



BENEFITS, RISKS AND CHALLENGES OF CLINICAL DECISION SUPPORT SYSTEMS

Prof. dr. apr. Pieter Cornu

PERSONAL BACKGROUND

- Appointments:
 - Assistant professor VUB pharmacoepidemiology, eHealth, pharmacology
 - Clinical decision support coordinator UZ Brussel
- Education:
 - Master Pharmaceutical Sciences (VUB, 2009)
 - PhD Pharmaceutical Sciences (VUB, 2015)
 - Master Epidemiology (UA, 2017)
- Research domains:
 - CDS and medical informatics
 - Pharmacoepidemiology
 - Clinical pharmacy





THE WONDERFUL WORLD OF CLINICAL DECISION SUPPORT

Goal of this presentation

- Give an introduction of CDS
 - Focus on medication related CDS
 - > Focus on CDS integrated in hospital information systems (HIS)
- Benefits of current CDS
- Risks of current CDS
- · Challenges for the future





28-10-2019 | 3

HOSPITAL INFORMATION SYSTEM UZ BRUSSEL



28-10-2019 | 4

HOSPITAL INFORMATION SYSTEM UZ BRUSSEL

Promotive Landes Reputation Flavore Labo Hos	abanadan I. 🖬 Translas	a romai 1 -	anteath A Spinest Annual	
Problemen mogel (): geltlierd door opname			Altergante	igent berrit B.
T E is geet opname gessiecteerd		6	Active presented by attacedenter	Harris Boll A
Probleman galant and de opennin	(pren skatss)	80 -	The last setting to	Onteriord
Passarve problemen	(peer dato)	B. C	ali jan discharante	Orbeitend
Actions proliferen	(10 Harto)	Bell A	111 months	Osbekend
Terranger .		Dispensioner of the second	authors bigsue	1012007
(in Filialamen malting (of R = 20000000)		0557/16	Panawe generalizedge artecolorities	Dimme B.C. A
Construction and South Providence		0507716	Internet in some state	Onomine Contented
Mark & Grandware And James		05/57/10	- initiate	Onbekend Onterland
Intel Conference and Barry State Conference		0102715		
rentian 1998 conferration		01/04/15	Hereitige anschliefen	Denter Porton
the second s		07/04/15	Street failing and	Onterent Orderand
Contraction of the second s		07/04/15	Isparum spinche cheiseyetschause	150100 Netingenitz
logo 1 Cadastas mellitas		07/04/15		8
hartrityrandhorstaase		DOUTS/14		



Кор

28-10-2019 | 5

HOSPITAL INFORMATION SYSTEM UZ BRUSSEL

Haare	13114
b more me	1701007
B Dentifications	Store of
	Mires a
D present onto	without a second s
De Reportanzia (McD) Atomaia	stimmine.
a contraction	and the second se
PED B: consultant	WOTED IE
B made	10x000
B mar	artitet.
(hans)	010
Annual Annual Statement	11110/A
B remethermon	
Deal Company	areas -
En von dagt angehalt in der	(Accorn
Enverse technische onderzummen	and the second se
Contraction Contraction (Contraction)	2900%
S De terrente	20024
(halometer exchange)	215
2 10	inclusion in the second s
100 mm	and a local division of the local division o
B contrast figure stars	Linear and



HOSPITAL INFORMATION SYSTEM UZ BRUSSEL

(Like)	
b for	
a mir	110/02/18
E reading and a second s	40000047
E transmission	10010017
a time	(1)((1)())
2 Mars	210(311)
a	2000010
(hereitige)	
a first	Reference 1
A min	social to the second se
	and the second se
The second second	Income II
8-04r	Decision of
S CON	25042017
S One	_040803117
b (m+	permitting.
Bedreiter .	and the second se
A mee	2 Manual VI
Constant for an end of the second s	Contraction of the local distance of the loc
	stoot!/
the second design of the second se	
A Dest	(DSB/P)
	10000
Reference of the local sector of the local sec	
	d3473875
2 Chart	Calculus 1
E transat	Jacob Contraction of
	0.0736
Theory and the second sec	and the second se
-10 B 100	Inclusion Inclusion
£ 100	1010017
5 Une	Beridert m
Commer Board Brand	

HOSPITAL INFORMATION SYSTEM UZ BRUSSEL

Laboratornervezo Katan Detail 1			- 18	10.00	C DEDGARET TEST ARDITOLDTODCY 11-05-0017 14:04 Microbiologie
Retreffende Aulert DEUGHET TEST Cellechedelant, 1101d313) Maart					DEUGNIET TEST (A810101DT090) Microbiologie 15/05/2017 14:14 (BY4394170515)
Capanersis Capanersis Record of the second s	Realize 44 53 55 10 10 10 15	Remote Treas Treas Treas Trease Treas Trea	Roman and 172 - 145 14 - 167 44 - 167 12 - 18 12 - 18 25 - 170		Broacho alvedoire lavage Recktiveska onleravate Citegeroard op gestmannesstil monarari Wine bloedcellen Wine bloedcellen Rade bloedcellen Preside bloedcellen Grann positieve bacilise; Orann negatieve bacilise; Plavenel epidemicellin Vitegeroard op gestieve bacilise; Plavenel epidemicellin Cellenveid Aerobe kreesk Presidonese arreginate >100.000 kinnen nL Gevorig angureilline; popracilline/tacobactan, cefprime-clavallangous, ceffurione, enducate, ceffurione, effurione, e
Oprivelsorgen: (1) Nationskand: Alle of meeriken van de	teltsillen paramellen ge	eft een twaitaise	ve nvartik		C annota anticona inducana inducana isis

28-10-2019 | 9

HOSPITAL INFORMATION SYSTEM UZ BRUSSEL

Hospital	water Van	2481-03817 micro tot 2401/2017 11448 (7016881)	Taurutay (Case Marko
2007	1.1.000		Contract Constanting
D Ress	9944 🗆 A	Reven Clogerande tadas Compensatularionologia	New dignets. Instructions. Versequentlespondus recents
5	CHERO I T	GADophersenet	
B :	1110-01	ATV From hand a same	
0 :	11/22/07	TERTS Transmission addressed a phone in	
0	ribusti (7	Dwill Inceptation in DVD	
0	110,000	CMB hospitalization notice	
B. 1	10000017	CER spoaranais	
(b) ;	11/02:54	PGP bizedulis electrola	
0.	NO 10017	CPR haspitalsalls mits -	
D :	012111	PEDI Nuberber etc.	
10 · ·	-Q-10017	PED Prospikal Allin Peter	
0 :	-> 100111	PET Naphan diserts	
0	+010017	The survey of the second second second second second	
0	40122017	A483 Vectoregeandry reportings (M. CELLEMANS, PAUL) Honoria	
ŭ 2	#01/2017	A488 Inspeceptunder rasentage IN, CEULEWINE, PAUL Batas gas, vioretide alvait genaal	
ñ ,	+D+20117	A480 Verplengstandige resourceps (M. DELA, DIA400, FAULU Dieno EVO voor de cotregars van zen Partjin Gent	
10	aluary .	Aten # 9 Set	

Кор

HOSPITAL INFORMATION SYSTEM UZ BRUSSEL

	A NUMBER OF DESIGN OF DESIGNOF DESIGN OF DESIGNOF DESIGNOF DESIGNOF DESIGNOF DESIGNOFO	The sum low just in the									
	and the second se	may 12 of harting lives	and the second se								
	In sufficiency in the second second	dost + leasthead +	other the particular	Harley I.	Tagaratuman - 1	Manager 1	contentioned -	examinate be -	stands -	iner.	Checkman growgers .
	HELPER AND	0 mark in summing	HE SECRETING IN	W. #	AD-DITH OF	e 1000 per titu	CROMOUNE ARPLE.	111	21100000	100	Arbaranear -
Image:	yers (2)	- HELENE	24,79828 00081/004,17	7K #	April 2014 Value	TTREAM THE				100	ardisereres:
	alterative encodera	U.S. 1986) NACE OF	-	N #	Harddens war	13.00 Mpt. 02*120245 13 III (PS 138)		2014/02/04 12:12	some serandering.	442	interest.
		35 HWD 1440.38	The second s	TV #	Q*G2018 var	CORPORE CON				103	States and
	and the second second second	Topla Troces	ACCURATE AND ADDRESS OF	10.0	CONTRACTOR VALUE	C TT NO LOG TON	or Berrauk			100	STRATEGY .
	121 [2] [2] [2] [47] [2] [47]	Col angle second	A SHAP AT BUILDING AND AN	10.1	111111111111	Contraction from				100	Service of the servic
		a man motion	and the second second second	24	- Property and		Conception and the			100	Contraction -
		+ more DOBUTE	AND DUAL OWNER.	10.00	interaction war	10.40 em chi	to Date \$16			122-	COLUMN TO A
	A. Dones we have been	THE PROPERTY PERTING	on a vestualities as	14 ×	16/11/0010 van	a 12 DL am. The	In place the			100	Witnesses
	Souths we parameter	I HEALT FOR STAR	PROPER TIME DAMA IN	W.W	INVESTIGATION AND	to to be used that	1000			188	ichayenegal
	20	BI THE BACK CO	F 16	74.4	10110310 101	CTERENC FROM				18.0	antipation and
	The second se										
	ALC: NOT ALC										
	instruction do your listena										
	Tactor suit to a statute and statu										
	Stand and an other stand and an an and and and and and										
	CHELINGER POLICY IN THE REAL POLICY AND A REAL P										
	Contractor destruction and the second second										
	Deskaak lag best with the first and the first and the first of the										
	Construction of the construction of the second seco										
	top contract print in the second										
	representation prime and particular										
	Top contract print in the local print of the local										
	rent de lanaet integration										
	t an analise i general internation enter de several integration (2000) angen										
	n ng mantanan ganak di salahan sa										
AND THE ADDRESS OF ADD	a na mathad point ing ann an										
	d og manfan et genaat <u>kanne</u> en eer de weest insperijen somer en en song tij get, tennet, waarde de de somerene genaamse weerene										
Livers Ten J Consider , I Exercit Ten Jones Ten Jones Ten	American production of a second secon										
Livery Tree Consumers of the second s	A can confined galant integral of the confined galant in the confine of the confi										
NewsyTem NewsyTem Exercitization NewsyTem An and and event NewsyTem	a paranteria gana di Angelan (Angelan) magina (Angelan) mana (Angelan) mana (Angelan) mana (Angelan) mana (Angelan) mana (Angelan) "Angelan (Angelan) "Angelan) "Angelan (Angelan) "Angelan) "Angelan) "Angelan (Angelan) "Angelan) "Angelan (Angelan) "Angelan) "Angelan) "Angelan) "Angelan) "Angelan) "Angelan) "Angelan) "Angelan (Angelan) "Angelan) "Angelan) "Angelan (Angelan) "Angelan) "Angelan) "Angelan) "Angelan) "Angelan (Angelan) "Angelan) "Angel										
A LEPTY THE RELATES	Experimentaria gana a la companya de										
Tarey Tree Insurance A 12 F2 F2 Tree Tree Advance A 12 F2	r per conferent parcent (parcent) (parcent) reger (parcent) (
Teleg Tries Telegations A LEP FT THE SC. TO LARDING THE THE THE SCHOOL OF THE STRUCTURE OF THE THE SCHOOL OF THE STRUCTURE OF THE STRU	ray monthered general (an angle of the second and angle of the second and and and and angle of the second and and and and and and and and and a										
Long Troit Constants of a second seco	la provinské posisti (konsti na provinské posisti (konsti na provinské konsti na provinské posisti (konsti posisti konsti posisti (konsti posisti konsti posisti (konsti posisti (konsti posis										
A VETATION DE CONTRACTO DE CONT	annake (University of the second seco										
an aar jalen hafte gebaar en geneendaar werk a heijer.	a up undre a para di anti a para di anti di anti a para di anti a										
		a facet			1005						

28-10-2019 | 11

HOSPITAL INFORMATION SYSTEM UZ BRUSSEL







28-10-2019 | 12

VERSITET

INFORMATION OVERLOAD?

- · All information in real-time available for every healthcare provider
- Enormous amount of data
- Difficult for healthcare providers to take all information into account when taking clinical decisions
- Every process requires information
 - Patient data (EMD, lab values, medications, ...)
 - > Knowledge (guidelines, databases for interactions and contraindications, ...)

Assist with Clinical decision support (CDS)

WHAT ARE CLINICAL DECISION SUPPORT SYSTEMS?

- 'Computer systems which assist humans (mainly clinicians) in making optimal clinical decisions' (Wright, 2009)
 - ➔ assist, not replace clinical reasoning!
- CPOE with CDS key element for safe decisionmaking and improving patient safety' (IOM)
- Help health care providers to take into account existing knowledge and clinical patient data when making decisions



Bron: http://kathymillersciencewriter.com







WHAT ARE CLINICAL DECISION SUPPORT SYSTEMS?

Different types based on:

RSTOR

- moment at which they deliver support / the type of decisions (diagnosis, prescribing, administration, preparation, ...)
- degree of active versus passive support (active = alerts, popups; passive = activation by physician)
- knowledge-based (using a database derived from the medical literature or guidelines) or non-knowledge-based (using computer learning from past experiences or data patterns)
- · stand alone or integrated in clinical information system







Кор

CDS AND ACCREDITATION STANDARDS

▶ Focus on medication related CDS because of accreditation standards

Intent of MMU.5.1

Good medication management includes two reviews of each prescription or order:

The process to conduct an appropriateness review (the first review) for an order or prescription prior to dispensing includes evaluation by a trained professional of

- a) the appropriateness of the drug, dose, frequency, and route of administration;
- b) therapeutic duplication;
- c) real or potential allergies or sensitivities;
- d) real or potential interactions between the medication and other medications or food;
- e) variation from hospital criteria for use;
- f) patient's weight and other physiological information; and
- g) other contraindications.

RSTOR

When computer software programs are used to cross-check drug/drug interactions and drug allergies, the software is current and updated according to recommendations of the software manufacturer.

CDS IN UZ BRUSSEL

Time required for appropriateness review (a \rightarrow g for all prescriptions):

- Check EMD + information retrieval: suppose 5 min.
- ▶ Number of electronic prescriptions on a weekly basis: 6414
- Time required for checking prescriptions:

6414 x 5 min. = 32070 min. = 534.5 hours per week or almost 76 hours per day





28-10-2019 | 17

9



evensiterit

BENEFITS AND RISKS OF CURRENT CDS

JOURNAL OF MEDICAL INTERNET RESEARCH

Review

Clinical Decision Support Systems for Drug Allergy Checking: Systematic Review

Laura Légat^{1*}, MSc; Sven Van Laere^{2*}, MSc; Marc Nyssen², PhD; Stephane Steurbaut¹, PhD; Alain G Dupont¹, PhD; Pieter Cornu¹, PhD

¹Research Group Clinical Pharmacology and Clinical Pharmacy, Centre for Pharmaceutical Research, Vrije Universiteit Brussel, Brussels, Belgium ²Research Group of Biostatistics and Medical Informatics, Department of Public Health, Vrije Universiteit Brussel, Brussels, Belgium ^{*}these authors contributed equally I Med Internet Par 2018 and 20 lice, 9 a258 p

J Med Internet Res 2018 | vol. 20 | iss. 9 | e258 | p.1 (page number not for citation purposes)

Universitair Ziekenhuis Brussel

28-10-2019 | 19

CDS FOR DRUG ALLERGY CHECKING

- Several key findings were identified:
 - > Evidence of the usefulness of clinical decision support for drug allergies
 - > Important problems associated with their use:
 - Accurate and structured documenting of information on drug allergies in electronic health records (EHRs) is difficult
 - Underreporting of drug allergies, outdated or inaccurate drug allergy information in EHRs
 - No generally accepted standard terminology for structured documentation of allergy information
 - Consistently reported low specificity of drug allergy alerts → alert override rates of up to 90%, leading to alert fatigue

Legat, L., et al. (2018). "Clinical Decision Support Systems for Drug Allergy Checking: Systematic Review." J Med Internet Res 20(9): e258.



28-10-2019 | 20

Légat et al



- Important challenges remain for increasing the specificity of drug allergy alerts
- It remains difficult to reduce drug allergy alert overload while maintaining patient safety as the highest priority
- We found only one study specifically reporting outcomes related to CDSS for drug allergies. It showed that adverse drug events resulting from overridden drug allergy alerts do not occur frequently

Legat, L., et al. (2018). "Clinical Decision Support Systems for Drug Allergy Checking: Systematic Review." J Med Internet Res 20(9): e258.

28-10-2019 | 21

CDS FOR DRUG DRUG INTERACTION CHECKING

International Journal of Medical Informatics 111 (2018) 185-171





Results: Of the 15 previously defined, high-priority, class-based DDIs, alert warnings were found to exist for 11 in both the Korean and UK systems, 9 in the Belgian system, and all 15 in the two US systems. The specific combinations that were included in these class-based DDIs varied considerably in number, type and level of severity amongst systems. Alerts were only active for 8.4% (52/619) and 52.4% (111/212) of the specific drug–drug combinations contained in the Belgian and UK systems, respectively. Hard stops (not possible to override) existed in the US and UK systems only. The override rates for high-priority alerts requiring provider action ranged from 56.7% to 83.3%. Of the 33 previously defined low-priority DDIs, active alerts existed only in the US systems, for three class-based DDIs. The majority were non-interruptive.

Conclusions: Alert warnings existed for most of the high-priority DDIs in the different EHRs but overriding them was easy in most of the systems. In addition to validating the high- and low-priority DDIs, this study reported a lack of standardization in DDI levels across different international knowledge bases.

Cornu, P., et al. (2018). "High-priority and low-priority drug-drug interactions in different international electronic health record systems: A comparative study." Int J Med Inform **111**: 165-171.



Universitair Ziekenhuis Brussel

28-10-2019 | 23

ORIGINAL RESEARCH

A Systematic Review of Clinical Decision Support Systems for Clinical Oncology Practice

Pamala A. Pawloski, PharmDab; Gabriel A. Brooks, MD⁺; Matthew E. Nielsen, MD^d; and Barbara A. Olson-Bullis, MA*

Pawloski, P. A., et al. (2019). "A Systematic Review of Clinical Decision Support Systems for Clinical Oncology Practice." J Natl Compr Canc Netw 17(4): 331-338.

B LAVERSTER BRUSSE



Voet

Abstract

Background: Electronic health records are central to cancer care delivery. Electronic clinical decision support (CDS) systems can potentially improve cancer care quality and safety. However, little is known regarding the use of CDS systems in clinical oncology and their impact on patient outcomes. **Methods:** A systematic review of peer-reviewed studies was performed to evaluate clinically relevant outcomes related to the use of CDS tools for the diagnosis, treatment, and supportive care of patients with cancer. Peer reviewed studies published from 1995 through 2016 were included if they assessed clinical outcomes, patient-reported outcomes (PROs), costs, or care delivery process measures. **Results:** Electronic database searches yielded 2,439 potentially eligible papers, with 24 studies included after final review. Most studies used an uncontrolled, pre-post intervention design. A total of 23 studies reported improvement in key study outcomes with use of oncology CDS systems, and 12 studies assessing the systems for computerized chemotherapy order entry demonstrated reductions in prescribing error rates, medication-related safety events, and workflow interruptions. The remaining studies examined oncology clinical pathways, guideline adherence, systems for collection and communication of PROs, and prescriber alerts. **Conclusions:** There is a paucity of data evaluating clinically relevant outcomes of CDS system implementation in oncology care. Currently available data suggest that these systems can have a positive impact on the quality of cancer care delivery. However, there is a critical need to rigorously evaluate CDS systems in oncology to better understand how they can be implemented to improve patient outcomes.

Pawloski, P. A., et al. (2019). "A Systematic Review of Clinical Decision Support Systems for Clinical Oncology Practice." J Natl Compr Canc Netw 17(4): 331-338.

International Journal of Medical Informatics 105 (2017) 22-50

Contents lists available at ScienceDirect



International Journal of Medical Informatics

Review article

A systematic review of the effectiveness of interruptive medication prescribing alerts in hospital CPOE systems to change prescriber behavior and improve patient safety



N. Page^{a,*}, M.T. Baysari^{a,b}, J.I. Westbrook^a

¹⁰ Centre for Health Systemu and Safety Research, Australian Institute of Health Innovation, Faculty of Medicine and Health Sciences, Macquarie University, Australia ¹⁶ St Vincent's Clinical School, University of NSW, Australia

Page, N., et al. (2017). "A systematic review of the effectiveness of interruptive medication prescribing alerts in hospital CPOE systems to change prescriber behavior and improve patient safety." Int J Med Inform 105: 22-30.

Results: Twenty-three studies describing 32 alerts classified into 11 alert categories were identified. The most common alert categories studied were drug-condition interaction (n = 6), drug-drug interaction alerts (n = 6) and corollary order alerts (n = 6). All 23 papers investigated the effect of the intervention alert on at least one outcome measure of prescriber behavior. Just over half of the studies (53%, n = 17) reported a statistically significant beneficial effect from the intervention alert; 34% (n = 11) reported no statistically significant effect, and 6% (n = 2) reported a significant detrimental effect. Two studies also evaluated the effect of alerts on patient outcome measures; neither finding that patient outcomes significantly improved following alert implementation (6%, n = 2).

Discussion and conclusion: The current evidence-base does not show a clear indication that particular categories of alerts are more effective than others. While the majority of alert categories were shown to improve outcomes in some studies, there were also many cases where outcomes did not improve. This lack of evidence hinders decisions about the amount and type of decision support that should be integrated into CPOE systems to increase safety while reducing the risk of alert fatigue. Virtually no studies have sought to investigate the impact on changes to prescriber behavior and outcomes overall when alerts from multiple categories are incorporated within the same system.

Page, N., et al. (2017). "A systematic review of the effectiveness of interruptive medication prescribing alerts in hospital CPOE systems to change prescriber behavior and improve patient safety." Int J Med Inform 105: 22-30.

CDS FUTURE CHALLENGES

- ➤ Develop CDS systems with adequate specificity → relevant alerts that are useful and not a burden for the healthcare provider
- Context-aware alerting (based on individual patient data)
- From separate CDS modules (DDIs, dosing, CIs) to integrated patient centered support complex decision rules
- > Finding the right balance between over- and under-alerting
- Evaluation of outcome





28-10-2019 | 28

EXAMPLE OF DRUG DRUG INTERACTION SCREENING



DRUG DRUG INTERACTION SCREENING UZ BRUSSEL

- homegrown hospital information system
- graphical user interface of the CDS is self developed
- ▶ DDI screening based on commercial Delphicare[®] database
- ▶ 8 severity levels of DDIs
- DDI screening version 1 implemented in 2009 by IT department, only screening for level 1 and 2 DDIs
- content of Delphicare[®] database was used without adjustments





28-10-2019 | 30



DDI ALERTS OLD SYSTEM

Intervention class	Potential drug-drug interaction	Number of alerts	Percentage of overridden alerts
1	risk of hyperkalemia	2084	85.7
	risk of myopathy and renal failure	200	74.5
	risk of bleeding	147	85.7
	premature baby and infants: lung and kidney damage	18	100.0
	increased effect of rifabutin	17	52.9
	reduced efficacy of azoles	7	85.7
	increased effect of pimozide (life-threatening arrhythmias)	3	100.0
	decreased effect of beta-symapthomimetics	3	33.3
	exceptional cases of circulatory disorders and infarction	2	100.0
	antagonistic effect on the bronchi resistance	1	100.0
2	reduced cardio-protective efficacy of clopidogrel	329	64.7
	stronger adverse effects of carbamazepine/may reduce the efficacy of azoles	29	93.1
	development of serotonin syndrome	13	69.3
	increased or decreased effect of bupropion	8	100.0
	reduced or increased efficacy of voriconazole is possible	8	50.0
	increased effect of tizanidine	6	50.
	reduced effect of opioid agonists	6	66.
	increased effect of rosuvastatin	4	25.
	increased effect of lercanidipine (hypotension)	2	100.
	amantadine intoxication is possible	2	50.
	increase in nephro-, oto- and neurotoxicity	1	100.0



DDI ALERTS OLD SYSTEM

- ▶ 2890 alerts between 1st January 2010 and 30 June 2011
- only screening for level "contra-indicated" (2482 alerts) and "precautionary contraindicated" (408 alerts)
- ▶ for 2373 (82,1%) DDI alerts the alert was overridden and the combination was given

Patient harm? With good reason overruled? Usefulness of the system?

REASONS OF POOR CDSS PERFORMANCE OLD SYSTEM

Delphicare[®] designed mainly for community pharmacists:

- often no clear alternatives
- > alerts don't take into account patient characteristics
- > same screening interval for every DDI
- pharmacist evaluates clinical relevance of DDI

Different situation in the hospital:

alerts provided to physicians

WUS ROTEIT

> only alert when relevant for the individual patient









Universitair Ziekenhuis

REDESIGNED THE SYSTEM

- > customization of the severity classification in three in-house severity levels
- context driven alerts
- > define individual screening intervals
- if possible, provide alternative medication
- > real time follow-up of alerts by clinical pharmacist





28-10-2019 | 35

CONTEXT AWARE: LAB VALUES

	Patient Collectedatum: Specimen: Bloed					
List o	Oegevens			1 months		i
	Minische Chamin		Resultant	Eenneid	Referencewaa.	-1
	Lizeuro		136	maid	19,43	1
	Creatinine (IDMS-norm	ð	1.02	mardt	0.66 - 1.25	÷,
	eGFR (MDRD-IDMS)		>60	mL/min/1.73m*	>60	ï
Desc	lonogram					
	Natrium		143	mmol/L.	137 - 145	
	Kalium		5.1 (1)	mmol4.	3.4 - 5.0	
	Chloride		105	mmol/L.	98 - 107	
	Bicarbonaat		29	mmol/L	22-30	
	Anion gap (berekend)		1.4	mmol/L	10-18	
Measu	a service a service and a service and a service a s	2		100		
	Cockcroft & Gault	Vereenvoudigde MDRD	oGFR (Schwartz)	CKD-EPI		
	Opmerkingen					_
Con	(1) Matice stilling Lou	, hemolyse:				-
influo	(1) manya angung cy.	nemolyse.				
innue						
as						
0						-
Ove	Druk af Q DE	ETAIL C Sluit				

28-10-2019 | 36

NUS NVERSTER

28-10-2019 | 37

CONTEXT AWARE: LAB VALUES





international Journal of Medical Informatics xxx (xxxx) xxx-xxx



Contents lists available at ScienceDirect

International Journal of Medical Informatics

journal homepage: http://ees.elsevier.com

Evaluation of context-specific alerts for potassium-increasing drug-drug interactions: A pre-post study

Katoo M. Muylle^{a,*}, Kristof Gentens^b, Alain G. Dupont^a, Pieter Cornu^{a,b}

^a Research Group Clinical Pharmacology & Clinical Pharmacy (KFAR), Foculty of Medicine and Pharmacy, Vrije Universiteit Brussel, Brusseli, Learbeeklaan 103, 1090, Brussela, Belgiam
^b Department of Medical Informatics, U2 Brussel, Learbeeklaan 101, 1090, Brussela, Belgiam



Universitair Ziekenhuis Brussel

28-10-2019 | 39

Objective:

- Reduced alert burden?
- > Improvement of alert acceptance?
- Effect on occurrence of hyperkalemia?

Design:

- Pre-post intervention study
- > Pre: all level 1 alerts advising absolute contraindication
- > Post: level 1, 2 or 3 based on the patient's recent lab value of potassium
- Alert acceptance:
 - → non-prescription or non-administration for level 1 alerts
 - ➔ monitoring of the potassium levels for level 2 alerts





Results:

	Pre-intervention	Post-intervention (level 1 and level 2)	Statistics
Acceptance = Prescription discontinued (level 1) or monitoring (level 2)	84 (5.7%)	77 (86.5%)	P = < 0.001 RR = 15.048 (95% CI 12.037 - 18.811)
Acceptance = DDI not administered (level 1) or monitoring (level 2)	356 (24.4%)	78 (87.6%)	P = < 0.001 RR = 3.597 (95% CI 3.192 - 4.053)



Universitair Ziekenhuis Brussel

28-10-2019 | 41

Risk of hyperkalemia:

> Crude incidence of hyperkalemia after a DDI alert was triggered

3.9%	pre-intervention	period
------	------------------	--------

5.1% post-intervention period

(P = 0.200)

➢ Generalized linear mixed model → effect of the intervention on the occurrence of hyperkalemia not significant (adj. OR 1.091, 95% CI 0.172 -6.919)

Variable	OR	95% CI
Intervention	1.091	0.172 - 6.919
Sex: female vs male	1.005	0.154 - 6.538
Pre-DDI alert potassium	5.703	2.569 - 12.657
ВМІ	0.915	0.748 - 1.118
Systemic corticosteroids	1.790	0.484 - 6.620
ACE inhibitors	0.611	0.155 – 2.409
eGFR: impaired vs normal	2.476	0.667 – 9.193





Risk of hyperkalemia:

- > Only patients with an available post-DDI measurement could be included
- > 69.22% of missing outcomes were from patients from the pre-intervention period
- > High-risk patients were more likely to have a post-DDI alert measurement

Conclusion:

Safely reduced the DDI hyperkalemia alert burden with 92.8 % without compromising patient safety → no significant difference in the occurrence of hyperkalemia



Universitair Ziekenhuis Brussel

28-10-2019 | 43

CDS FOR DDI SCREENING: FUTURE CHALLENGES

- Evaluation of outcome for other DDIs
- Development of context-aware algorithms for complex DDIs
 - Pharmacoepidemiological approach
 - > Build prediction models with large datasets from EPD

 - Validate and handle missing data
 - > Requires availability of structured (coded) data
 - Machine learning approach?





28-10-2019 | 44





Universitair Ziekenhuis Brussel