

The Safety and Effectiveness of Electronic Decision Support to Improve Care Decisions and Outcomes



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AUSTRALIAN INSTITUTE
OF HEALTH INNOVATION

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CAOH – ISQua Webinar 6th December 2022



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Outline

- Role of electronic decision support in improving health care safety and efficiency
- Challenges in the design and use of electronic decision support
- What we have learnt about individual and contextual factors which impact the effectiveness of electronic decision support in practice
- Future directions

Electronic Decision Support



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Tools that utilise information within electronic health record systems to support decision making.

Basic decision support – tools which focus attention e.g. providing test thresholds, alert to indicate a possible drug-drug interaction, dose range, allergy.

Advanced decision support – aims to provide patient-specific recommendations e.g. drug-disease interactions, or recommendations on laboratory testing during drug use.

Both of the above are rule or algorithm-based approaches which rely upon existing clinical knowledge and evidence.

Effects of clinical decision-support systems on practitioner performance and patient outcomes: a synthesis of high-quality systematic review findings

Monique W M Jaspers,¹ Marian Smeulers,² Hester Vermeulen,² Linda W Peute¹

J Am Med Inform Assoc 2011;**18**:327–334.

- ❑ Good evidence that EDS can positively impact providers drug ordering and preventive care reminders.
- ❑ Few studies have found benefits on patient outcomes – many small samples and short followup

Effects of computerized decision support system implementations on patient outcomes in inpatient care: a systematic review FREE

Julian Varghese ✉, [Maren Kleine](#), [Sophia Isabella Gessner](#), [Sarah Sandmann](#),
[Martin Dugas](#)

Journal of the American Medical Informatics Association, Volume 25, Issue 5, May 2018,
Pages 593–602, <https://doi.org/10.1093/jamia/ocx100>



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12 Quality systematic reviews
52 of 91 studies showed EDS impacted practitioner performance.
25 of 82 studies reported evidence of improved patient outcomes

70 studies

Most CDSS associated with positive patient outcomes.

- 5 reduced mortality
- 16 reduced life-threatening events
- 28 reduce non life threatening events
- 20 no impact on patient outcomes
- 1 negative impact

Approach to Providing Advice



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Passive DS requires the user to do something to receive advice, for example clicking a button or opening a tab.


Active decision support pushes information to users and usually requires users to acknowledge the information before proceeding with their task. I.e. interruptive alerts

A challenge of active systems is to avoid the generation of excessive amount of alerts, causing alert fatigue with the user.







Evidence that targeted decision support can be highly effective

Dicloxacillin Capsule 

Drug to Allergy/Intolerance Interactions

 **Class Allergy to Penicillins**  (facial swelling)

Dicloxacillin Capsule contains Dicloxacillin which is in the class Penicillins to which the patient is allergic.

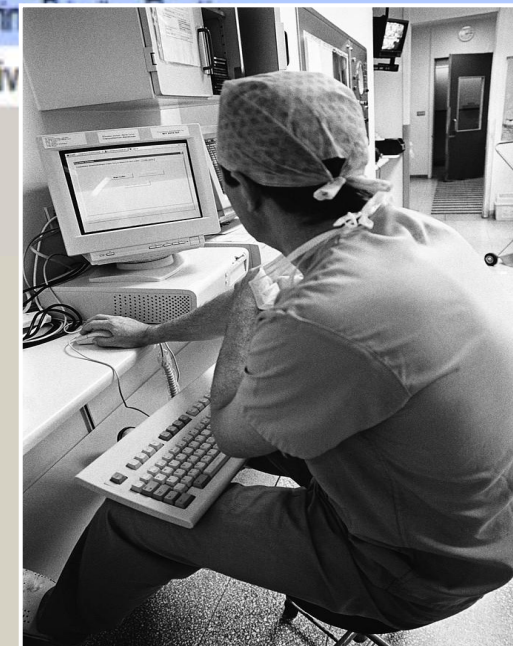
Action	Comment
<input type="radio"/> Override	
<input type="radio"/> Remove	

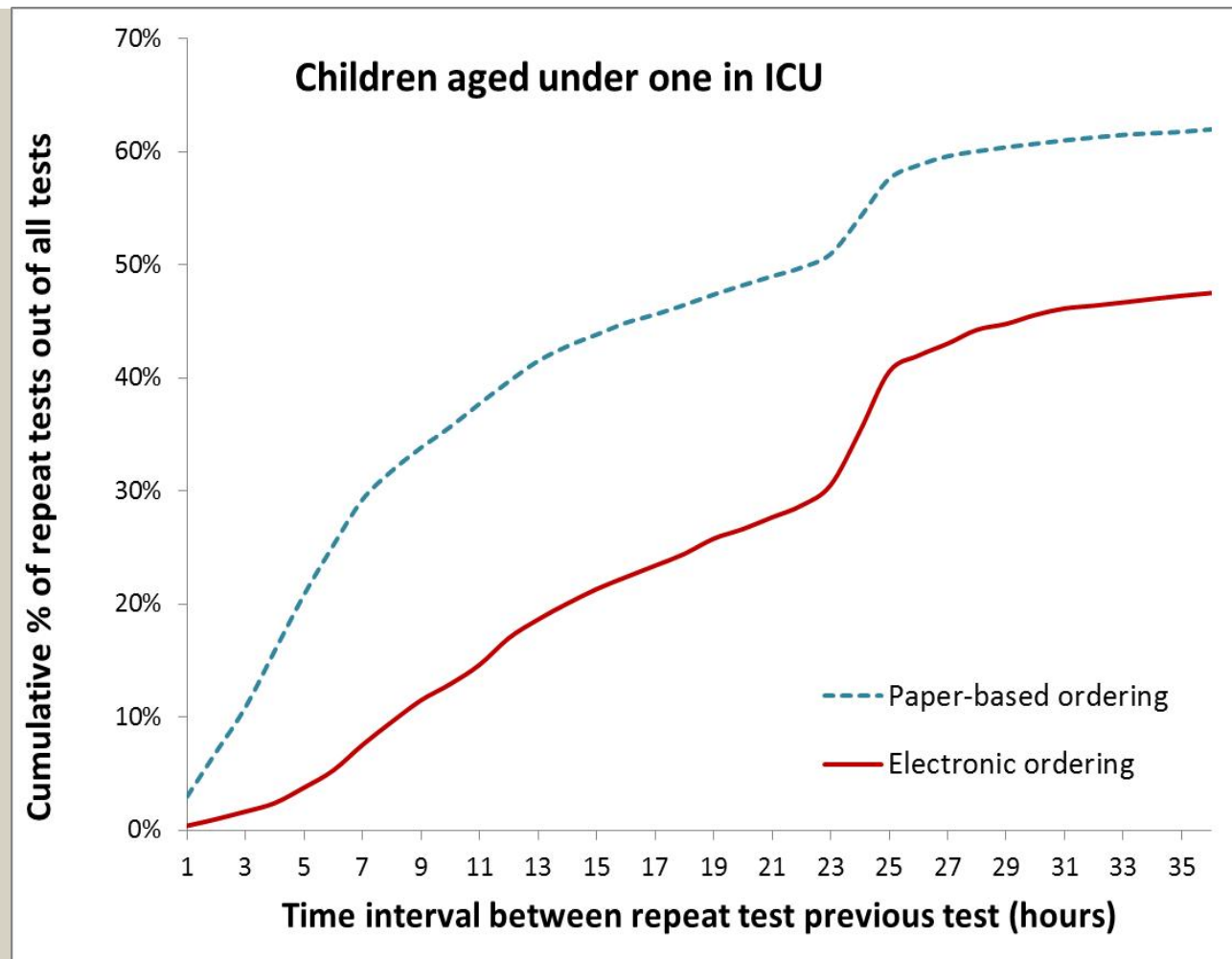
Impact of decision support on repeat laboratory test ordering rates



****Duplicate Order Alert****

Orderable	Order Details
✘ APTT Mixing Studies	Citrate plasma, Req D/T: 21/02/2012 16:17 AEDT, Collected, Follow up prolonged APTT Liver Disease Lupus Inhibitor? On Heparin On Warfarin Post Op
APTT Mixing Studies	Citrate plasma, Req D/T: 21/02/2012 16:17 AEDT, Not Collected, Liver Disease On Warfarin, Priority: Routine
✘ APTT Mixing Studies	Citrate plasma, Req D/T: 21/02/2012 16:17 AEDT, Not Collected, Liver Disease On Warfarin
APTT Mixing Studies	Citrate plasma, Req D/T: 21/02/2012 16:17 AEDT, Collected, Follow up prolonged APTT Liv





Repeat testing for 5073 children under 1 year in ICUs significantly ($p < 0.0001$) declined following the introduction of electronic test ordering

But.....

A large body of work demonstrating that doctors override alerts (i.e. click past alerts without following recommendations), up to **95%** of alerts

→ Alert fatigue - mental state resulting from excessive numbers of alerts being triggered

Leads to:

- User frustration and annoyance
- Prescribers overwhelmed by alerts
- Learn to ignore all alerts



Many Interruptive Alerts are Overridden

- ❑ 49%-96% Medication alerts have been estimated to be overridden
- ❑ Reasons include that many alerts are irrelevant to the specific task

Original research

A cross-sectional observational study of high override rates of drug allergy alerts in inpatient and outpatient settings, and opportunities for improvement



Sarah Patricia Slight^{1,*}, Patrick E Beeler^{2,*}, Diane L Seger³, Mary G Amato^{4, 5}, Qoua L Her⁵, Michael Swerdloff⁵, Olivia Dalleur⁶, Karen C Nanji⁷, InSook Cho^{8, 9}, Nivethietha Maniam⁵, Tewodros Eguale⁵, Julie M Fiskio¹⁰, Patricia C Dykes¹¹, David W Bates⁵

BMJ Quality & Safety 2017;26:217-225.

- ❑ Sample: 793-bed hospital and 36 US primary care practices
- ❑ 29,420 drug allergy alerts – 83% in hospitals 17% outpatient
- ❑ In total 81% of alerts were overridden. Sample were reviewed and >96% considered appropriate. 71% of alerts that warned a risk of anaphylaxis were overridden.
- ❑ Most common reasons – Patient has previously taken without allergic reactions
- ❑ Conclusions – Information in patient drug lists needs to be regularly updated. Alert rules should be reviewed, modified or removed.

Design is Critical



THINK ABOUT THE FIT!



Patient Note

Created: 17/06/2016 JMK Edited: Locked:

Subject: Drug-Drug Interaction Warning(s)

Font: Arial 9 Bold Italic Underline

Patient Name: TEST, FIVE

----- Warning: Drug-Drug Screening Result(s) -----
Severity: *** Severe
Interaction between AZATHIOPRINE and ALLOPURINOL
Thiopurines/ALLOPURINOL; OXPURINOL
CLINICAL EFFECTS: Potentiation of thiopurine effects, with increased bone marrow suppression.

----- <References for Drug-Drug Interactions> -----
Interaction between AZATHIOPRINE and ALLOPURINOL
REFERENCES:
1.Hitchings GH. Summary of informal discussion on the role of purine antagonists. Cancer Res 1963 Sep;23:1218-25.
2.Levine AS, Sharp HL, Mitchell J, Krivit W, Nesbit ME. Combination therapy with 6-mercaptopurine (NSC-755) and allopurinol (NSC-1390) during induction and maintenance of remission of acute leukemia in children. Cancer Chemother Rep 1969 Feb;53(1):53-7.
3.Nies AS, Oates JA. Clinicopathologic conference: hypertension and the lupus syndrome--revisited. Am J Med 1971 Dec;51(6):812-4.
4.Berns A, Rubinfeld S, Rymzo WT Jr, Calabro JJ. Hazard of combining allopurinol and thiopurine. N Engl J Med 1972 Mar 30;286(13):730-1.
5.Zazgornik J, Kopsa H, Schmidt P, Pils P, Kuschan K, Deutsch E. Increased danger of bone marrow damage in simultaneous azathioprine- allopurinol therapy. Int J Clin Pharmacol Ther Toxicol 1981 Mar;19(3):96-7.
6.Brooks RJ, Dorr RT, Durie BG. Interaction of allopurinol with 6-mercaptopurine and azathioprine. Biomed Pharmacother 1982;36(4):217-22.
7.Krowka MJ, Breuer RI, Kehoe TJ. Azathioprine-associated pulmonary dysfunction. Chest 1983 Apr;83(4):696-8.
8.Zimm S, Etinger LJ, Holcenberg JS, Kamen BA, Vietti TJ, Belasco J, Cogliano-Shutta N, Balis F, Lavi LE, Collins JM, et al. Phase I and clinical pharmacological study of mercaptopurine administered as a prolonged intravenous infusion. Cancer Res 1985 Apr;45(4):1869-73.
9.Cox GJ, Robertson DB. Toxic erythema of palms and soles associated with high-dose mercaptopurine chemotherapy. Arch Dermatol 1986 Dec; 122(12):1413-4.
10.Boyd IW. Allopurinol-azathioprine interaction. J Intern Med 1991 Apr; 229(4):386.
11.Zimm S, Collins JM, O'Neill D, Chabner BA, Poplack DG. Inhibition of first-pass metabolism in cancer chemotherapy: interaction of 6-mercaptopurine and allopurinol. Clin Pharmacol Ther 1983 Dec; 34(6):810-7.
12.Anonymous. Case records of the Massachusetts General Hospital. Weekly clinicopathological exercises. Case 4-1972. N Engl J Med 1972 Jan 27; 286(4):205-12.
13.Anonymous. Hypertension and the lupus syndrome. Am J Med 1970 Oct; 49(4):519-28.
14.Purinethol (mercaptopurine) US prescribing information. Gate Pharmaceuticals May, 2011.

OK
Cancel

Two options

**Design
is
critical**

Clinical Application Suite [4.3.42] Thursday Aug 15, 2002 5:45 PM You are logged in as: Physician 1

Select pt PATIENT 1 BWH 11489879 42y M Pt Details PG

Drug Warning(s) Found Active Pt: PATIENT 1


DRUG WARNING(S)

Current Order:
NAFCILLIN IV

Warning(s):

Status	Order
New Order	Allergy to : Penicillins Reaction: Anaphylaxis

Message:
Reaction: Anaphylaxis. The patient has a DEFINITE sensitivity to NAFCILLIN.



Keep (override) order Cancel (D/C) order

Use mouse or arrow keys to select an Order. Alt-K to Keep (override) order. Alt-C to cancel.

Start Clinical Application Suite (...) 5:49 PM



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Designing Clinical Decision Support



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Box 1. Interface features categorized as presentation, placement, positioning, and provision of multiple presentation layers

Interface (Presentation)

Presentation

- Make it simple
- Use appropriate font sizes
- Use meaningful colors
- Ensure acceptable contrast between text and background

Keep presentation consistent

Deploy space-filling techniques

Make icons bold or bigger in size

Placement and positioning

Display information in prominent positions to ensure that it is seen

Allow for reading left to right

Localize information

Provision of multiple presentation layers

Avoid using only text

Box 2. Information features categorized as clean and concise, content guidance, and consistency

Information (Content)

Clean and concise

Standardize terminology

Use concise and effective language

Content guidance

Provide a recommendation, not an assessment

Justify recommendations

Suggest alternative recommendations

Provide additional resources

Make evidence-based recommendations the default

Keep recommendations up to date

Consistency


Recommendations should come from the same place

Have the same display of basic CDSS for all members of the health care team

Optimising decision support alerts

- Clinician feedback – Committee used consensus to determine alerts to be implemented or modified
- Examination of data on alert firing and override rates
- Visual dashboard to monitor and evaluate alerts – tracking alert firing and override rates after modifications
- Use of research evidence and drug references to inform decisions about alert design

Optimizing clinical decision support alerts in electronic medical records: a systematic review of reported strategies adopted by hospitals

Bethany A. Van Dort ,¹ Wu Yi Zheng,¹ Vivek Sundar,² and Melissa T. Baysari¹

Deciding when
to add decision
support

Is decision support a solution in
response to a problem

or

a solution looking for a problem?

Drug-drug Interaction (DDI) Alerts



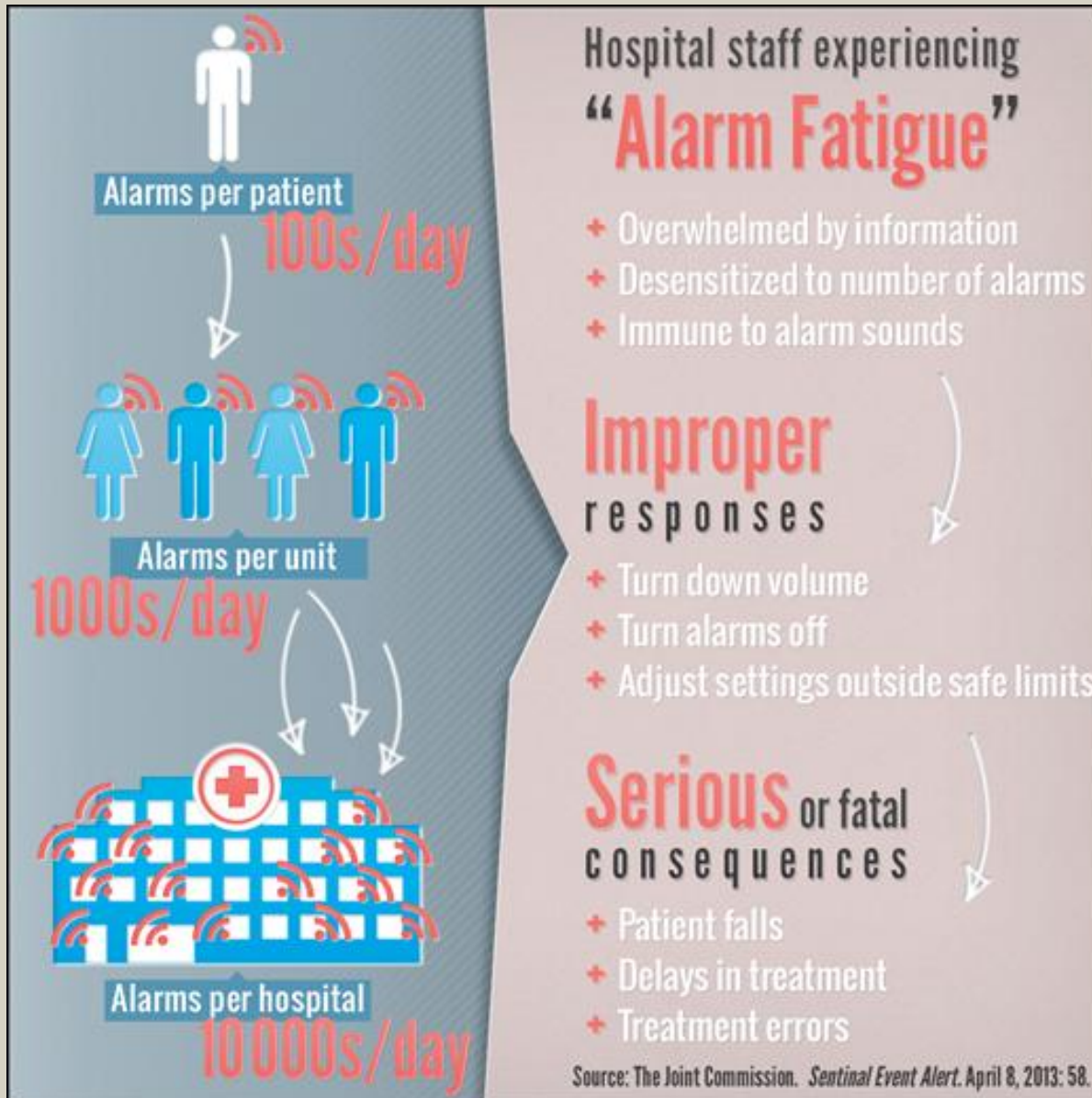
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Large potential number – 100s - >15,000 alerts

15,000 alerts???

Does the size of the problem warrant the solution?

An alert regarding - Alert Fatigue!



“How many alerts can you fire at users before they become ineffective?”

Assessing the impact of adding DDI alerts – Test before you buy



- Compared alerts in current hospital system with alerts if DDIs were added in a test system
- The 'Test' system had DDI alerts enabled – moderate, severe, unknown

	Allergy & Intolerance	Dose Range	Local rules	Therapeutic Duplication	DDIs
Live Hospital System Reference condition	✓	✓	✓	✓	✗
Adding DDI alerts (Test system)	✓	✓	✓	✓	✓

Overall alert volume by adding DDIs



Patients

Orders for 254 admitted inpatients

Hospital no DDI alerts

209 alerts

145 (25%)
medication orders
generated at least 1
alert

1.4 alerts per
medication order
(range: 0 - 4)

Hospital adds DDI alerts

1063 alerts

348 (60%)
medication orders
generated at least 1
alert

3.1 alerts per
medication order
(range: 0 - 11)

Increase with alerts

+509% in total
alerts

+240% in orders
with at least one
alert

+212% in number
of alerts per order

Organisations require clear criteria for when decision support should be added and also when it should be removed



When and why decision support may be effective?



What impact does medication decision support have during ward rounds?



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- 58.5 hrs, 14 teams, 96 orders
- 48% of medication orders triggered alerts
- 17% read
- No orders changed



Research and applications

J Am Med Inform Assoc 2011;**18**:754–759.

The influence of computerized decision support on prescribing during ward-rounds: are the decision-makers targeted?

Melissa T Baysari,¹ Johanna I Westbrook,² Katrina L Richardson,³ Richard O Day^{4,5}

Junior doctors' response to computerised alerts at night 16:30-22:30

Observational study - 65 hours

78% of alerts were read

5% resulted in a change in prescribing



Context Matters

Junior doctors' prescribing work after-hours and the impact of computerized decision support



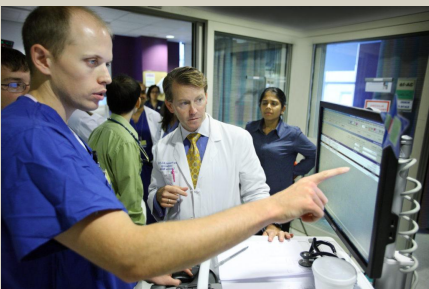
Samantha L. Jaensch^{a,b}, Melissa T. Baysari^{b,c,*}, Richard O. Day^{a,b},
Johanna I. Westbrook^d

INTERNATIONAL JOURNAL OF MEDICAL INFORMATICS 82 (2013) 980-986

Impact of Alerts Varies by Context



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Context	Alert impact
	17% alerts read No orders changed following an alert
	78% alerts read 5% of orders changed following an alert
	43% alerts read 3% of orders changed following an alert



What can we learn from experiences with Electronic Decision Support ?

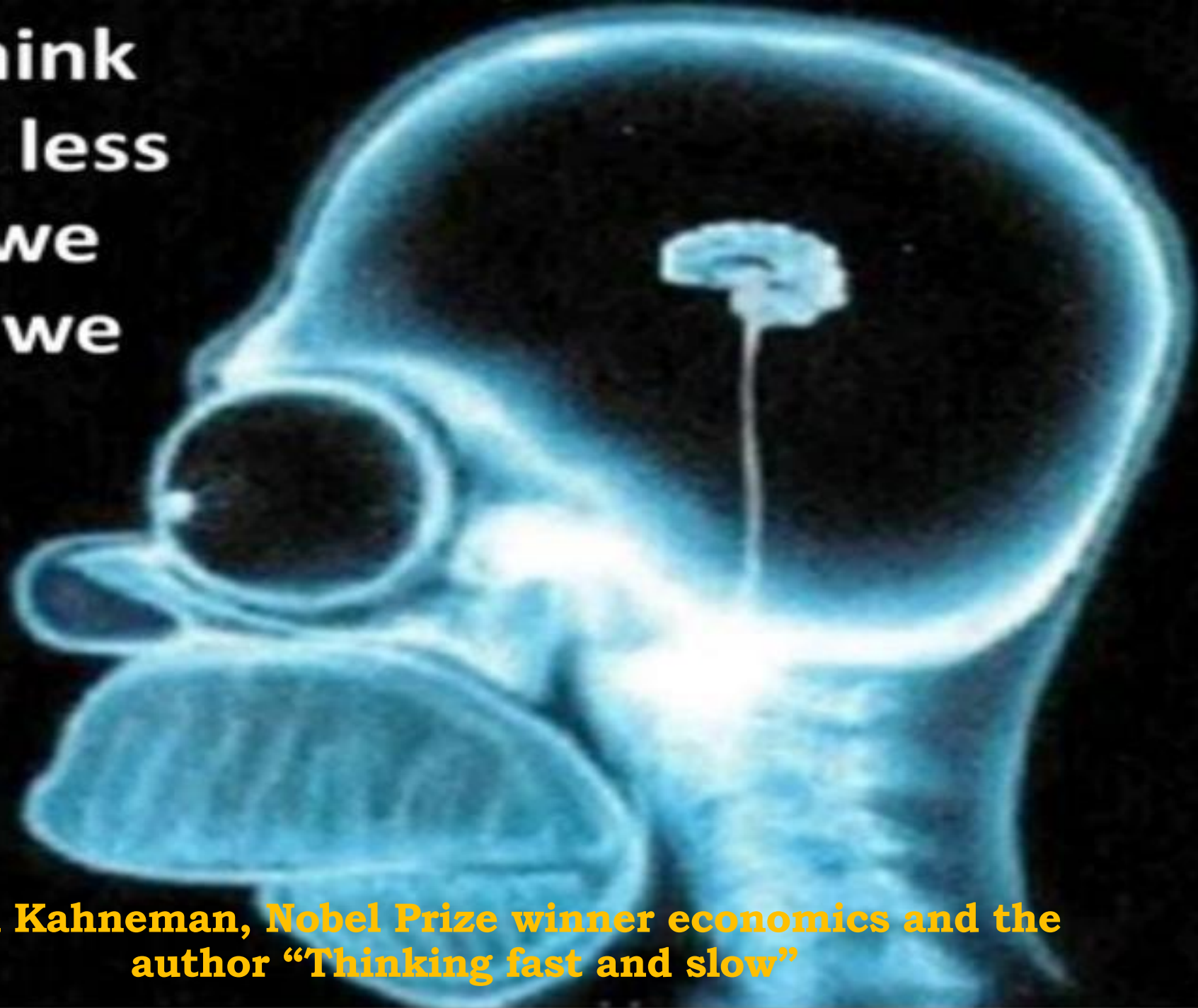
Human Factors Design –
Critical

Context important -

Behavioural Economics -
Evidence of how people
make decisions



**We think
much less
than we
think we
think**



Daniel Kahneman, Nobel Prize winner economics and the author "Thinking fast and slow"



Decision Support Design Architecture



Research on decision-making



- Decision option presentation influences user choice.
- Providing option to maintain the status quo selected over making a change
- Items placed first selected more frequently
- E.G Presenting antibiotic choice grouped according to narrow or broad spectrum, rather than listing individual drugs, resulted in a significant reduction in inappropriate antibiotic use.
- Tests or medications in an order-set increases use, even in situations when not clinically appropriate.

How behavioural economics helps us choose.

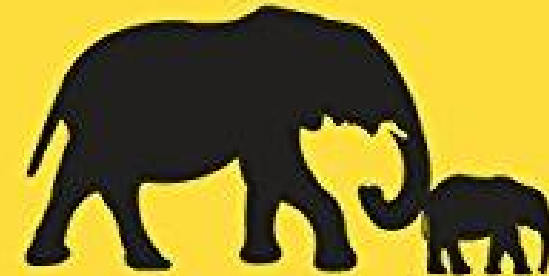


Choice Architecture

NUDGING PEOPLE TO MAKE A 'DESIRABLE'
CHOICE

Digital nudging and the future of decision-support

RICHARD H. THALER
WINNER OF THE NOBEL PRIZE IN ECONOMICS
and CASS R. SUNSTEIN



Nudge

NEW YORK TIMES Bestseller

Improving Decisions About
Health, Wealth, and Happiness

"One of the few books . . . that fundamentally changes the way I think about the world." —Steven D. Levitt, coauthor of FREAKONOMICS

An evidence-based approach to electronic decision support



- Understanding decision-making context
- Target support to area with evidence of big safety/quality problems
- Apply choice architecture and digital nudges
- Evaluate and monitor both expected and unexpected changes using robust measurement approaches

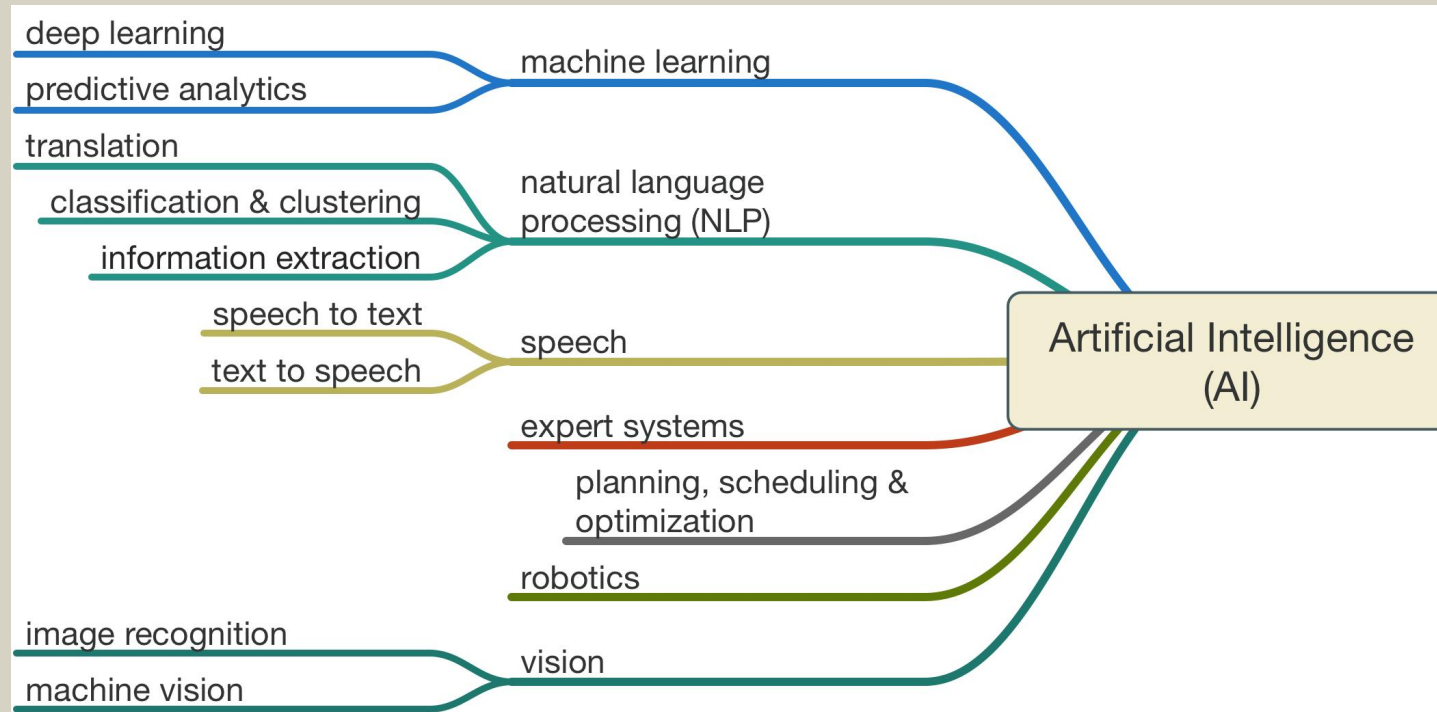




Future Directions



Next generation of decision support driven by AI approaches



Assisted Intelligence – Helping providers perform tasks faster and better

Augmented intelligence – Helping providers make better decisions

Autonomous intelligence – automating decision making processes without human interventions

Adaptive Clinical Decision Support






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- Decision support that trains itself and adapts its algorithms based on new data. – AI driven decision support
- Additional management challenges in terms of ensuring safety and effectiveness
- Transparency about how the decision support works and changes including limitations
- Awareness of potential bias in algorithms developed e.g. racial, socioeconomic, age, gender – determine how bias affects machine learning

AMIA Position Paper

Journal of the American Medical Informatics Association, 28(4), 2021, 677–684

Recommendations for the safe, effective use of adaptive CDS in the US healthcare system: an AMIA position paper

Carolyn Petersen ¹, Jeffery Smith², Robert R. Freimuth³, Kenneth W. Goodman ⁴,
Gretchen Purcell Jackson^{5,6}, Joseph Kannry⁷, Hongfang Liu⁸, Subha Madhavan⁹,
Dean F. Sittig ¹⁰, and Adam Wright¹¹

Decision Support Governance



- Processes for overseeing the management of decision support
- Determining the type and nature of decision support using an evidence-based approach – criteria for inclusion and removal
- Monitoring use, effectiveness and safety of decision support
- Assessment of the impact of decision support on workflows
- Ensure robust testing and transparency metrics e.g. details of algorithms applied and variables used
- Workforce education about decision support increasingly important in terms of when adaptive decision support should be applied.



In an era of AI driven clinical decision support the challenges of designing effective mechanisms and models for incorporating decision support into clinical workflows remain.

Transparency and evaluation become more imperative

Thank You & Questions



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