

The Fallback Workflow Patterns

Jens H. Weber and Craig Kuziemsky



SHE@ICSE'19



University of Ottawa

What is interoperability?

Interoperability describes the extent to which systems and devices can exchange data, and interpret that shared data. (HiMSS 2013)



Semantic





Interop. Deemed unreliable

"Interoperability between different EHR systems has languished despite large efforts towards that goal."

AMIA EHR 2020 Task Force Report, JAMIA May 2015 [Payne et al. 2015]

"eHealth interoperability is improving, but it remains a challenge."

Antilope EU Interoperability Final Handover Workshop [Bourquard 2015]

"EHR adoption up, challenges in interoperability and meaningful use remain."

CIO Magazine [Corbin 2015]



Where does it break down?

Ultimately, interoperability is about one system carrying out operations on behalf of another: the Use of data



An emerging field...

44 unique definitions for Pragmatic Interoperability

F. W. Neiva, J. M. N. David, R. Braga, and F. Campos, "Towards pragmatic interoperability to support collaboration: A systematic review and mapping of the literature," Inf. Softw. Technol., vol. 72, pp. 137–150, Apr. 2016.

We are not going to add one here, but rather point out the consensus that **PI deals with Workflows**



Engineering Guidance beyond Data Exchange Formats

Interoperability Workflow Patterns

Akin to, which are design artifact **Design Patterns**, which provide solutions to a recurring engineering problem



Structure of the rest of this talk

A Sociotechn e-Referrals

Fallback Export / Import Patterns

Experience in Real-World Projects

Conclusions

A Sociotechnical Systems Model for

Referral

The act of sending of a patient to another physician for ongoing management of a specific problem, with the expectation that the patient will continue seeing the original physician for co-ordination of total care.

J. C. Segen, "The Dictionary of Modern Medicine," CRC Press, 2011



Computer-supported (e)Referrals



Consultant



A Socio-Technical Model for e-Referrals

Based on System Theoretic Accident Model and Processes (STAMP) [Leveson'11]



Hazards may arise from:

- 1. Inappropriate, ineffective or missing control actions, and
- 2. Inadequate or missing feedback.

Problems with foundational and structural interoperability are rare

-> semantic interoperability issues

10

Electronic Medical Summaries

- Often exchanged as HL7 CDA documents
- 3 Levels of standardization
 - Level 1 CDA: only header is standardized
 - Level 2 CDA: body structure is standardized (not content of entries)
 - Level 3 CDA: content is fully encoded

Even certified interoperable systems are unreliable:

D'Amore et al. observed 615 errors in a sample of 91 CDA documents, generated from 21 distinct technologies

J. D. D'Amore et al., "Are Meaningful Use Stage 2 certified EHRs ready for interoperability? Findings from the SMART CCDA Collaborative," J. Am. Med. Inform. Assoc., vol. 21, no. 6, pp. 1060–1068, Nov. 2014.



Two principle types of root causes for incorrect/incomplete semantic encoding

1. software defects

(i.e., the HIS export function fails to generate the correct encoding)

2. human factors / user errors (i.e., the HIS user failed to use the system as intended by its designers).





Towards an error-tolerant systems model



HIS 2

13

A more detailed model of the e-Referral Workflow



The Fallback Export Workflow Pattern

Context

• Electronic medical summaries are exported at one HIS in order to be sent to one or more receiving HIS.

Problem

- Semantic interoperability requires the exchange of encoded (i.e., machinereadable) information.
- Medical summaries also contain human-readable content. • Empirical studies have shown frequent errors in the machine-readable content and inconsistencies with the human and machine-readable. Such problems may lead to safety issues, in particular inappropriate, ineffective or missing remote interventions.

Solution

 The Fallback Export (FE) pattern provides a generic workflow with the purpose of detecting and correcting the above problems during the export of medical summaries. The workflow "falls back" to exporting human-readable content only if the above problems with the machine-readable content cannot be resolved.



The Fallback Export Workflow Pattern





Implementation Comment

User should validate concordance of summary data ***after*** generation of IIR • This requires "standard" way of viewing interoperable summaries

		OSCAR COnsul	tation request								
localhost:808	3/oscar/oscarEncounter/View	Request.do?requestId=24			··· 🖂 🕁						
nsultation	ELDER, JUNE F 76										
eated by:	Update Consultation Request	Update Consultation Request &	Print Preview	Print Preview Update & Se	end CDX e-Referral						
elby, Marcus	Referral Date:	2019-05-23		Patient:	ELDER, JUNE						
Referral	Service:	Cardiology	\$	Address:	456 Main Streets						
story	Consultant:	(CDX) Plisihb, Lucius Dr.	\$	Tel.No.:	416-555-6789						
ot Sent	Referrer Instructions			Work No.:							
atus			///	Cell No.:							
Nothing:	Urgency	Non-Urgent	\$	Email:							
Pending	Phone:			Birthdate:	1942-06-06						
Specialist	Fax:			Sex:	F						
Callback	Address:			Health Card No.:	8888999904 ZE ON						
 Pending Patient Callback 			1.	Send to:	Teams						
	Appointment		 ≎	Appointment Notes:							
Completed	Instructions										
	Appointment Date:										
Attach File to Consultation Currently Attached Files:	Appointment Time:	• • AM •		Last Follow Up Date	:						
	Letterhead Name:	Welby, Marcus		\$							
	Letterhead Address:	Hamilton Ham	Hamilton Hamilton Ontario LOR 4K3								
None	Letterhead Phone:	555-555-5555	555-555-5555								
Blue - Documents	Letterhead Fax:	faxUser1 ᅌ									
Purple - Labs	Reason for Consultation										
	· · ·										
	Pertinent clinical infor	nation: Social History Family	History Medical Hist	tory Ongoing Concerns Other Me	ds						
	Pertinent clinical infor	nation: Social History Family Reminders Risk Fact	History Medical Hist rrs Medications	tory Ongoing Concerns Other Me	ds						
	Pertinent clinical infor Mother had Alzheimer's,	mation: <u>Social History</u> Family <u>Reminders</u> <u>Risk Fact</u> onset age 70. Father ha	rHistory Medical Hist ors Medications d d Acute Myocal	tory Ongoing Concerns Other Me Long Term Medications rdial Infraction age 5	ds 0. Father retired in 200						
	Pertinent clinical infor Mother had Alzheimer's, Significant concurrent	Mation: Social History Family Reminders Risk Fact onset age 70. Father ha Social History Family	History Medical Hist ors Medications d Acute Myoca History Medical Hist	tory Ongoing Concerns Other Me Long Term Medications rdial Infraction age 5	ds 0. Father retired in 200 ds						

JUNE ELDER
June 6, 1942 Age: 76
Home: 456 Main Street Toronto, null M6P 4J4 Tel (Home): 416-555-6789
Lucius Plisihb 93188 (BC Ministry Practition
Home: , null, null null Tel (Home): 2504140376
Oscar Service Provider
Marcus Welby
Home: Hamilton Hamilton, Ontario LOR 4K3 Tel (Home): 555-555-5555
cdxpostprod-otca (CDX Clinic
May 12, 2019, 04:04+0000
17bb2879-fcf8-4d6c-870d-cc



The Fallback Update Workflow Pattern



18

Implementation Comments

					End	counter - F		NE E 76 voar					
		_	_	_	LIN		-DER, 501	NET 70 years			_		
i localhost:	8083/oscar/cas	emgmt/f	orward.jsp	?action=	view&c	lemograph	icNo=818	&providerNo	=111112&provid	erName=N	/larcus-	⊦Welby≈⊧	··· ⊠ ☆ Ξ
MRP DR MAR	RCUS WELBY		INE E 76 ve	ars 416-	555-678	9 Novt Au	unt:			_	_		Help About
Proventions		Medical I	<u>Uictory</u>		555-070		b Social	History					
HZV		 Hystered 	ctomy: PM/S Hx	Note			F SOCIAL	HIStory			- 12	-	
RZV		 Corneal 	Ulcer: Note abo	out corneal ulce	r								
Td												All and a second second	
FOBT												1000	
BMD													
H1N1		Ongoing	Concorne				L Domin	dovo					
Tickler	+	Drgolog Concerns + Problem list note for Infective Otitis Externa					r Kemin	sportation needs - S	nouse unavailable		-		
outstanding lab, one G	SFR, 25-Apr-2018	Infective ot	itis externa or A	cute swimmers	'ear		¢ man	spontation needs - e			All	ergies	+
overdue flu shot	25-Apr-2018										PEA	NUTS	06-Jul-2018
overtue for annual phy	ysice 25-Apr-2018										PEN	ICILLINS	29-Mar-2018
	+										CEL	EBREX 100MG	29-Mar-2018
DIABETES MELLITUS*											Ме	dications	+
ANGINA PECTORIS*	29-Mar-2018										Ot	ner Meds	+
Forms	+												
Lab Reg 2007	29-Sep-2018	ĽQ,						Search	OSCAR Search	\sim			
eForms	+				Filter	Calculat	ors ᅌ	Templates	\bigcirc		Ris	k Factors	+
Documents	+									VICV	100 Hie	acco smoke - Seco	ond nand smoke
eReferral Note	14-May-2019	PDT 2019	bv Marcus W	elbv.								lory of neavy alcon	or consumption.
eReferral Note	14-May-2019						0 47 40 00			\ <i>r</i>			
eReferral Note	14-May-2019	Documen	t General Lab	Report templa	ate create	ed at Thu May (2 17:46:22			View	Fai	nily History	+
eReferral Note	14-May-2019	PDT 2019 by Marcus Welby.									Fat	her had Acute Myo	cardial Infraction age 50
eReferral Note	13-May-2019	Document Microbiology Lab Report template created at Thu May 02 View									Mo	her had Alzheimer	's, onset age 70.
eReferral Note	13-May-2019 🔻	17:46:53	PDT 2019 by M	Marcus Welby									
Lab Result	+	Document	t Referral note	created at Fr	i May 03	12:54:12 PDT :	019 by Marc	2115		View	Un	resolved Tssue	+ ·
CHEMISTRY	15-0ct-2017	Welby.			i may oo	12.04.121 011	lo to by marc			VICW	COF	NEAL ULCER*	
ROUTINE	31-Jul-2017										ACU	TE MYOCARDIAL	INFARCT*
ROUTINE	26-Jul-2017	Documen	t Referral note	created at Fr	i May 03	12:55:10 PDT :	2019 by Marc	cus		View	Re	solved Issues	+
CHEMISTRY	12-Sep-2016	Welby.									De	cision Support	Alerts +
CHEMISTRY	10-Aug-2016 -	Documen	Document Referral note created at Fri May 03 12:56:27 PDT 2019 by Marcus View								Eni	sodes	
Messenger	+	Welby.										olth Care Team	
Report on bulk setting	of 10-Nov-2018	Document	t General Lab	Report Temp	ate creat	ad at Eri May 1	00.50.51 D	т		View	He	ann care Team	+
Report on bulk setting	of 03-Nov-2018	2019 by M	Arcus Welby				103.33.31 FI			view			
Measurements	+	2013 by N	narcus weiby.										
CDM Indicators		Documen	t eReferral Not	te created at I	Fri May 1	0 13:26:13 PD1	2019 by			View			
Health Tracker		Marcus W	/elby.										
	5 20-Oct-2017	Document	t General Lab	Report create	d at Fr <u>i M</u>	lay 17 12:3 <u>9:2</u> 2	PDT 201 <u>9 b</u>			View			
FBS	. 10.2 20-Oct-2017	Marcus W	/elby.										
Consultations		Dooumon	t Conoral Leb	Poport orgete	d at Eri-N	17 12:40:41	DDT 2010 L			View			
Cardiology	23-May-2019	Marcus M		Report create		ay 17 12.40:42	20190	<u>y</u>		view			
Cardiology	17-May-2019	warcus w	leiby.										
Cardiology	17-May-2019	Documen	t General Lab	Report create	ed at Fri M	lay 17 15:15:12	PDT 2019 b	у		View			
Cardiology	17-May-2019	Marcus W	/elby.										
Cardiology	17-May-2019	Document	t History & Phy	vsical Note cr	eated at F	Fri May 17 15·1	5:44 PDT 20	19		View			
Cardiology	17-May-2019 🔻	by Marcus	s Welby.		outou ut i	10.1				v.ew			
HRM Documents	+												
PHR	+	[27-Ma	v-2019 .: L	ab Results	1								
Register for PHR			,										

 Users should validate concordance of data *after* update
 The import software may work as designed – but if the user cannot recall the imported data, then pragmatic interoperability breaks down

Industrial Application

- The collaborate with two e-Referral engineering projects (B.C. and Ontario)
- Fallback Interoperability Workflow patterns are implemented in B.C. project
 - BC Clinical Data Exchange <u>https://bccdx.ca</u>
 - OSCAR EMR (Open Source System)



Conclusions

- Interoperability seen as a "systems property" (with humans inside)
- Pragmatic interoperability (use of information) deserves more attention
- Interoperability not a "yes/no" property that can be established in conformance testing
- Need to design systems that are tolerant to failure

jens@uvic.ca