryant, 2014; Wong, 2017)

Vary by provider, with more variation in areas with more inappropriate overrides (Beeler, 2016)

Large-scale inpatient analysis found variation by type and appropriateness (Nanji, 2017)

Most common reasons for overrides (Wright, 2019)

- Will monitor or take precautions
- Not clinically significant
- Benefit outweighs risk
- Patient tolerated previously
- Dose adjusted
- Not related to DDIs
- Not ordering a medication
- Alert is not the recipient's responsibility
- Agreement, though alert was overridden
- Order is urgent
- Error in data

Alert type	Total alerts N (%)	Alert overrides N (%)
Patient allergy	131 615 (61.7)	107 812 (81.9)
Drug-drug interaction	37 579 (17.6)	25 616 (68.2)
Duplicate drug	44 059 (20.7)	22,855 (51.9)
Total	213 253 (100.0)	156 283 (73.3)

Alert type	Sample size reviewed for appropriateness	Appropriate override (%)
Duplicate drug	200	98.0
Patient allergy	200	96.5
Formulary substitution	206	82.5
Drug-drug interaction	250	62.0
Age-based suggestion	208	26.4
Renal suggestion	1033	2.2
Total	2097	61.3

Safety of CPOE

One early study found increased mortality in pediatric ICU after implementation (Han, 2005), although it was not confirmed in other centers (Del Baccaro, 2006; Longhurst, 2010) and probably due to implementation problems (Sittig, 2006)

Recent recommendations for safe e-prescribing (Schiff, 2018)

- Incorporate medication indications
- Establish single shared online medication list
- Implementing the transmission of electronic cancellation orders to pharmacies (CancelRx)
- Standardized structured and codified prescription instructions
- Reengineering CDS
- Redesigning to facilitate ordering of nondrug alternatives

Toward the future – guidance from the past

Ten commandments of CDS (Bates, 2003)

- Speed is everything
- Anticipate needs and deliver in real-time
- Fit into workflow
- Little things make a big difference
- Physicians resist stopping – offer alternatives
- Changing direction is easier than stopping
- Simple interventions work best
- Ask for only additional information that is needed
- Monitor impact, obtain feedback, and modify
- Manage and maintain knowledge

Five rights for CDS (Osheroff, 2007)

- The right information (e.g., evidence-based guidance)
- To the right people (i.e., clinical care team—including the patient)
- Through the right channels (e.g., electronic health records, patient portal, other means)
- In the right intervention format (e.g., prompts, order sets, alerts)
- At the right points in the workflow (i.e., for decision-making or action)

Toward the future (cont.)

Attention to entire life-cycle of CDS is critical (Sittig, 2023)

Automated but personalized care – need eActions from validated CDS in routine use (Morris, 2023)

Need clinician and informatician training with all aspects of CDS and applicable standards – [CDS-Sandbox](#) (Soares, 2023)

Role and challenges for machine learning and AI (Khalifa, 2024)

