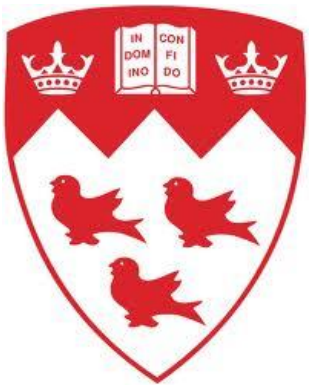

Content Validation of the Information Assessment Method for Delivery of Educational Material: a Mixed Methods Study

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TABLE OF CONTENTS

Contents

BOXES, FIGURES, AND TABLES

Boxes

Figures

Tables

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PREFACE

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AUTHORS' CONTRIBUTIONS

Badran carried out the literature review, the mixed methods research design, the quantitative data analysis, the qualitative research design, the qualitative data collection and analysis, and the integration of quantitative and qualitative results. Pluye and Grad supervised the work and contributed to all stages of the research. All authors participated in drafting the manuscript. All authors read and approved the final version of the manuscript.

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ETHICAL APPROVAL

This study was conducted according to the ethical principles stated in the declaration of Helsinki. Ethical approval was obtained from the McGill University Institutional Review Board (IRB). The IRB provided ethical approval #A11-E25-05A for collecting and analysing the quantitative data, and # A06-E44-13A for the qualitative data collection/analysis (see Appendix 11 and Appendix 12).

ABSTRACT

Context & Objective

The online delivery of educational material constitutes an opportunity to engage physicians in continuing education. Specifically, educational email alerts for physicians can improve knowledge translation, i.e., promote the use of research-based information in clinical practice. In turn, this can improve the quality of health care. The Information Assessment Method (IAM) is based on the 'Acquisition, Cognition, Application, Level of Outcome' theoretical model (ACA-LO). This model explains the four levels of outcomes (the four constructs) associated with the acquisition, cognition, and application of clinical information. The IAM questionnaire contains 23 items that allow physicians to report the four levels of outcomes (clinical relevance, cognitive impact, information use, and health benefits) associated with clinical information they read as an educational email alert. IAM is a unique and popular tool for knowledge translation, used by more than 10,000 physicians and pharmacists across Canada within accredited continuing education programs. Although the IAM has been validated in the context of information retrieval, the 2011 version of the IAM (IAM-v2011) is not yet fully validated in the context of information delivery. The use of assessment instruments that lack content validity can lead to invalid conclusions as well as the misapplication of findings to practice. My goal is to assess the content validity (logical and ecological content validity) of IAM-v2011 in a push context. My specific objectives are (i) to measure the relevance and (ii) assess the representativeness of IAM-v2011 items.

Research Design

To achieve these objectives, I conducted a three-part mixed methods research that combined and integrated quantitative and qualitative results using a convergent 'triangulation' design. First I used quantitative methods to measure the relevance of all 23 IAM-v2011 items (relevance ratio). Second, I used qualitative methods to assess the representativeness of each IAM-v2011 item. The relevance of items refers to their degree of appropriateness for the proposed construct (e.g., the construct of 'information use'), and their representativeness refers to which they represent all the aspects of the proposed construct, respectively. Third, results from quantitative and qualitative analyses were reviewed, combined, integrated and discussed with experts.

Participants and Setting

Part 1 (quantitative): 5596 Canadian Medical Association (CMA) members who used IAM-v2011 to rate research synopses called Daily POEMs (Patient-Oriented Evidence that Matters). Part 2 (qualitative): 15 family physicians from the department of Family Medicine, McGill University. Part 3: Seven members of the Information Technology Primary Care Research Group (ITPCRG) (including my supervisors) were consulted regarding the quantitative and qualitative data analysis, the integration of quantitative and qualitative results, and the final results. ITPCRG members are researchers and experts in the IAM and in the field of information science in primary health care.

Data Collection and Analysis

Part 1 (quantitative): 234,194 ratings (completed IAM questionnaires) were collected on 270 Daily POEM email alerts in 2012 (a subset of data collected in a longitudinal project led by my supervisors). I used descriptive statistics to calculate the relevance of each IAM item. Part 2

(qualitative): I sent an email invitation to family physician members of the McGill Department of Family Medicine to participate in a semi-structured one-on-one interview. I recorded, transcribed, summarized, coded, and analysed (inductive-deductive thematic analysis) the data collected from 15 interviews to assess the representativeness of each item. Part 3 (mixing): I combined and integrated results from part 1 and 2 to assess ecological content validity. This integration led to a matrix that contained the quantitative and the qualitative results for each item; the matrix was discussed with ITPCRG experts to assess the logical content validity.

Results

Of 23 IAM items, 21 were validated for content, while two were removed. Part 1 (quantitative results - relevance): 21 items were deemed relevant and kept for the new IAM version (relevance ratio above 10%), while two items were deemed not relevant (relevance ratio below 10%) and therefore removed; e.g., the item *'My practice will be changed and improved'* was not relevant for the construct 'cognitive impact'. Part 2 (qualitative results - representativeness): 22 items were deemed representative, while one item was not; the item *'I did not know what to do, and I will use this information to manage this patient'* was not relevant and not representative of the construct 'information use'. Part 3 (mixing results): I combined and integrated the quantitative and qualitative results to generate a new version of IAM (IAM-v2014) following discussions with ITPCRG experts.

Contributions to knowledge

The content validation (ecological and logical) of the IAM in the context of delivery of educational material will lead to three major contributions. At the individual knowledge user level, physicians and pharmacists will use a validated method to assess the clinical information

they read in accredited continuing educational programs. At the organizational information provider level, the analysis of ratings collected through the IAM-v2014 will provide valid results for assessing and improving information. For information science, this work validates a unique method that operationalizes the ACA-LO theoretical model. Using a validated questionnaire offers at least two advantages: (i) researchers will save time and resources by avoiding the lengthy process of developing and validating their own instrument, and (ii) they can compare their results with those obtained from other IAM-based studies.

RÉSUMÉ

Contexte et objectif

La mise en ligne d'outils pédagogiques représente une belle occasion d'engager les médecins dans un processus de formation continue. Par exemple, les courriels éducatifs envoyés sous forme d'alertes aux médecins peuvent améliorer l'application pratique des connaissances issues de la recherche. Cela peut en retour améliorer la qualité des soins. La Méthode d'évaluation des informations (MEI) est fondée sur le modèle théorique 'Acquisition, Cognition, Application – Niveaux de résultats' (ACA-NR). Ce modèle explique les quatre niveaux de résultats (les quatre construits) liés au processus d'acquisition, de cognition, et d'application des informations cliniques. Le questionnaire de la MEI contient 23 items qui permettent aux médecins d'évaluer quatre niveaux de résultats (pertinence clinique, impact cognitif, utilisation des informations, et bénéfices de santé) concernant l'information qu'ils reçoivent et lisent dans des courriels éducatifs. La MEI est un outil unique et populaire pour promouvoir l'application des connaissances; cette méthode est utilisée par plus de 10000 médecins et pharmaciens à travers le Canada dans le cadre de multiples programmes de formation continue. Avant mon travail de maitrise, la MEI était validée dans le contexte des recherches d'information (*pull context: information retrieval*), mais la version 2011 de la MEI (MEI-v2011) n'était pas encore entièrement validée dans le contexte de la diffusion de l'information (*push context: information delivery*). L'utilisation de méthodes d'évaluation qui manquent de validité de contenu peut conduire à des conclusions erronées et à une utilisation inappropriée de ces conclusions. En conséquence, mon objectif général est d'évaluer la validité de contenu (validité de contenu logique et écologique) de la MEI-v2011 dans un contexte de diffusion des

informations via des courriels éducatifs. Mes objectifs spécifiques sont (i) de mesurer la pertinence, et (ii) d'évaluer la représentativité des items de la MEI-v2011.

Plan de l'étude

Pour atteindre ces objectifs, j'ai mené une étude en trois parties, en ayant recours aux méthodes mixtes qui combinent et intègrent des résultats quantitatifs et qualitatifs (devis de convergence 'triangulation'). Dans un premier temps, j'ai utilisé des méthodes quantitatives pour mesurer la pertinence des 23 items de MEI-v2011 (coefficient de pertinence). Dans un second temps, j'ai utilisé des méthodes qualitatives pour évaluer la représentativité de chaque item de MEI-v2011. La pertinence des items fait référence à leur adéquation avec le construit proposé (par exemple le construit 'Application des informations'). La représentativité fait référence à la mesure dans laquelle les items intègrent tous les aspects du construit proposé. Dans un troisième temps, les résultats des analyses quantitatives et qualitatives ont été examinés, combinés, intégrés et discutés avec des experts.

Participants et Cadre de l'étude

Partie 1 (quantitative): Ont participé les 5596 membres de l'association Médicale Canadienne (AMC) qui ont utilisé MEI-v2011 pour évaluer des synopsis de recherche appelés « Daily POEMs » (*Patient-Oriented Evidence that Matters*). Partie 2 (qualitative): 15 médecins de famille du département de médecine familiale de l'Université McGill ont participé. Part 3: Sept membres du Groupe de recherche en technologies de l'information en soins de santé primaires (ITPCRG), incluant mes superviseurs, ont été consultés au sujet de l'analyse des données quantitatives and qualitatives, de l'intégration des résultats quantitatifs et qualitatifs, et

des résultats finaux. Les membres de l'ITPCRG sont des chercheurs et des experts dans la MEI et dans le domaine des sciences de l'information et des technologies de l'information en santé.

Collecte et analyse des données

Partie 1 (quantitative): 234,194 évaluations (questionnaires MEI complétés) ont été recueillies, à partir de 270 courriels éducatifs "Daily POEM" en 2012 (sous ensemble de données collectées dans le cadre d'une étude longitudinale dirigée par mes superviseurs). Pour calculer la pertinence de chaque item de la MEI, j'ai utilisé des statistiques descriptives. Partie 2 (qualitative): J'ai envoyé une invitation par courriel aux médecins de famille membres du département de médecine familiale de McGill; je les ai invité à participer à un entretien individuel semi dirigé. J'ai enregistré, transcrit et synthétisé 15 entretiens. Pour évaluer la représentativité de chaque item, j'ai codé et analysé les données issues des entretiens (analyse thématique inductive-déductive). Partie 3 (mixte): J'ai combiné et intégré les résultats des parties 1 et 2 pour évaluer la validité de contenu écologique. Cette intégration a permis de construire une matrice qui juxtapose les résultats quantitatifs et qualitatifs pour chaque item; la matrice a été discutée avec les experts de l'ITPCRG pour évaluer la validité de contenu logique.

Résultats

Sur les 23 items de la MEI, 21 ont été validés (validité de contenu), deux ont été retirés. Partie 1 (résultats quantitatifs - Pertinence): 21 items ont été jugés pertinents et ont été gardés dans la nouvelle version du questionnaire MEI (coefficient de pertinence supérieur à 10%), deux items ont été jugés non pertinents (coefficient de pertinence inférieur à 10%) et ont été retirés du questionnaire. Par exemple, l'item *'Ma pratique est changée et améliorée'* n'était pas pertinent

pour le construit 'Impact cognitif'. Partie 2 (résultats qualitatifs - Représentativité): 22 items ont étaient représentatifs, un ne l'était pas. Par exemple, l' item *'Je ne savais pas quoi faire et je vais utiliser cette information pour prendre en charge ce patient'* était ni pertinent ni représentatif du construit *'Application des informations'*. Partie 3 (résultats mixtes): J'ai combiné et intégré les résultats quantitatifs et qualitatifs dans le but de mettre au point une nouvelle version de la MEI (MEI-v2014), en accord avec les discussions que j'ai eu avec les experts de l'ITPCRG.

Contributions pour l'avancement des connaissances

La validation de contenu (écologique et logique) de la MEI dans un contexte de diffusion des informations via des courriels éducatifs apporte trois contributions majeures. Au niveau individuel des utilisateurs de connaissance, les médecins et pharmaciens pourront utiliser une méthode validée pour évaluer l'information clinique qu'ils lisent dans les programmes de formation continue. Au niveau organisationnel des fournisseurs d'information, l'analyse des données qui sont collectées avec la MEI-v2014 fournira des résultats valides pour évaluer et améliorer l'information. Pour le domaine des sciences de l'information, ce travail valide une méthode unique qui rend opérationnel le modèle théorique ACA-NR. L'utilisation d'un questionnaire validé offre au moins deux avantages: (i) les chercheurs gagneront du temps et des ressources en évitant le long procédé de développement et de validation de leur propre outil, et (ii) ils pourront comparer leurs résultats avec ceux des études qui utilisent la MEI.

LIST OF ABBREVIATIONS

1- **ACAO** – Acquisition-Cognition-Application-Outcome

2- **CME** - Continuing Medical Education

3- **CPhA**- Canadian Pharmacists' Association

4- **CMA**- Canadian Medical Association

5- **FP** – Family Physician

6- **EKR** – Electronic Knowledge Resource

7- **IAM** – Information Assessment Method

8- **POEM** – Patient-Oriented Evidence that Matters

INTRODUCTION

1.1 Overview

Many clinically relevant research studies are published daily; thus, it is difficult for physicians and pharmacists (indeed all health care professionals) to find the time to absorb this new knowledge. Electronic knowledge resources, specifically the pre-appraised evidence resources, can help family physicians in two ways. These resources provide clinical information to answer clinical questions at the point of care (Pull Technology) (e.g. Up-To-Date and Essential Evidence Plus), and they raise awareness of new research through information delivery systems (Push Technology) (e.g. Daily POEMs and e-Therapeutics+ Highlights educational emails). These EKR are credible pre-appraised evidence resource summarizes and provides evidence-based clinical recommendations which are the results of research studies that have been selected for clinical relevance and critically appraised for methodological quality. These resources: (i) are selected based on evidence grading methodology and criteria, (ii) present the date of evidence review for each piece of information, (iii) correlate the treatment recommendations to the specific evidence, and (iv) are continuously revised and updated.

"The value of information (educational material) can be conceptualized as, the acquisition of information, associated cognitive impact, its use or application and, information related patient health benefits" (1, 2). The presence of a feedback system can enable researchers to assess the value of information: the reasons why physicians' access or receive information, the related cognitive impacts, the types of information use and patient health benefit. "A feedback system can be in the form of a comprehensive and systematic tool, such as the Information Assessment Method (IAM) questionnaire" (3). For example, the IAM stimulates reflective

learning and enables the information users (e.g. family physicians) to provide constructive feedback that can be used by the information providers (e.g., the Canadian Pharmacist Association) for improving their educational program (e.g., e-Therapeutic+ Highlights) (3).

1.2 The problem

The Information Assessment Method (IAM) is a unique feedback system that is used for Continuing Medical Education (CME) and knowledge translation. Previously, IAM has been validated in the Pull context (information retrieval). IAM remains to be validated in the Push context (information delivery). Content validity of instruments depends on the context of their utilization, and information retrieval (Pull) and delivery (Push) are different contexts in terms of the value of information. For example, information retrieval (Pull) is an active process driven by a specific information-seeking objective or intention (4, 5), while receiving email alerts (Push) constitutes passive information behaviour; thus, we need to content validate the 2011 version of the IAM for educational email alerts (IAM-v2011).

1.3 Importance of the problem

Since 2006, IAM has been used by more than 10 000 family physicians and pharmacists across Canada. IAM allows health care professionals to report the situational relevance, cognitive impact and use of information as well as the expected patient health benefits associated with clinical information retrieved or delivered by electronic knowledge resources. IAM is based on a theoretical model called ‘Acquisition, Cognition, Application and Levels of Outcome’ (ACA-LO) derived from information studies (2). This model was operationalized to study the

value of information according to health professionals. Assessment tools need to be validated. Validity evaluates if a tool does evaluate what it is supposed to evaluate (6). The use of assessment instruments that lack content validity can lead to invalid conclusions as well as the misapplication of findings to practice (7). Assessment tools need to be validated in context of their purpose (6).

1.4 Background and previous work

Validity refers to the extent to which an instrument measures what it is supposed to measure. Content validity refers to the extent to which an instrument measures all the aspects of what it is supposed to measure, and can be divided into (a) logical content validity, which is primarily determined by experts in the domain who evaluate whether the instrument measures the construct it is supposed to measure, and (b) ecological content validity that explains how a measurement tool can be used in the real world, and can be determined by information obtained from individuals representing the population of users of the instrument (8, 9). The logical content validity of IAM-v2011 has been evaluated in previous work (theory-driven work conducted with information experts through qualitative research, literature review, and an expert panel) (2, 10-25)

1.5 Objectives and research question

Therefore, my goal is to evaluate the content validity of IAM-v2011 for educational email alerts, i.e., to know whether FPs in accredited CME programs use a validated method to assess information they receive by email. In line with standard procedures for content validation

of evaluation tools (7), my specific objectives are to measure the relevance and evaluate the representativeness of IAM-v2011 items for assessing information received from educational email alerts. The relevance of items refers to their degree of appropriateness for the proposed construct, and their representativeness refers to which they represent all the aspects of the proposed construct, respectively. The overall research question is as follows: what is the content validity (relevance and representativeness) of IAM-v2011 items for educational email alerts? My specific research questions will be: what is the relevance of each IAM item compared to the other items in the same construct? For family physicians, does each IAM item belong to its corresponding construct? How do family physicians interpret each of the IAM items in relation to their construct?

1.6 Method

To address our research questions a mixed methods convergent 'triangulation' design was followed (26) (27). The triangulation process involves the usage of different sources such as quantitative and qualitative to improve the validity of the study (28). A quantitative method was used to measure the relevance of IAM-v2011 items (5596 participants). Concomitantly, a qualitative method was used to evaluate the representativeness of the IAM-v2011 items (15 participants). Then, the results from quantitative and qualitative data analyses were integrated. Integrated results were interpreted by experts. Specifically, I did not collect the quantitative data. My contributions were as follows. I conducted a comprehensive literature review regarding the levels of outcome associated with the information delivered to physicians. I conducted the quantitative data analysis (descriptive statistical analysis), and I calculated the relevance ratio of each item of the IAM. I conducted the qualitative data collection (interviewing, recording,

transcribing, summarizing, and coding,), and analysis (inductive deductive thematic analysis). I combined and integrated the quantitative and qualitative results, presented and discussed the results with experts.

1.7 Outcomes

This MSc thesis produced a content validated version of the IAM (called IAM-V2014). A validated IAM will offer the information provider with validated feedback from the end users; hence, feedback will help information providers improve their services. This research is important for two reasons: educational email alerts help prepare clinicians to practice in a constantly evolving knowledge environment, while IAM stimulates their reflective learning, and links this to their patients.

BACKGROUND

Since this project is assessing the content validity of the IAM for Push Technology, we will define three main concepts in this section: (i) information, and Electronic Knowledge Resources including Push technology; (ii) the theoretical model supporting the IAM and the IAM-v2011 questionnaire; and (iii) the notions of validity, content validity, ecological content validity, logical content validity and validation process. In the following chapter (literature review), we report a comprehensive literature review regarding the levels of outcomes associated with the delivery of educational material to practicing physicians. Since theory constitutes an essential component of validity, the purpose of this review is to check how the levels of outcome of information, which are based on the '*Acquisition, Cognition, Application, Level of Outcome*' theoretical model (ACA-LO), have been addressed in the literature, and if there were any other levels of outcome that were reported, which can lead to support or revise our theory.

2.1 Information

Information can be produced from research and experience, and is communicable. The word information comes from the Latin word (informare) which means "give form to". People mostly think that "information as disjointed little bundles of facts"(29). Information is also defined as "codified knowledge" (30). In the Oxford dictionary, information is what is conveyed or represented by a particular arrangement or sequence of things: "Computing data as processed, stored, or transmitted by a computer" (31). In addition, the Oxford dictionary connected information to knowledge and communication and defined it as knowledge communicated regarding some specific fact, subject or event; that was refined and appraised; intelligence, news.

Information transmission was quantified and explained in Information theory which addressed the sender-to-receiver module through one channel (32).

Until recently, theories did not address a communication situation where messages are conveyed from one sender to many receivers via a broadcasting mass medium. Hence there was a need for a theoretical model to explain this relation; later in this chapter I will introduce such a model. The conclusion is that "information has no value in itself" (32). Information value comes out mainly from its relation to the "human action or as an indirect relation" (29). Hereinafter, this was the need for the Information Assessment Method (IAM) to evaluate the value of information retrieved and received from electronic knowledge resources.

2.2 Electronic Knowledge Resources and Push Technology

The internet is a worldwide computer network that interconnects other computer networks (33). The internet includes commercial, educational, governmental, and other types of networks, all of which use the same set of communications protocols (33). The internet provides end-user services, such as data archives, enabling the exchange of information (34). In 1969, the Advanced Research Projects Agency Network (ARPANET) of US department of Defense was launched, followed by the National Science Foundation (NSFNET), which were the first two comprehensive electronic knowledge resources (35). The development of internet and email dramatically increased in the 1990s (36). According to the latest national survey of Canada Statistics, 80.3% of Canadians were using the internet on a regular basis in 2009 (appendix 3).The main reason for internet usage was email; 93.0% of Canadians reported using email. Regarding specific search topics, searching for medical or health related information was the

leading search drive for Canadians; 69.9% of Canadians reported searching the internet for health related information (appendix 2).

Specifically, internet facilitates access to the information needed by health professionals, e.g., to answer their clinical questions (5). The information can be accessed primarily in two ways, through online libraries (PULL) and educational email alert services (PUSH). The use of internet in its different forms facilitates research (the selection of the topic, review of literature, designing the research, finding the techniques, and discussion of the findings, among others). The internet is commonly used to search for any type of information, and communicate via email and other platforms.

In particular, many educational email channels deliver clinical information to health professionals (3). While CME programs serve health care professionals in different forms and languages all over the world (37), many programs deliver information using clinical email channels such as E-Therapeutics+ Highlights (appendix 4) and daily POEM alerts (http://www.essentialevidenceplus.com/product/features_dailyip.cfm). Nine studies that focused on the use of information from educational email alerts in the health sciences were identified.

Overall, these studies present interesting results. On the one hand, email alerts have been associated with physicians' commitment to change their clinical practice and expectation of patient health benefits (subjective); on the other hand, no studies have been conducted on the association between email alerts and observable practice change (objective).

Three studies globally evaluated satisfaction and usefulness of receiving health information via email. In these studies, the users of educational email alerts reported high levels of satisfaction

and perceived them to be useful for continuing education (38-40). The fourth study evaluated the effect of educational email alerts on the information familiarity and knowledge acquisition of the users. While subscribers of educational email alerts became more aware of the recent literature, their knowledge did not improve (41). The fifth study evaluated the effect of educational email alerts on subsequent information retrieval by physicians and demonstrated that users of educational email alerts (Push technology) are more likely to use information retrieval (Pull technology) (42). The sixth study examined self-reported 'cognitive impact' of emailed synopses of recently published clinical research (POEMs), and the results indicated that educational email alerts have a positive effect (13). Subsequently, another study indicated that educational email alerts are infrequently retrieved after initial reading (14), although confidence in this finding was limited by socio-technical problems with study hardware and software. Finally, two studies suggested that dissemination of synopses of systematic literature reviews by email (21), and of 'Highlights' of treatment recommendations within book chapters are associated with expected benefits for patient health (15).

2.3 Theoretical model supporting the Information Assessment Method

The IAM questionnaire is based on a model called ACA-LO (Acquisition, Cognition, Application, and Levels of Outcome). Information "has value only in context": the value given by its users (43). One theoretical model is based on the generic human-information interaction ACA cycle (Acquisition Cognition Application cycle)(4, 24). This cycle is explained as follows: (1) Acquisition: Health professionals search for information with an intention to fulfill an objective. (2) Cognition: They absorb, understand, and integrate information objects. (3) Application: They use newly understood and cognitively processed information. The ACA cycle

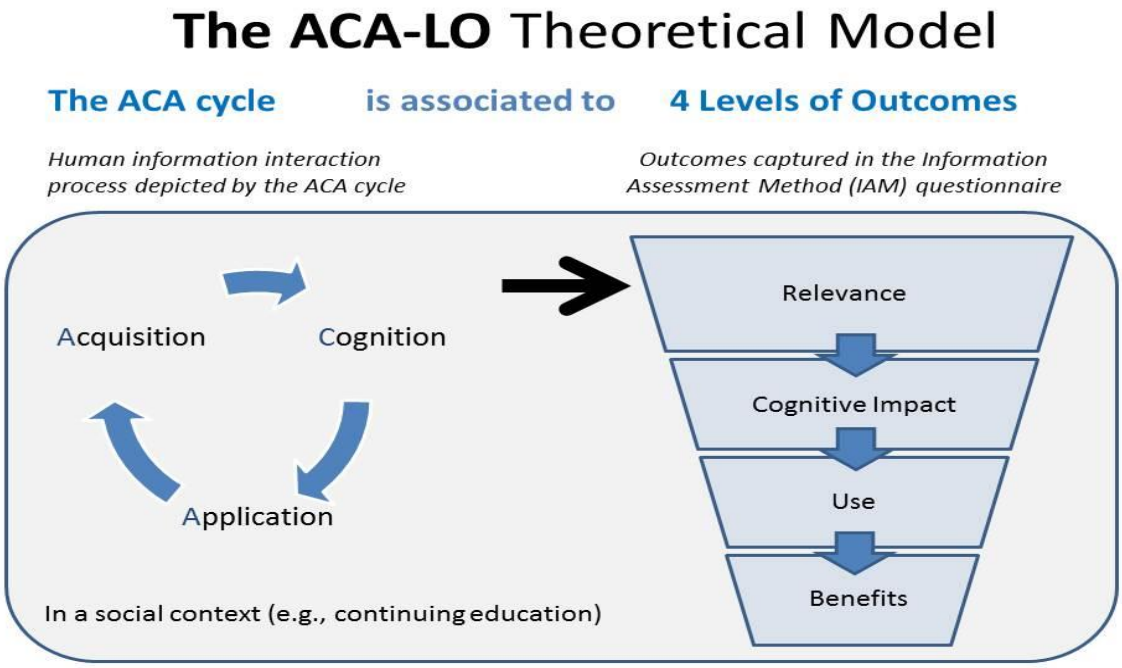
is iterative, i.e., it "may be repeated several times for the same task or problem" (1). However, the scope of the ACA cycle is limited, as it does not distinguish between the application of information and the outcomes of this application. Electronic knowledge resources allow the systematic tracking of the application of discrete information objects, that is, the examination of outcomes of information. This tracking possibility reflects a departure from the past when information was delivered on paper (44).

As a result, a new model (ACA-LO) was proposed, integrating the ACA cycle with levels of outcomes of information. Presented more fully elsewhere (2, 45) the ACA-LO model explains the 'value' of information, i.e., how information is valuable from the user viewpoint. In this model (Figure 1), four levels of outcomes (LO) are associated with the process (the ACA cycle). To illustrate this process in the 'push' context: health professionals subscribe to an alerting service and then acquire a passage of text (acquisition), which they read, understand and integrate (cognition). Subsequently, they may use this newly understood and cognitively processed information for a specific patient (application). The four levels of outcomes are as follows: the situational relevance of the information (level 1), its cognitive/affective impact (level 2), the use of information (level 3), and subsequent health benefits (level 4). These are four levels because relevance is necessary for information to have positive cognitive impact. In turn, a positive cognitive impact is necessary for using information, which could eventually result in health benefits. The outcomes are operationalized by the IAM questionnaire items.

The proposed ACA-LO model is operationalized by the IAM-v2011 questionnaire. The IAM questionnaire has been refined iteratively since 2001 through literature reviews, qualitative, quantitative, and mixed methods research. More than ten years of research and development

efforts have demonstrated that health professionals can assess information objects systematically by integrating the IAM checklist within electronic knowledge resources using a technique called Computerized Ecological Momentary Assessment (46). The IAM checklist is linked directly to all accessed or opened information items, thus health professionals can easily report the perceived relevance, cognitive impact, use, and outcomes associated with each information object, hence a method to assess the effect of information objects has been developed.

Figure.1: The ACA-LO Theoretical Model



Source: Big Data in Health Analytics, Taylor and Francis 2014 (Chapter: Big Data from the Push of Clinical Information: Harvesting User Feedback for Continuing Education) (45).

2.4 Information Assessment Method and IAM-v2011 questionnaire

For the continuing education of health professionals and in partnership with national organizations of physicians and pharmacists, Drs. Pluye and Grad developed the IAM with

members of the Information Technology Primary Care Research Group over more than ten years conducting quantitative, qualitative, mixed methods researches in addition to reviewing the literature. The IAM questionnaire is available at www.mcgill.ca/iam. When linked to one 'object' of clinical information such as that delivered by an alerting service, the IAM questionnaire systematically documents health care professionals' reflection on clinical information, delivered or retrieved from electronic knowledge resources in accredited continuing educational programs. IAM allows health care professionals to report the relevance, cognitive impact and use of clinical information, and expected health outcome(s) associated with information use. IAM enhances continuing education by stimulating reflective learning, evaluation of knowledge resources, and two-way knowledge exchange between information users and information providers (3, 47).

IAM is linked to two types of electronic knowledge resources involving: the 'pull' and 'push' of electronic information. On the one hand, 'Pull' refers to information-seeking behaviour, such as active searches for information from an electronic knowledge resource. 'Push', on the other hand, describes information delivery, a passive acquisition of information, such as educational email alerts. It is considered to be a systematic and comprehensive method to assess information from the perspective of primary health care professionals: family physicians, nurse practitioners, and pharmacists (2, 10, 19-21, 24, 25).

In its current form, in the context of information received by email, the IAM questionnaire contains 23 items distributed on four levels of outcomes; (i) the 'cognitive impact' construct which contains six items of positive impact, and four items of negative impact, (ii) the

'relevance' construct which contains three items, (iii) the 'use' construct which contains seven items and (iv) the 'health benefit' construct which contains three items.

Information Assessment Method V2011 layout (appendix 9):

1- Target construct: Cognitive Impact.

The question is: What is the impact of this information on you or your practice?

Items:

1) My practice is (will be) changed and improved

   If Yes, what aspect is (will be) changed or improved?

2) I learned something new
3) I am motivated to learn more
4) This information confirmed I did (am doing) the right thing
5) I am reassured
6) I am reminded of something I already knew
7) I am dissatisfied
8) There is a problem with the presentation of this information
9) I disagree with the content of this information
10) This information is potentially harmful

2- Target construct: Relevance.

The question is: Is this information relevant for at least one of your patients?

Items:

1) Totally relevant
2) Partially relevant
3) Not relevant

3- Target construct: Application of information for a specific patient.

The question is: Will you use this information for a specific patient?

Items:

1) As a result of this information I will manage this patient differently
2) I had several options for this patient, and I will use this information to justify a choice
3) I did not know what to do, and I will use this information to manage this patient
4) I thought I knew what to do, and I used this information to be more certain about the management of this patient
5) I used this information to better understand a particular issue related to this patient
6) I will use this information in a discussion with this patient, or with other health professionals about this patient
7) I will use this information to persuade this patient, or to persuade other health professionals to make a change for this patient

4- Target construct: Patient health benefit.

The question is: For this patient, do you expect any health benefits as a result of applying this information?

Items:

1) This information will help to improve this patient's health status, functioning or resilience (i.e., ability to adapt to significant life stressors)
2) This information will help to prevent a disease or worsening of disease for this patient
3) This information will help to avoid unnecessary or inappropriate treatment, diagnostic procedures, preventative interventions or a referral, for this patient.

2.5 Validity, content validity, ecological validity, and validation process

Validity is derived from the Latin word (valere), meaning to be strong. The Webster's New International Dictionary (1952) offers the following synonym: "effective tool; accomplishing what is claimed or intended to be measured; for example a valid method or test". In psychology, validity refers to whether an assessment tool measures what it is supposed to measure (6, 48-50). "Validity refers to the degree to which evidence and theory support the interpretations of test scores entailed by proposed uses of tests" based on the American Psychological Association definition of 1999. There are multiple types of validity, which we defined in a glossary, such as concurrent, content and construct validity (Appendix 1).

Validation is the process gathering evidence to prove "a sound scientific basis" for interpreting the scores collected by the assessment tool as proposed by the test developer and interpreted by the test user (51). Validation therefore begins with a conceptual framework or a theoretical model that defines the scope and aspects of the proposed interpretation. The framework or model also includes a rationale or justification for linking the interpretation to the test in question such as the ACA-LO model and the IAM-v2011 questionnaire.

Assessment of validity involves evaluating the inferences of the scores on a test, not the test itself (52). Several judgments can be made based on test scores (49):

1) Whether the test looks appropriate for a particular use (face validity).
2) Whether the test is made up of stimuli calling for construct-relevant responses (content validity).
3) Whether responses to the test stimuli relate to other types of responses, either concurrently available or to be available sometime in the future (criterion-related validity).
4) Whether relationships entered into by scores on the test are consistent with theory (construct validity).
5) Whether predictions based on test scores add incremental value in decision-making (intervention or treatment validity).

Validity is generally considered as one of the most important issue with respect to an educational assessment tool (53), because it directly affects the interpretation of the results obtained using this tool (54).

Content validation is an essential task in the creation of a new assessment tool or in revising an existing one. Content validity is defined as "the degree to which elements of an assessment tool are relevant to and representative of the targeted construct for a particular assessment purpose" (7). The relevance of an assessment instrument refers to the appropriateness of its elements for the targeted construct and function of assessment (50, 55-57). The representativeness of an assessment instrument refers to the degree to which its elements are proportional to the aspects of the targeted construct (58-60). Content validity affects the clinical

inferences that can be drawn from the obtained data. Data from an invalid instrument can over represent underrepresent some aspects of the proposed measurement and may reflect variables outside the proposed construct. “A content-invalid assessment tool could erroneously indicate the occurrence or non-occurrence of clinically important treatment effects” (7).

According to (7), items of assessment instruments should be derived from:

1) Items from previously published instruments.
2) Clinical experience or deductive reasoning by the developers.
3) Theories and literature about the target behaviour.
4) Expert sampling.
5) Population sampling.
6) The results of empirical research.

In addition, the literature suggests the following eight rules for content validation:

1) Careful definition of the domain and facets of the construct are subjected to content validation before developing other elements of the assessment instrument (57, 61, 62).
2) Use population (ecological) and expert (logical) sampling for the initial generation of items and other elements (7).
3) Subject all elements of an assessment instrument to content validation (63).
4) Use multiple judges of content validity and quantify judgments using formalized scaling procedures (60, 64-67).
5) Review for technical quality (e.g., for grammar, wording, randomization of items, and scaling) by measurement specialists (65).

6) Report the results of content validation when publishing a new assessment instrument (6, 60).
7) Examine the proportional representation of items (7).
8) Use subsequent psychometric analyses for instrument refinement (7).

Regarding the IAM-v2011 for PUSH technology, items were developed in accordance with Haynes' guidance, and the first two validation rules were followed (theory-driven work conducted with information experts through qualitative research, literature review, and expert panel) (2, 4, 10, 11, 16, 18-21, 23, 24, 68-74). In this thesis we will follow the third rule as the main focus, as we will assess the ecological content validity of the IAM-v2011.
Content validity can be divided into (see table 1):

(1) Logical content validity in which a determination is left to experts in the domain of the construct regarding what the test intends to measure.

(2) Ecological content validity, the determination of which comes from information obtained from group discussion comprised of individuals representative of the population covered by the new instrument (8).

Table 1: Comparison between content validity and ecological validity

	Content validity	**Ecological validity**	**Logical Validity**
Definition	Refers to the extent to which a measure represents all facets of a given social construct. Can be assessed by measuring the relevance and assessing the representativeness of the measurement tool.	Understanding information obtained from a group comprised of individuals' representing the population covered by the new instrument. This information can be obtained through questionnaires (IAM) or face to face interviews.	Refers to the extent to which the logic and the verbal composition of the items is appropriate from the experts' viewpoint.
Components	Ecological validity Logical validity	Part of content validity	Part of the content validity

Assessment	Determining the relevance of a measure (e.g., using a questionnaire completed by experts and users) Assessing the representativeness of a measure (e.g., interviewing experts and users).	Measuring the relevance (e.g., using a questionnaire completed by non-expert users , IAM) Assessing the representativeness (e.g. interviewing non-expert users).	Consulting experts regarding each item logic and verbal composition.

Ecological validity is the degree to which the behaviors observed and recorded in a study reflect the behaviors that actually occur in natural settings. In addition, ecological validity is associated with "generalizability". Essentially, ecological validity is the extent to which findings (from a study) can be generalized (or extended) to the "real world"; it is one of the most important issues within research (75, 76). Therefore psychological research depends upon ecological validity for its ability to generalise to others, and if results cannot be generalised, they lack use within the wider society. It is important to study the ecological validity of psychological measures in both normal-range and clinical populations (77).

Examining the ecological validity of the assessment tool is useful because ``there is increasing awareness of the importance of executive functions to independent and responsible social behavior" (77). “The executive function contains the cognitive capacities of judgment, decision making, planning, and social behaviour” (78).

“There are many ways to improve the ecological validity of the assessment tools such as; item correlations, multiple regression, and factor analysis” (79). In addition, it is essential to understand the perception of the vocabulary used depending on the group of users by testing, understanding of terms and the reading level required, so researchers must examine whether the terms they use are understood by the users of the tool? For example, in the case of our method

(IAM) we have examined the extent to which family physicians' understanding of the meaning of each item is concordant with our understanding. This latter form of content validity has been recently promoted in psychometrics research for instance (9).

2.6 Conclusion

In this chapter we addressed the three main concepts of: Information, Electronic Knowledge Resources including Push technology. In addition, we described the theoretical model supporting the IAM and the IAM-v2011 questionnaire. Finally, we presented the notions of validity, content validity, ecological validity, and validation process. Since this project is assessing the content validity (ecological and logical content validity) of the IAM for the delivery of educational material, we will discuss the levels of outcome associated with information delivered as educational email alerts to physicians in the following chapter (literature review), considering the four levels of outcome addressed by the ACA-LO theoretical model as the basic concepts in our review.

LITERATURE REVIEW

We carried out a literature review regarding the levels of outcome associated with educational email alerts. Based on the theoretical model of IAM (ACA-LO), we proposed the following levels of outcome: (i) cognitive impact, (ii) information use, (iii) clinical relevance, and (iv) health benefits. One important aspect of the content validation of an assessment tool such as the IAM questionnaire is to ensure that all aspects of the measurement are covered (7). Specifically, Haynes (1995) mentions that an assessment tool must 'specify' the constructs 'to be included' (such as the levels of outcome of information for the IAM) in accordance with a theory and the literature. In Table 2, we present three literature reviews that supported these four levels of outcomes of clinical information (cognitive impact, n=3; Information use, n=3; clinical relevance, n=1; and health benefits, n=2).

3.1 Goal of this Literature Review

We reviewed the literature to explore whether all proposed levels of outcome were associated with push educational emails for physicians (including family physicians). Specifically, we carried out this literature review to (i) explore how the four levels of outcome are addressed in primary studies, and (ii) to search for any other additional levels of outcome (constructs) that are not currently included in the ACA-LO model and the IAM.

3.2 Review Question

In the literature on push technology for practicing physicians, what do the published qualitative, quantitative and mixed methods research studies tell us about the four levels of outcomes of information: (i) clinical relevance, (ii) cognitive impact, (ii) information use, and (ii)

health benefits? In other words, for physicians, what are the levels of outcomes in the context of information delivered by push technology?

Table 2: Literature reviews that supported the levels of outcomes of clinical information

First author, year, country	Design	Relevant outcome	Reported level of outcome
(Pluye et al., 2010)(20), Canada	Literature review	Compared with existing evaluation tools, this interdisciplinary critical review suggests IAM is a comprehensive, generic and systematic tool for evaluating Clinical Emailing Channels in clinical practice. Based on an information framework, IAM documents clinicians' self-evaluation of relevance, cognitive impact, information use and health benefits of email alerts.	Cognitive impact Information use Clinical relevance Health benefits
(Lam-Antoniades et al., 2009)(80), Canada	Systematic review	Of 6 studies, 4 showed a statistically significant advantage of the e-CE (push& pull) intervention and 2 showed no significant effect. Positive effects of EKR persist for up to 12 months and effects on practice up to 5 months with respect to changing health professionals' behaviour 1- Practice patterns 2- Improve their knowledge. These support the use of e-CE as a method of CE delivery.	Cognitive impact Information use Health benefit
(Law et al., 2008)(81), South Africa	Systematic review	Most internet activity focuses on emails. Professional emails are increasing. Factors discouraging usage are: 1- Time 2- Workload 3- Cost 4- Too much information 5- Liability issues 6- Lack of skills Specialists use the internet (push &pull) more than generalists Doctors are highly connected to the internet.	Cognitive impact Information use

3.3 Review Methods

3.3.1. Eligibility Criteria

To address our review question, we determined the eligibility criteria to identify and select potentially relevant research. On the one hand, the inclusion criteria were: the research should (i) be a primary study reported in English, AND (ii) focus on educational emails directed to physicians, AND (iii) report outcomes associated with emails such as cognitive impact, OR information use, OR clinical relevance, OR health benefits. On the other hand, the exclusion criteria were: (i) communication emails, OR (ii) emails directed to students, residents or patients, OR (iii) research reported in a language other than English.

3.3.2 Information sources

The information sources used in our search were mainly citation tracking and personal searches. Full-text publications were retrieved via the McGill University library. The last date of searching the literature was March 10th, 2014. Our search is presented below.

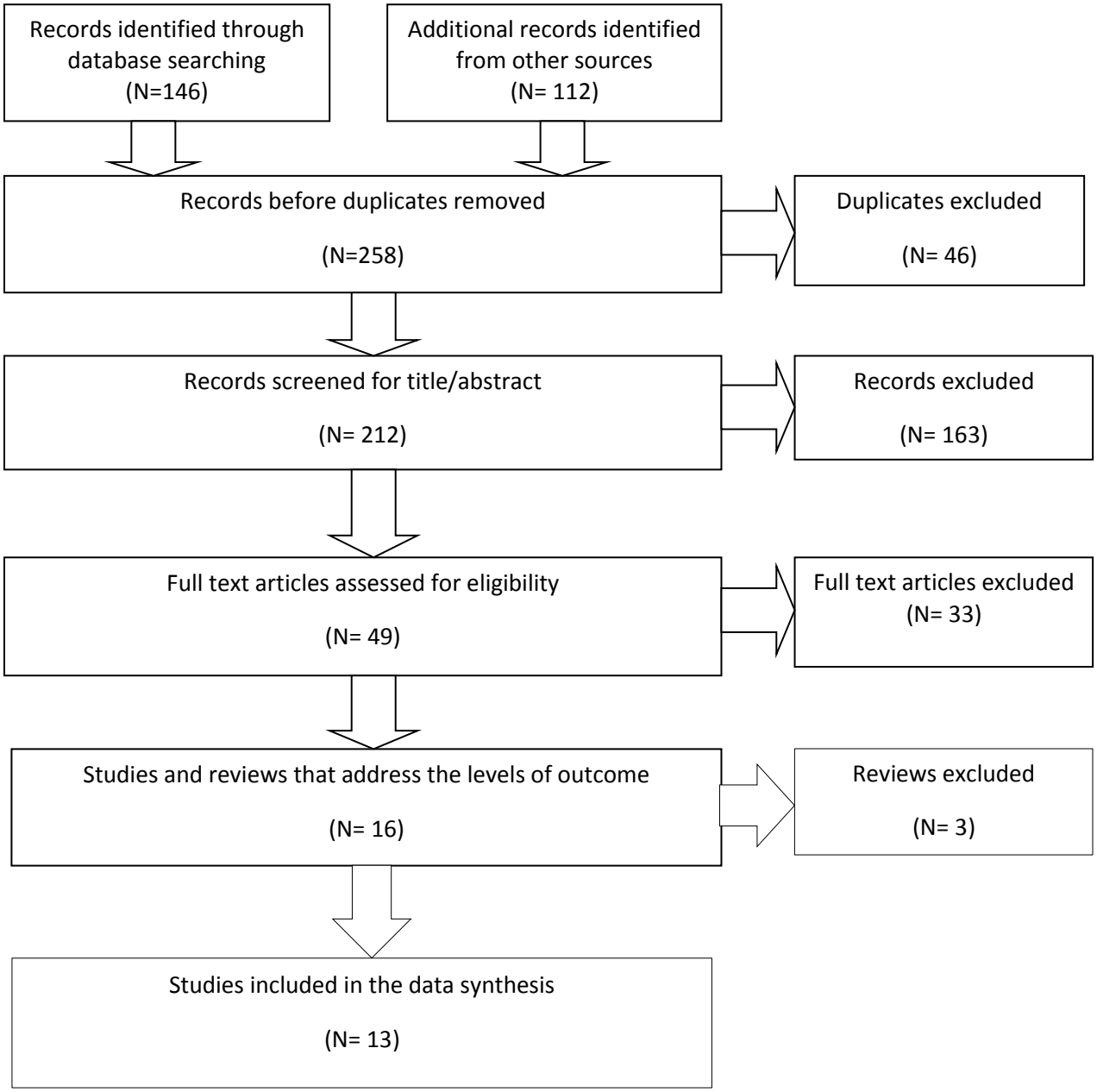
1) Citation tracking: We tracked research cited by or citing the three reviews (index papers) and the five research studies included in the most recent review conducted by my supervisor (PP) using the Scopus bibliographic database (4, 13, 20, 38-40, 42, 73).
2) Personal searches: In addition, we conducted three personal searches using Google Scholar, MEDLINE via Ovid, and Scopus (one in preparation for the study protocol, one for a graduate course on mixed studies reviews, and one for this thesis).

3.3.3 The study selection process (see figure 2)

Citation tracking: In the Scopus database I looked for research that met our inclusion criteria. I identified 129 database records (including authors, year, title, source, and abstract). All records were imported in reference management software (Endnote), and duplicates were removed. Records were screened, which led me to select potentially relevant research. For each potentially relevant study, the corresponding full text article was retrieved and read. Articles reporting research that met our eligibility criteria were included.

Personal searches: I searched Google Scholar, Scopus, and MEDLINE for potentially relevant research using our eligibility criteria, and identified 93 records. Similar to phase-one, records were imported in Endnote, duplicates removed, records screened, and potentially relevant full-text articles retrieved.

Figure.2: Flow diagram



3.3.4 Data extraction

The included research studies were read and their main characteristics were extracted. A table was created (see appendix 8) to summarize key characteristics of the included research. These characteristics are: First author, Journal, Year, Country and ID number of the study; Study design or approach; Participants (age, sex, number); Setting (e.g., types and number of organizations); Data collection and data analysis; Intervention/exposure (if applicable), or relevant considerations for non-intervention research; Outcomes (if applicable), or relevant considerations for non-intervention research; The levels of outcome addressed in the study.

3.3.5 Data synthesis

For synthesizing data on the levels of outcomes, I used an inductive-deductive thematic analysis. Inductive-deductive thematic analysis is a method that assigns data to themes proposed by the researcher (deduction), and to new themes that are suggested by the data (induction) (82). The deductive component was prominent because we used the four IAM constructs (levels of outcome) as initial themes: cognitive impact, information use, clinical relevance, and health benefits. The inductive component was used to explore new constructs addressed in the literature.

3.4 Results

Results are presented in the flow diagram below (Figure 2). I identified 665 records, and included 16 research studies (three reviews and 13 primary studies). The primary studies were: (i) six quantitative studies, (ii) two qualitative studies, (iii) two mixed methods studies,(iv) two controlled trials, and (v) one prospective observational study.

Regarding the levels of outcome: (i) “cognitive impact” was reported in 9 studies, (ii) “information use” was reported in 7 studies, (iii) “clinical relevance” was reported in 6 studies, (iv) “health benefits” was reported in 4 studies. No other levels of outcome were reported in this literature.

Table 3: Summary of the review results

First author, year, country	Design	Reported level of outcome
(Pluye et al., 2010)(19), Canada	Mixed Methods study	Cognitive impact Information use Clinical relevance Health benefits
(Grad et al., 2011)(24), Canada	Mixed methods study	Cognitive impact
(Pluye et al., 2012)(21), Canada	Quantitative (longitudinal web-based) study	Cognitive impact Information use Clinical relevance Health benefits
(Cook et al., 2013) (83), Australia	Qualitative (Focus groups)	Cognitive impact Information use Health benefits
(Ebell & Grad, 2012)(84) , Canada	Quantitative (A longitudinal web-based) study Summary of the most relevant 20 Daily POEMs, 2011	Cognitive impact Clinical relevance
(Ebell & Grad, 2013)(85), Canada	Quantitative (A longitudinal web-based) study Summary of the most relevant 20 Daily POEMs, 2012	Cognitive impact Information use Clinical relevance Health benefits
(Galvao et al., 2013) (69), Canada	Quantitative (longitudinal web-based) study	Clinical relevance
(Law et al., 2008)(81), Canada	Quantitative (longitudinal web-based) study	Cognitive impact Clinical relevance Information use
(Leung et al., 2010)(16), Canada	Qualitative (multiple-case) study	Cognitive impact
(McMullin & Singh, 2006)(86), USA	Randomised controlled trial	Information use Health benefits
(Schopf & Flytkjaer, 2012) (87), Norway	Randomized controlled trial	Information use Health benefits
(Strayer et al., 2010) (88), USA	Quantitative (web-based) study	Cognitive impact Information use
(Wang et al., 2009) (89), Canada	Prospective observational study	Cognitive impact

3.5 Conclusion

My literature review shows that the four proposed levels of outcome were associated with educational emails for physicians. No additional pertinent construct has been found in the literature.

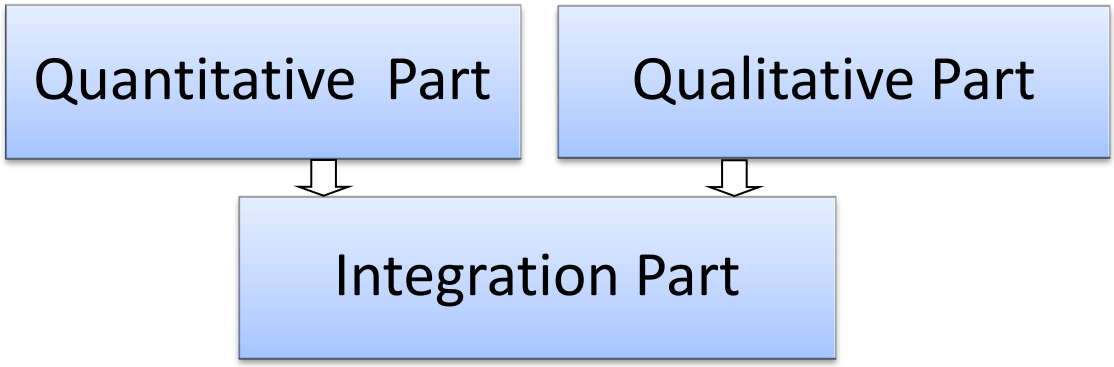
METHODS

To address our research question, the relevance and representativeness of IAM-v2011 items were studied in the Push context. The relevance of an assessment instrument refers to the degree of the appropriateness of its items with respect to the proposed constructs (7). The representativeness of an assessment instrument refers to whether items represent all the aspects of the proposed constructs (7).

An accredited and reflective continuing medical education program (daily POEM alerts), which uses IAM-v2011 to get feedbacks from participants, was used. Daily POEM alerts ("Patient-Oriented Evidence that Matters") are synopses of new research tailored to a primary care audience. Daily POEM alerts emerge from scanning the published research based on criteria of relevance to practice and validity through critical appraisal. POEMs are selected from among thousands of studies published in more than 100 monthly medical journals (see appendix 4).

A three-part mixed methods research convergent design(26) was followed (see appendix 5). Why Mixed methods research? Mixed methods research is an approach or a methodology that can outline the research question that address a 'real life' issue (90). On the one hand mixed methods research employ quantitative methods to assess the relevance and frequency of subjects (e.g. items and constructs) under investigation, on the other hand it employs qualitative methods to understand the real life aspects of the same items or constructs (91, 92). Utilizing multiple methods (e.g., longitudinal web questionnaires (quantitative) and in-depth face to face exploratory interviews (qualitative)), integrating the results of these methods will enhance the final outcome of this study (27) (see figure 3).

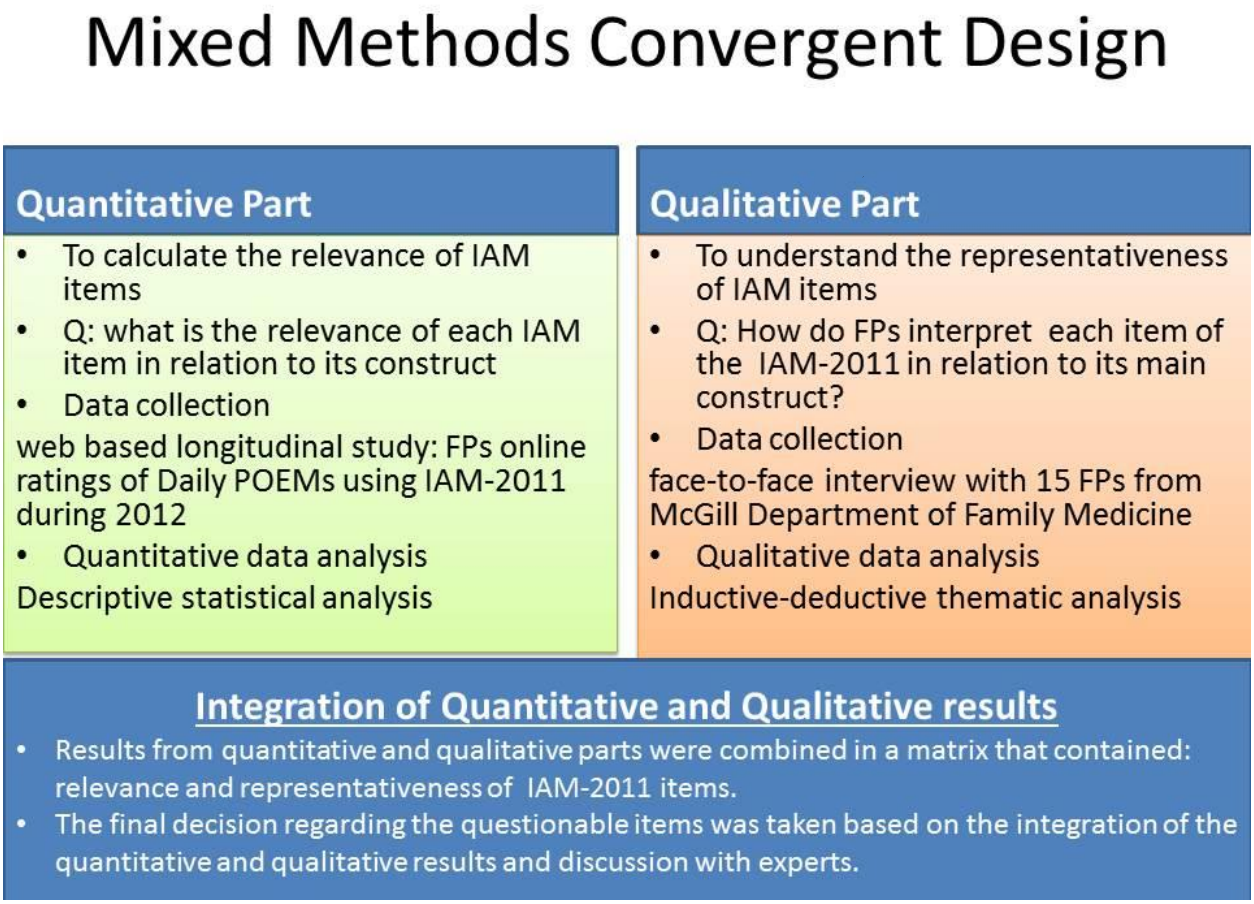
Figure.3: Mixed methods convergent triangulation design



Our mixed methods convergent design is comprised of three parts (see figure 3). First, in the quantitative part, the relevance of IAM-v2011 items was measured using data collected from a web-based quantitative longitudinal study involving family physicians rating daily POEM alerts using the IAM-v2011 questionnaire. Calculating the relevance of items enabled us to identify and eliminate items that "have highly skewed and unbalanced distributions" (93). Second, in the qualitative part, I assessed the representativeness of IAM-v2011 items, and their relation to the IAM constructs. In both parts, the ecological content validity was evaluated by the users (family physicians) through questionnaires and interviews. In line with the literature on validity of assessment tools, the main constructs and IAM-v2011 items were examined with a sample of the users (target population) (93). Third, results from quantitative and qualitative parts were combined and integrated to get the final results.

This study was conducted according to the ethical principles stated in the declaration of Helsinki. Ethical approval was obtained from the McGill University Institutional Review Board (IRB). The IRB provided ethical approval #A11-E25-05A for collecting and analysing the quantitative data (see appendix 11), and # A06-E44-13A for the qualitative data collection/analysis (see appendix 12).

Table 4: Summary of mixed methods convergent design in our study



4.1. Part-one (quantitative)

The relevance of IAM-v2011 items was measured using ratings collected with the IAM questionnaire.

Design: A web based longitudinal quantitative study of all ratings submitted by physicians after reading daily POEM alerts using IAM-v2011.

Participants: Physicians across Canada who received daily POEM email alerts and rated them using the IAM-v2011.

Intervention: In 2012, 270 POEMs alerts were sent to physicians (85).

Data Collection: 234,194 ratings were collected from January 1st to December 31st, 2012.

Data analysis: For each IAM-v2011 item, a ratio (R1) was calculated (number of completed questionnaires where the item was rated / total number of items selected for the same construct in all the completed questionnaires) using this formula:

$$R1 = \frac{\text{The number of completed questionnaires where the item was selected}}{\text{The Total number of items selected for the same Construct in all the completed questionnaires}}$$

For example, with regard to the item "I learned something new", the ratio was calculated as: the number of completed questionnaires where the "learning" item was selected / total number of items selected for the same construct in all the completed questionnaires.

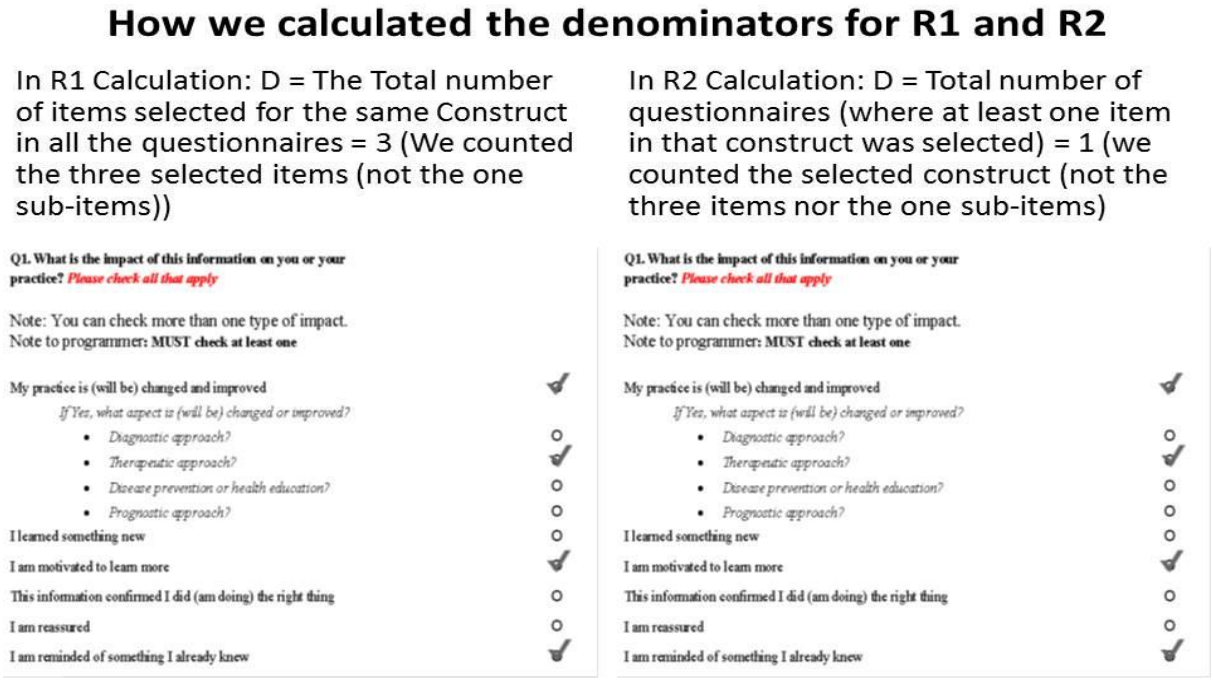
In addition, a ratio (R2) was calculated (number of completed questionnaires where the item is rated/total number of questionnaires where at least one item in the same construct is rated) using this formula:

$$R2 = \frac{\text{The number of completed questionnaires where the item was selected}}{\text{Total number of questionnaires (where at least one item in that construct was selected)}}$$

For example, with regard to the item ″I learned something new″, the ratio was calculated as: the number of completed questionnaires where the ″learning″ item was selected / total number of IAM items in which at least one item of the same construct was selected.

Interpretation of the results: In line with our content validation study in a PULL context (94), an item was deemed relevant when the value of R1 or R2 was 10% and above. The items were categorized according to their ratio as follows; less than 10% irrelevant, and more than 10% relevant. Irrelevant items were excluded from the IAM-v2011. R < 10% was chosen as the cut-off to exclude items as there is no agreed upon criterion or universal cut off to determine content validity (6).

Figure 4: How we calculated the denominators for R1and R2



4.2. Part-two (qualitative)

In the qualitative part of the study, the representativeness of IAM-v2011 items was evaluated. To better know the participants and interpret the qualitative data, the interviews

started with general questions, e.g., to explore participants' experience with educational email alerts and continuing medical education activities.

Design: A qualitative descriptive study was conducted through semi-structured face to face interviews with family physicians. The purpose of qualitative descriptive studies is: to discover new meaning, to describe what exists, and to categorize information (95). According to O'Toole, qualitative research deals with phenomena that are difficult to quantify statistically, such as personal experiences, beliefs, and meanings, and descriptive research provides an accurate description of characteristics of a particular individual, situation, or group.

Participants: An invitation to participants in a semi-structured one-to-one interview was sent by email to 269 family physicians, members of the Department of Family Medicine at McGill University, working in the Greater Montreal Area. A contest for a 100$ gift card was offered to encourage participation in the study. In total, 17 family physicians agreed to participate, and 15 were interviewed. Two did not complete the interview: one had no experience with the IAM-v2011 and one was not available. The selection criteria were; (i) family physicians, who are (ii) in practice, (iii) working in Greater Montreal Area, (iv) receiving educational email alerts (e.g. daily POEM alerts) and (v) rating POEMs using IAM.

Setting: Family Medicine, Montréal.

Data collection: Participants received an email with a brief lay summary of the study, the time and date of the interview. Before interviews, participants signed consent forms which we kept in a secured drawer. While focus groups can be used in content validation studies (9), we decided to conduct semi-structured face-to-face individual interviews because we were interested mainly in individual experience and perception of the use of the IAM linked to educational

emails. Interviews were recorded using two digital recorders to avoid accidental data loss. Then, interviews were entirely reviewed and transcribed (on the same day of the interview).

The interviews started with four demographic questions followed by four questions that assessed participants' experience with emails in general and educational emails in particular. In addition, participants were asked three questions about their preferences for CME activities including one question about their perception of the advantages and disadvantages of educational emails (see interview guide, appendix 6). Then, for each IAM-v2011 item, participants were asked about its representativeness as follows: (i) I started by explaining each construct and the definition of this construct, (ii) each participant was asked to read the construct and the corresponding items on paper, (iii) for each construct, the participant was asked whether the items were suitable to that construct. For example, I asked whether they would add, modify or delete some items if they had the option to do so and the reasons behind their opinions. Finally, I asked how educational email alerts and IAM-v2011 can be improved.

Data analysis: Interviews were transcribed, revised, summarized and analyzed, and then a deductive-inductive thematic analysis was conducted (82). Thematic analysis is a search for themes that emerge because of their importance to the description of the phenomenon under study (96). The inductive process involves the identification of emerging or new themes through "careful reading and re-reading of the data" (97). To this end, I assigned preliminary themes based on the ACA-LO theoretical model (theory-driven) and the interview guide, and then I searched for themes that emerged during interviews. The inductive process involved the identification of themes through careful reading and re-reading of the data in six sessions.

The coding process was conducted in six stages (82).

(1) We developed the code manual. For each code, the manual contains: (i) the code label or name, (ii) the definition of what the theme concerns, and (iii) a description of how to know when the theme occurs. The manual was based on the interview guide, the theoretical model, and the emerging codes. It contained code labels and definitions such as; PCI#^{n} for items belonging to the construct of 'positive cognitive impact construct', NCI#^{n} for items belonging to the construct of 'negative cognitive impact', IU#^{n} for the items belonging to the construct of 'information use', HB#^{n} for the items belonging to the construct of 'health benefits', P for participants, NRI#^{n} for new recommended items, D for delete, and M for modify. The manual is presented in Appendix 7.

(2) We tested the reliability of the codes, because determining the applicability of codes to the raw information is an essential step in the development of a useful framework in the analysis (98). Following the coding process of the documents and using predefined codes, my supervisor (PP) independently coded the documents. There were no disagreements between coders. In addition, my co-supervisor (RG) reviewed the documents that contained the meaningful transcriptions, themes, and codes, for example (i) meaningful feedback from the interviews (see box 1), (ii) the code manual (see appendix 6), (iii) the coded themes (see table 5), (iv) the table connecting the patterns of codes (see table 6). There were only minor revisions to the codes, e.g., 'family physicians' was replaced by 'participants'.

(3) We summarized the data and identified the initial themes. The process of interpreting (e.g., paraphrasing) each piece of data enters information "into your unconscious, as well as consciously processing the information" (98). This process involved listening to the recordings three times, reading the transcripts six times, summarizing the raw data and

revising summaries three times. For each interview, I did the listening followed by transcription on the same day as the interview, while the summary was done for all interviews at once (see box 1). For each construct, my supervisor (PP) checked the coherence between transcriptions and summaries. The summaries were presented to my co-supervisor and the members of Information Technology Primary Care Research Group (ITPCRG). ITPCRG is a group of researchers founded in 2007 to promote research and teaching of health informatics in primary health care (http://itpcrg.pbworks.com/w/page/9565915/FrontPage).

Box 1: Example of the summarized transcripts for the "positive cognitive impact" construct

1-My first comment was on the first one it is very rare that I would change my practice based on a single piece of information. I would say that is better phrase this in that I just went through (will cause me to re-evaluate my practice) okay? So, I will not say you change it now, I would say more valid question in my mind, and whatever this was that it just has caused me to initiate a re-evaluation practice.

2-It is in the same direction but I would say subset to be more specific, because we have the same set of questions for everything and what comes up more than anything is the new question, so the idea you are motivated to learn more about hypertensive medications it's not like saying I'm motivated to me know learned why the new antihypertensive medications can't be used in this patient, is more like I'm motivated to go find the answer to the question about why this medication should be used in black people members that's the only thing

3-This information confirms, I'm reassured, for me is the same. I would remove that one.

4-I do not know, I may remove the last one (I'm reminded of something I already knew). It seems that it gives the same meaning of I learned something new. If you give me something new, it implies reminding me of something I already knew.

5-My practice will be changed and improved, I do not know how to judge my practice changed and improved? Because I have new information, I come here to my clinic and use this information, will this improve my practice? I do not know, I have to try it first, it seems to me that this. Diagnostic approach, if the article about diagnostic approach, I may be doing another test, but my practice in general will be improved, it is a big word, practice is very wide, I will say, yes I'm planning to use this information, more than my practice will be changed and improved, I will use, I will say.

6-I'm motivated to learn more, who can benefit from this information? I may be motivated to do this but I do not have the time. I'm always motivated to learn more but it may happen may not, I do not know, it is according to me.

7-I will remove (I'm reassured), I do not know what to do with this? I do not understand it.

8-In terms of my practice has changed and improved, I do not think it is important to have these choices; diagnostic, therapeutic, prevention or prognosis. To simplify for people I would literally leave a box where you can say what changes. It does not have to be long

9-I'm learned something new and I'm motivated to learn more, I'm thinking if you learn something new you going to read about it more. I would say that you could put both together

10-I'm learned something new and I'm motivated to learn more, I'm thinking if you learn something new you going to read about it more. I would say that you could put both together

(4) We applied a template (theory-driven and interview guide-driven) of codes and additional emerging codes for the meaningful themes. For example the code manual included, (i) theory-driven codes (e.g. PCI, NCI, IU, HB), (ii) interview guide-driven codes (e.g. K, D, M, P, NRI), and (iii) emerging codes (e.g. MR, KD, MRA, KA). Themes were extracted from the meaningful units of the summarized text, and then codes were applied to the extracted themes and tabulated for each construct. A table that contains codes, themes, and text summary was created for each construct (see table 5)

Table 5: Applying the codes to the construct of "positive cognitive impact"

	Items	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15
PCI	1	K	K	M change to re-evaluate	K	M Planning to use	KD Long time	M Not clear	KD Long time	K	K	K	K	KD Time	KD Time	K
	2	K	K	K	K	K	MR 2,3 Same	K	K	K	K	K	K	K	K	K
	3	K	K	M The same topic	K	D No value	MR 2,3 Same	M Same topic	KA Link	K	K	K	K	D Not clear	K	K
	4	K	K	K	K	K	MR 4,5,6 Same	K	K	K	D or MR 4,5 Same	K	K	K	K	K
	5	K	K	D Repetitive (4)	K	D Redundant	MR 4,5,6 Same	M CME or understand Specify	K	K	D or MR 4,5 Same	K	K	K	D Same as (4)	K
	6	K	K	K	D Repetitive (2)	D Redundant	MR 4,5,6 Same	K	K	K	K	K	K	K	D Same as (4)	K
NRI								I have new information to share and discuss with other colleagues and as teaching material	To host a discussion forum for the hot topics.	It helped me to teach						I would use this information as a reminder

P = physician, K = keep, KD = keep + delete sub-items, KA = keep and add, M = modify, MR = merge, D = delete

(5) We connected the codes in accordance with the process of discovering themes and patterns in the data (99). We applied codes for each item in a table that contained all the constructs and their items. Colored highlights were applied to each code. The colored highlights enabled us to discover the patterns of our collected data (see table 6). For

example, we identified (i) item-related, (ii) construct-related and (iii) ,participant-related patterns (e.g. on the one hand, participants who like a construct gave the whole construct the "Keep" theme, this was assigned as a "construct-related" pattern, on the other hand, for participants who gave the "keep" theme for all the items, this pattern was assigned a "participant-related" pattern. The rest of the codes were assigned "item-related" patterns, which was our main interest. As we were interested in the ecological content validity of the items, construct-related and participant-related patterns were excluded. We used the item-related meaningful feedback for the final analysis.

Table 6: Connecting codes and applying colored highlights to discover patterns

Construct	Items Number	Participants (Interviewee)														
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15
Positive Cognitive impact items	1	K	K	M[1]	K	M[3]	KD[9]	M[14]	KD[18]	K	K	K	K	KD[22]	KD[23]	K
	2	K	K	K	K	K	MR 2,3[10]	K	K	K	K	K	K	K	K	K
	3	K	K	M[2]	K	D[6]	MR 2,3[10]	M[15]	KA[19]	K	K	K	K	D[24]	K	K
	4	K	K	K	K	K	MR 4,5,6[11]	K	K	K	D or MR 4,5[22]	K	K	K	K	K
	5	K	K	D[3]	K	D[7]	MR 4,5,6[12]	M[16]	K	K	D or MR 4,5[22]	K	K	K	D[26]	K
	6	K	K	K	D[4]	D[8]	MR 4,5,6[13]	K	K	K	K	K	K	K	D[26]	K
New recommended items								1	2	3						4
Negative Cognitive impact	7	K	M[1]	M[2]	K	M[3]	MRA[8]	M[9]	K	K	K	K	K	K	K	K
	8	K	M[1]	M[3]	K	M[3]	MRA[8]	K	K	K	K	K	K	K	K	M[16]
	9	K	M[1]	K	M[3]	M[3]	MRA[8]	K	K	K	M[12]	K	K	K	K	K
	10	K	M[1]	D[4]	K	D[7]	MRA[8]	D[10]	K	K	D[13]	K	K	K	K	K
New recommended items								1		2			3		4	5
Information use	11	K	M[1]	K	K	K	MR 1,2,3[8]	M[11]	K	D[14]	M[18]	D[21]	K	D[22]	K	K
	12	K	M[1]	K	K	D[7]	MR 1,2,3[8]	K	K	M[13]	MR 2,4[19]	K	K	D[22]	K	K
	13	K	M[1]	K	K	K	MR 1,2,3[8]	K	K	D[14]	D[20]	K	K	D[22]	K	K
	14	K	M[1]	M[2]	K	D[7]	MR 4,5[9]	M[12]	K	K	MR 2,4[19]	K	K	D[22]	K	K
	15	K	M[1]	K	D[5]	D[7]	MR 4,5[9]	M[13]	K	K	K	K	K	D[22]	K	K
	16	K	M[1]	K	K	D[7]	MR 6,7[10]	K	K	K	K	K	K	D[22]	K	K
	17	K	M[1]	D[3]	K	D[7]	MR 6,7[10]	K	K	D[17]	K	K	K	D[22]	K	K
New recommended items				1	2											3
Health Benefits items	18	K	K	M[1]	K	K	K	D[4]	K	D[5]	K	K	K	K	K	K
	19	K	K	K	K	K	K	D[4]	K	D[5]	K	K	K	K	K	K
	20	K	K	M[2]	K	K	K	D[4]	K	D[5]	K	K	K	K	K	K
New recommended items						1						2		3		4

K = keep, D = delete, M = modify, MR = merge, KD = keep and delete sub-items, P = physician, MRA = merge and add, KA = keep and add

(6) We corroborated and legitimated coded themes, especially the item-related codes. This stage illustrates the process of further clustering the coded themes that were previously identified from the summarized text (100). We set out to study the representativeness of all IAM-v2011 items, thus we identified the item-related coding patterns, and then clustered the codes for each item. These themes were used to achieve our final results

(e.g. for PCI#1, there were three KD (keep main item and delete sub-items), two D (delete), and one M (modify)).

Finally, for each item, my supervisor and I compared our final decision based on item-related codes. I prepared two tables: (i) one table contained the clustered item-related codes, and (ii) one table contained the themes extracted from the data summary for each item. I prepared a paper copy of the tables and presented them to my supervisors and other ITPCRG members. A time was given to discuss each item, and then one week was given to the six ITPCRG members to read, revise and submit their final decisions regarding each item. A week later, we had a prolonged discussion in which we arrived at a final decision for each item given all possibilities. The final decision was based on a consensus of participants of the ITPCRG.

For each construct (four initial themes), there were four possibilities in the deductive phase:

(1) Addition of a new item.

(2) Deletion of an item.

(3) Modification of an item.

(4) No change.

In addition, another four possibilities emerged in the inductive phase:

(5) Merge two or more items.

(6) Merge two or more items and add a new part

(7) Keep the main item and delete sub-items

(8) Keep the main item and add a new sub-item

For each construct a matrix was created which contained the codes and themes collected from participants. Each item was assigned to one of these eight possibilities.

4.3. Part-three (Integration)

Mixed methods convergent design was used to enable us to calculate the relevance, and understand the representativeness of all IAM-v2011 items. The integration process was a triangulation in which both qualitative and quantitative data were combined, integrated and compared, and then an expert panel discussion was conducted with the ITPCRG members. For excluding items, priority was given to the quantitative data received from thousands of physicians, as in the qualitative part, only 15 physician interviews were conducted.

4.3.1 Combination and integration of the quantitative and the qualitative results:

In this stage, a matrix was created that contained all the IAM-v2011 items, and I tabulated the relevance and representativeness of each item. In addition, suggested modifications and recommended new items were added to the matrix.

4.3.2 Expert panel discussion:

In this stage, Items with questionable relevance or representativeness were identified and modified based on discussions with my supervisors and other ITPCRG members. Items with low relevance were identified and deleted; items with low representativeness were identified and discussed with my supervisors and ITPCRG members. The clarity and language of all items was discussed and reviewed by my supervisors. A final decision regarding each item was taken by ITPCRG members.

The triangulation of quantitative and qualitative showed two patterns (e.g. convergence and divergence). First, convergent triangulation refers to a pattern in which the final decision regarding one item was the same based on concordance between quantitative and qualitative

results. For example, the final decision for item 2 (PCI#^{2}) was "keep" based on concordance between qualitative (keep) and quantitative (keep) results, and the final decision for item 13 (IU#^{3}) was "delete" based on concordance between quantitative (delete) and qualitative (delete) results. So for items 2 and item 13, there was convergence triangulation, meaning concordance between the quantitative and the qualitative results. Second, divergent triangulation refers to a pattern in which the decision regarding an item was based on discordance between quantitative and qualitative results. For example, the final decision for item 1 (PCI#^{1}) was "delete" based on discordance between the quantitative (delete) and the qualitative (keep) results, and the final decision for item 3 (PCI#^{3}) was "keep" based on discordance between the quantitative (keep) and the qualitative (delete) results. So for items 1 and 3 there was divergent triangulation, meaning discordance between quantitative and qualitative results (Table 7).

Table 7: Triangulation of quantitative and qualitative results (e.g. convergence and divergence)

Item	Quantitative result	Qualitative result	Final decision	Triangulation pattern
Item 2: (I learned something new)	Keep	Keep	Keep	Convergence (Concordance)
Item 13: (I did not know what to do, and I will use this information to manage this patient)	Delete	Delete	Delete	
Item 1: (My practice will be changed and improved)	Delete	Keep	Delete	Divergence (Discordance)
Item 3: (I'm motivated to learn more)	Keep	Delete	Keep	

RESULTS

The study was conducted in three parts as shown in the methods section. I present the results corresponding to these three parts. In part one; I will present the relevance ratios of the IAM-v2011 items in relation to their main construct. In part two; I will present the qualitative findings about the representativeness of IAM-v2011 items. In part three; I will present the combination and integration of the results from part one and part two, and the results of a discussion with experts regarding IAM items, which led to the IAM-V2014.

5.1. Results from Part one (quantitative)

As mentioned, two relevance ratios (R1 and R2) were calculated (for each IAM-v2011 item) using the following formulas. An item was deemed relevant when the R1 or R2 ratio was 10% or greater:

Equation 5.1: R1 Ratio

$$R1 = \frac{\text{The number of completed questionnaires (where the item was selected)}}{\text{The total number of items selected for the the same construct in all the completed questionnaires}}$$

Equation 5.2: R2 Ratio

$$R2 = \frac{\text{The number of completed questionnaires where the item was selected}}{\text{Total number of questionnaires (where at least one item in that construct was selected)}}$$

As shown in table 8, I had three different levels of relevance described as follows:

First, sixteen items had a value of R1 and R2 of greater than 10%, so they were kept in the new version; IAM-V2014 (see table 8: items without highlight).

Second, the value of R1 and R2 for two items was borderline (see table 8: items with yellow highlight);

1- Item#10 (NCI#[4]) of the negative cognitive impact construct (This information is potentially harmful); by a percentage 9.8% for R1 and 11.4% for R2 with a mean 10.6%.
2- Item#17 (IU#[7]) of the information use construct (I will use this information to persuade this patient, or to persuade other health professionals to make a change for this patient) by a percentage 8.5% for R1 and 12.4% for R2 with a mean 10.4%.

The final decision for those two items was to keep both in the new version; IAM-V2014 (see table 8: items with red highlight).

Third, two items showed low relevance;

1- Item#1 (PCI#[1]) of the positive cognitive impact construct (My practice will be changed and improved); by a percentage 3.6% for R1 and 4.9% for R2.
2- Item#13 (IU#[3]) of the information use construct (I did not know what to do, and I will use this information to manage this patient); by a percentage 2.1% for R1 and 3.1% for R2.

The final decision for items #1 (PCI#[1]) and #13 (IU#[3]) was to delete both from the new version; IAM-V2014.

Table 8: Calculation of relevance (R1 and R2 ratios) and decision for each IAM-v2011 item

CONSTRUCT	Total number	R1	R2	Final decision
COGNITIVE IMPACT				
A) Items of positive cognitive impact:		(315,872)	(234,196)	
1. My practice will be changed and improved.	113,80	3.6%	4.9%	Remove
2. I learned something new.	135,055	42.8%	57.7%	Keep
3. I'm motivated to learn more.	51,763	16.4%	22.1%	Keep
4. This information confirmed I did (am doing) the right thing.	39,383	12.5%	16.8%	Keep
5. I am reassured.	43,835	13.9%	18.7%	Keep
6. I am reminded for something I already knew.	34,456	10.9%	14.7%	Keep
COGNITIVE IMPACT		R1	R2	
B) Items of negative cognitive impact:	Total number	(7,832)	(6,742)	Decision
7. I am dissatisfied.	4,190	53.5%	62.2%	Keep
8. There is a problem with the presentation of this information.	1,478	18.9%	21.9%	Keep
9. I disagree with the content of this information.	1,289	16.5%	19.1%	Keep
10. This information is potentially harmful.	766	9.9%	11.4%	Keep
APPLICATION	Total number	R1 (66,170)	R2 (45,394)	Decision
1. As a result of this information I will manage this patient differently.	10,460	15.8%	23.1%	Keep
2. I had several options for this patient and I will use this information to justify a choice.	15,944	24.1%	35.1%	Keep
3. I did not know what to do, and I will use this information to manage this patient.	1,378	2.1%	3.0%	Remove
4. I thought I knew what to do, and I used this information to be more certain about the management of the patient.	6,752	10.2%	14.9%	Keep
5. I used this information to better understand a particular issue related to this patient.	7,894	13.5%	17.4%	Keep
6. I will use this information in discussion with this patient or with other health professionals about this patient.	18,135	27.4%	40.0%	Keep
7. I will use this information to persuade this patient, or to persuade other health professionals to make a change for this patient	5,607	8.5%	12.4%	Keep
HEALTH BENEFITS	Total number	R1 (46,931)	R2 (38,753)	Decision
8. This information will help to improve this patient's health status, functioning or resilience (i.e. ability to adapt to significant life stressors)	12,935	27.6%	33.4%	Keep
9. This information will help to prevent a disaese or worsining of disease for this patient.	13,522	28.8%	34.9%	Keep
10. This information will help to avoid unnecessary or inappropiate treatment, diagnostic procedures, preventive interventions or a referral of a patient.	20,474	43.6%	52.8%	Keep
CLINICAL RELEVANCE		R1 (234,193)	Decision	
1- Totally relevant	82,368	35.2%	Keep	
2- Partially relevant	85,227	36.4%	Keep	
3- Not relevant	66,500	28.4%	Keep	

Based on the qualitative data analysis, two items were deleted and 21 items were kept in the new IAM version (IAM-V2014) (see box 2).

Box 2: IAM-V2014 draft based on the results of part 1

Construct: Cognitive Impact

A) Positive cognitive impact items:

1. I learned something new.
2. I'm motivated to learn more.
3. This information confirmed I did (am doing) the right thing.
4. I am reassured.
5. I am reminded for something I already knew.

B) Negative cognitive impact items:

1. I am dissatisfied.
2. There is a problem with the presentation of this information.
3. I disagree with the content of this information.
4. This information is potentially harmful.

Construct: Application

1. As a result of this information I will manage this patient differently.
2. I had several options for this patient and I will use this information to justify a choice.
3. I thought I knew what to do, and I used this information to be more certain about the management of the patient.
4. I used this information to better understand a particular issue related to this patient.
5. I will use this information in discussion with this patient or with other health professionals about this patient.
6. I will use this information to persuade this patient, or to persuade other health professionals to make a change for this patient

Construct: Health Benefits

1. This information will help to improve this patient's health status, functioning or resilience (i.e. ability to adapt to significant life stressors)
2. This information will help to prevent a disease or worsening of disease for this patient.
3. This information will help to avoid unnecessary or inappropriate treatment, diagnostic procedures, preventive interventions or a referral of a patient.

Construct: Clinical Relevance

1. Totally relevant
2. Partially relevant
3. Not relevant

5.2. Results from Part two (qualitative)

In this part, the representativeness of IAM-v2011 items was evaluated. I interviewed 15 family physicians working in the Greater Montreal Area (nine males and six females). Nine participants were working in academic health science centres, university, and teaching units while the other six were working in community and private clinics. The participants' number of years in practice ranged from 9 to 38. Five participants indicated no clinical focus to their practice, while 10 expressed special interests such as maternity and newborn care (n=3), care of the elderly (n=3), adult care (n=2), and global health (n=1) (see table 9).

All interviews (except one) were done face-to-face in participants' offices. The participants were welcoming and co-operative. 11 of 15 gave adequate time for the interview while four seemed rushed. All interviewees answered all my questions about each IAM-v2011 item and its relation to its construct. For example, they all answered whether they would add, modify or delete some items if they had the option to do so.

The interview was conducted in two parts. First, participants were asked three questions about their knowledge, attitude and behaviour regarding emails in general and educational email in particular, and then they were asked about their CME activities and preferences. Second, participants were asked specific questions about each IAM-v2011 item and its relevance to the main construct, and then participants were asked a specific question about the "relevance" construct. Finally participants were asked for their recommendations to improve educational email.

Table 9: Participants' demographic data

Participant	Speciality	Years of practice	Special interest	Work setting
1	Family physician	32	No	**Private office**
2	Family physician	38	No	**AHSC (university affiliated teaching hospital)**
3	Family physician	36	No	**Private office**
4	Family physician	34	Healthcare of the elderly Home care	**AHSC**
5	Family physician	12	Hospital medicine	**Private office**
6	Family physician	7	Maternity and newborn care Tropical and travel medicine	**AHSC**
7	Family physician	35	Global health Healthcare of the elderly Mental health Family care giving	**University Affiliated Teaching Hospital**
8	Family physician	20	Maternity and newborn care Obstetrics /Gynecology	**AHSC (University)**
9	Family physician	20	Maternity and newborn care Immigration and refugees	**Community clinic** **AHSC (Family Medicine Teaching Unit))**
10	Family physician	30+	Adult ADHD	**Private office**
11	Family physician	37	No	**AHSC (University)**
12	Family physician	31	No	**AHSC**
13	Family physician	9	Healthcare of the elderly Hospital medicine Diabetic foot and wound clinic	**AHSC (University)** **Nursing home**
14	Family physician	9	HIV and STD	**Private office**
15	**Family physician**	**23**	**Child and adolescent health**	**Private office**

5.2.1 Results of the first part of the interview

To better understand the participants, I asked four questions that assessed their experience (knowledge, attitude, and behaviour) with emails in general and educational emails in particular. In addition, participants were asked three questions about their preferences for CME activities including one question about their perception of the advantages and disadvantages of educational emails. The results for this section were as follows:

5.2.1.1 ***Participants' knowledge about email***: on the one hand, 13 of 15 participants said that they are familiar with email and check their email from one to four times per day, they

use email for clinical, educational and personal purposes. Regular users receive from 10 to 100 emails per day; two of them use smartphones to check their email. On the other hand, two participants do not use email regularly because of the lack of time, they check their email two or three times a week, and use it just for personal communication. Their reasons for not using emails regularly were: (i) limited time because of family obligations, and (ii) aging related issues such as familiarity with technology and vision problems.

5.2.1.2 ***Participants' attitude towards emails***: nine participants feel comfortable with, and like email, four expressed a neutral attitude, while three dislike or feel overwhelmed by emails in general. Three participants said they are not overwhelmed by email, while two participants mentioned that they are overwhelmed by the volume of emails. Just one participant expressed a concern regarding patient confidentiality when using email in communication with patients.

5.2.1.3 ***Participants' behaviour when receiving emails***: all the participants mentioned that they (i) scan email by reading the title, (ii) prioritize email according to their importance, (iii) reply to the urgent emails (e.g. emails that require immediate reply), (iv) delete irrelevant emails and (v) keep the others when they have time to read and reply if required. Thirteen participants mentioned that they archive important emails in a folder, while two participants said that they delete all emails after reading. Regarding the participants' behaviour towards educational email (e.g. daily POEMs), all 15 participants mentioned

they follow the same procedure for educational email as for regular email (e.g. scan, prioritize, reply, etc.).

5.2.1.4 ***Participants' continuing medical education (CME) activities***: participants are involved in different kinds of continuing medical education activities such as: (i) conferences and forums (n: 13), (ii) online activities (e.g. journals, video conferences and emails) (n: 11), (iii) reading (e.g. journals, books and magazines) (n: 9), (iv) teaching and academic activities (n: 9), (v) journal clubs and lunch time meetings (n: 4), (vi) university courses and one day courses (n: 3), and (vii) hospital rounds (n: 3). Regarding preferences for continuing medical education activities: (i) six participants mentioned that they have no specific preference, (ii) five participants expressed an interest in web-based educational activities (e.g. educational emails, searching Electronic Knowledge Resources, and reading online journals), (iii) three participants expressed interest in conferences and clinical rounds , (v) and just one participant expressed interest in reading magazines and journals.

5.2.1.5 ***Advantages of educational emails***: participants mentioned a wide range of advantages such as: (i) educational emails are time convenient (e.g. it is brief and comprehensive and can be read anytime) (n: 11), (ii) educational emails contain valid information they can trust (n:5), (iii) the users have the option to use or not to use the information included in the educational emails (e.g. emails can be deleted easily) (n:4), (iv) participants do not have to look for information, educational emails offer ready and validated information (e.g. save time and cognitive effort) (n:4), (v) educational emails contain brief clinical

synopses (n:3), (vi) educational emails are an easy way to disseminate information (n:2), (vii) educational emails broaden the spectrum of participants' knowledge (n:2), (viii) educational emails are regularly sent at a specific time (e.g. educational programs are continuous) (n:2).

5.2.1.6 ***Disadvantages of educational emails***: (i) three participants mentioned no disadvantages for educational emails, (ii) six participants mentioned that emails are overwhelming (e.g. emails are difficult to manage, and participants miss important emails because of the huge number they receive), (iii) two participants mentioned that educational emails are not relevant to their practice, (iv) others offered a variety of disadvantages such as; too expensive, resembles commercial emails, time consuming, and reviewers of educational emails are not professional.

5.2.2. Results from the second part of the interview

In the second part of the interview: (i) I started by asking specific questions about the IAM-v2011 items, for example, whether the items are representative of their main construct, and if the participant has the option to add, modify or delete items, what would he like to do? (ii) I then asked specific questions about the clinical relevance construct. For example, what is the participants' understanding of this construct, and what could be a good example of the item 'partially relevant' (iii) finally I asked the participants about their recommendations to improve educational emails.

5.2.2.1 The results for IAM-v2011 items

1) Item 1 (PCI#1: *My practice is (will be) changed and improved*): This item was removed based on its low value of R1 and R2. I found no explanation to support this decision in the qualitative part. As four participants (P6, P8, P13, and P14) expressed disagreement with the sub-items, but not with the main item, a new theme was developed based on their opinions; "keep the main items and delete the sub-item (coded as KD)".

   Decision: The final decision was to delete this item.

2) Item 2 (PCI#2: *I learned something new*): The only meaningful comment received was to merge it with item PCI#3 (P6, MR (merge) 2 and 3: "I'm thinking if you learn something new you are going to read about it more, I would say that you could put both together". The two items express different types of impact; the first addresses the learning value of the information, while the second addresses an expression of interest by the physician. So motivation to learn more and I learned something new cannot be combined in one item.

   Decision: The final decision was to keep this item.

3) Item 3 (PCI#3: *I am motivated to learn more*): The meaningful feedbacks from participants were, firstly make it specific for the information presented (e.g., P3-M (modify): "be more motivated to learn more about this topic"). Logically, participants answer the questionnaire in the context of the presented information

(which may contain one / or many topics), and this may motivate them to learn more regarding one specific aspect of the presented information. Second is to merge it with item 2 (P6, MR (merge) 2 and 3: "Thinking if you learn something new you are going to read about it more". Our interpretation of this comment was presented above in item 2 (PCI#^{2}).

Decision: The final decision was to keep this item.

4) Item 4 (PCI#4: *This information confirmed I did (am doing) the right thing*): Two of fifteen participants suggested to merge it with item 5 (e.g., P6 and P10, D (delete) or MR (merge) 4 and 5: 'These items look the same for me' I'm reassured because this information confirmed I'm doing the right thing, so you can delete or combine them. However, these two items can be chosen separately. For example, physicians can be reassured when they receive information that a particular medication does not work or when they do not currently prescribe this treatment. If I combined both items, we will lose an aspect of the cognitive impact of information.

   Decision: The final decision was to keep this item.

5) Item 5 (PCI#5: *I am reassured*): There were two different opinions regarding this point. First, to remove it as it adds nothing new (P3, D (delete): 'This information confirms, I'm reassured, for me is the same'). Second, to merge it with item 4 (e.g., P10, D (delete) or MR (merge) 4 and 5: 'These items look the same for me' I'm reassured because this information confirmed I'm doing the right thing, so

you can delete or combine). The two opinions have the same origin, and the reason for keeping both as individual items was presented in item 4.

Decision: The final decision was to keep this item.

6) Item 6 (PCI#6: *I am reminded of something I already knew*): Three participants suggested deleting it (e.g., P4, D (delete) : 'the same meaning of I learned something new', P5, D (delete) : 'If I'm reminded it does not mean I'm going to use it, so it does not mean anything', and P14, D (delete) : 'I'm reminded, I am reassured, this information confirms, are the same thing'). First, learning something new is not the same as being reminded of something that is already known. Second, assessing the reminding aspect of information is separate from assessing the application of information. Third, the context of being reminded is different from being reassured or believing that one is doing the right thing (confirmation).

   Decision: The final decision was to keep this item.

7) Item 7 (NCI#1: *I am dissatisfied*): Four of fifteen participants recommended to modify it (e.g. P3, M: 'Instead of dissatisfied, I would use 'useful, not useful, minimal usefulness', P5, M (modify): 'change the font to bold or italic', P6, MRA (merge and add): 'you are either happy and say why or not?' and P9, M (modify): 'I think dissatisfaction needs to be quantified, highly, moderate, or '). These recommended modifications would narrow the spectrum of assessing information; in addition, modification of the font would bias our questionnaire.

Decision: The final decision was to keep this item.

8) Item 8 (NCI#2: *There is a problem with the presentation of this information*): Four of the fifteen participants recommended minor modifications (e.g. P3, M (modify): 'presentation is not clear, it could mean the font or the context', P5, M(modify): 'change the font to bold or italic', P6, MRA (merge and add): 'you are either happy and say why or not?' and P15, M (modify): 'I would delete too technical' sub-item). Some of these recommendations are already included in other items; other recommendations would reduce the value of this item that assesses the "presentation" aspect of information.

   Decision: The final decision was to keep this item.

9) Item 9 (NCI#3: *I disagree with the content of this information*): Four of fifteen participants recommended minor modifications (e.g. P4, M (modify): 'should be able to ask about facts not the contents', P5, M (modify): 'change the font to bold or italic', P6, MRA (merge and add): 'either happy and say why or not happy and say why', and P10, M (modify): 'I'm not sure, I disagree with what? I would modify it I will write that: I disagree with the outcome or the methodology, which would be my comment'). The decision around these proposed modifications was presented in item 8.

   Decision: The final decision was to keep this item.

10) Item 10 (NCI#4: *This information is potentially harmful*): Four participants of fifteen recommended deleting this item (e.g. P4, D (delete): 'This destroys trust, the situation where somebody sent you information to be harmful', P5, D (delete): 'I do not know why somebody will answer this question; it comes from experts, to family physicians', P7, D (delete): 'I do not know what that means and I would not like to include that because POEMs are reviewed by experts', and P10, D (delete) 13: 'I do not know what you mean. It is a study that is published in CMAJ, and I would remove it because I do not know what is behind this"). Assessing the harmful aspects of information is as important as assessing the beneficial aspects, so this item is important to maintain trust in the educational system. In addition, this item gives the experienced clinician a chance to report any harm that may appear as a consequence of applying the information, for example using this item enables family physicians to report their 'experiential expertise' in assessing educational information (3).
Decision: The final decision was to keep this item.

11) Item 11 (IU#1: *As a result of this information I will manage this patient differently*): Two participants suggested modifying this item (e.g. P7, M (modify): 'I may use this information to manage the patient differently' and P10-M (modify): 'I will not manage the patient differently; I will consider management of the patient differently') and three participants suggested to delete or merge this item (e.g. P9, D (delete): 'I will not manage the patient differently based on information I receive in an email', P6, MR (merge) 1, 2,3: 'the first three are

pretty much the same, for those three could be together as one', and P11, D (delete): 'I would like to delete that one; I will use this information to manage the patient differently' The first two comments reveal the uncertainty regarding the use of information. I will; indicate different meaning (e.g. the desire, purpose, or determination, especially of one in authority, deliberate intention or wish), so all the recommended meanings are already included in the literal meaning of the item. Regarding the second comment, many physicians report using information to manage their patient in a different way. So this type of use is an important aspect of the information to be assessed. Finally, this item showed relevance ranging from 16% to 23% for R1 and R2 respectively.

Decision: The final decision was to keep this item.

12) Item 12 (IU#2: *I had several options for this patient, and I will use this information to justify a choice*): One participant recommended its modification to be in the context of the provided information (e.g. P9, M (modify): 'depends on the context of the information received'). However, it is clear that the IAM questionnaire is provided in the context of the information delivered. Three participants recommended deleting or merging it (e.g. P6, MR (merge) 1, 2, and 3: 'the first three are pretty much the same, for those three could be together as one', P5, D (delete): 'I will keep only two; the first and the third, the rest are very similar', P10, MR (merge) 2 and 4: 'I thought I knew what to do, and I had several options - for me it is pretty much the same'). This item is assessing an important aspect of information as a complementary piece of knowledge that

physicians' need to make the right choices. Merging or deleting this item will lose this aspect.

Decision: The final decision was to keep this item.

13) Item 13 (IU#3: *I did not know what to do, and I will use this information to manage this patient*): A decision to delete this item was made following the quantitative analysis and analysis of interviews provided an explanation. Five participants recommended this item be deleted, merged or modified (e.g. P9, D (delete): ' it is redundant; it gives the same meaning as the first', P10, D (delete): 'I will not use a study to manage the patient, based on a single study', P13, D (delete): 'I will never change my practice based on just one email', P6, MR (merge) 1,2,3: 'the first three are pretty much the same, for those three could be together as one' and P2, M (modify): ' I would like to make it shorter').

Decision: The final decision was to delete this item.

14) Item 14 (IU#4: *I thought I knew what to do, and I used this information to be more certain about the management of this patient*): Two participants recommended modification (e.g. P3, M (modify): 'I think you should be very specific, e.g., the information confirms my management strategy', P9, M (modify): 'I will use the information to be more comfortable with the management of this patient'), these two comments support the importance of the item and the recommended modification will narrow the spectrum of the item. Three participants recommended the item be deleted or merged (e.g. P5, D

(delete): ‘I will keep only two; the first and the third, the rest are very similar’, P6, MR (merge) 4 and 5: ‘For the fourth and the fifth ones, again sound the same’, and P10, MR (merge) 2 and 4: ‘I thought I knew what to do, and I had several options - for me it is pretty much the same’), but deleting or merging the item will ignore an assessment of the confirmatory value of information.

Decision: The final decision was to keep this item.

15) Item 15 (IU#5: *I used this information to better understand a particular issue related to this patient*): Four participants recommended it be deleted, modified, or merged (e.g. P4, D (delete): ‘It does not really mean application it is a kind of cognitive statement’, P5, D (delete): ‘I will keep only two; the first and the third, the rest are very similar’, P7, M (modify): ‘I will use the information to extend my knowledge’, and P6-MR (merge) 4 and 5: ‘the fourth and the fifth ones, again sound the same’). As mentioned in Grad et al, research-based information can be used in three different ways: (i) Instrumental, (ii) Conceptual and (iii) Legitimating. “Conceptual use involves using research results for general enlightenment” (13). Understanding is the conceptual aspect of information use.

Decision: The final decision was to keep this item.

16) Item 16 (IU#6: *I will use this information in a discussion with this patient, or with other health professionals about this patient*): Two participants recommended I delete or merge this item (e.g. P5, D (delete): ‘I will keep only two; the first and the third, the rest are very similar’, and P6, MR (merge) 6 and 7: ‘For the sixth

and the seventh, I find them so similar'). Information use for patient education is an important aspect of information that needs to be assessed.

Decision: The final decision was to keep this item.

17) Item 17 (IU#7: *I will use this information to persuade this patient or to persuade other health professionals to make a change for this patient*): This item was kept based on the qualitative data analysis. Three participants recommended it be deleted or merged (e.g. P5, D (delete): 'I would keep only two; the first and the third, the rest are very similar', P9, D (delete): 'I can use this information in a discussion but I won't persuade a patient', and P6-MR (merge) 6 and 7: 'For the sixth and the seventh, I find them so similar'). Information use in patient education or professional education is an essential aspect of assessing the value of information. This is the legitimating aspect of information use (13).

18) Item 18 (HB#1: This information will help to improve this patient's health status, functioning or resilience (i.e., ability to adapt to significant life stressors)): One participant recommended its modification (e.g., P3, M (modify): 'I think it's just grammatically incorrect, could be this information will contribute to improved health wellness and functioning'). Health status has a wider spectrum than wellness.

Decision: The final decision was to keep this item.

19) Item19 (HB#2: This information will help to prevent a disease or worsening of disease for this patient): There were no comments regarding this item.

Decision: The final decision was to keep this item.

20) Item 20 (HB#3: This information will help to avoid unnecessary or inappropriate treatment, diagnostic procedures, preventative interventions or a referral, for this patient): One participant recommended its modification (e.g., P3, M (modify): 'this information will help to avoid needless investigations and treatment, usually treatment comes after diagnostic procedure'). Family physicians use their clinical judgment more than investigation to reach a tentative clinical diagnosis and they may use investigations to raise or lower the probability of a suspected diagnosis. For family physicians diagnosis comes before investigation, so the sequence of words in this item is suitable in the context of primary care.

Decision: The final decision was to keep this item.

Table 10: The collective results from the qualitative part

Item number	Code	Item details	Decision
Item 1	PCI#1	*My practice is (will be) changed and improved*	Keep
Item 2	PCI#2	*I learned something new*	Keep
Item 3	PCI#3	*I am motivated to learn more*	Keep
Item 4	PCI#4	*This information confirmed I did (am doing) the right thing*	Keep
Item 5	PCI#5	*I am reassured*	Keep
Item 6	PCI#6	*I am reminded of something I already knew*	Keep

Item 7	NCI#1	*I am dissatisfied*	Keep
Item 8	NCI#2	*There is a problem with the presentation of this information*	Keep
Item 9	NCI#3	*I disagree with the content of this information*	Keep
Item 10	NCI#4	*This information is potentially harmful*	Keep
Item 11	IU#1	*As a result of this information I will manage this patient differently*	Keep
Item 12	IU#2	*I had several options for this patient, and I will use this information to justify a choice*	Keep
Item 13	IU#3	*I did not know what to do, and I will use this information to manage this patient*	Delete
Item 14	IU#4	*I thought I knew what to do, and I used this information to be more certain about the management of this patient*	Keep
Item 15	IU#5	*I used this information to better understand a particular issue related to this patient*	Keep
Item 16	IU#6	*I will use this information in a discussion with this patient, or with other health professionals about this patient*	Keep
Item 17	IU#7	*I will use this information to persuade this patient or to persuade other health professionals to make a change for this patient*	Keep
Item 18	HB#1	*This information will help to improve this patient's health status, functioning or resilience (i.e., ability to adapt to significant life stressors)*	Keep
Item19	HB#2	*This information will help to prevent a disease or worsening of disease for this patient*	Keep
Item 20	HB#3	This information will help to avoid unnecessary or inappropriate treatment, diagnostic procedures, preventative interventions or a referral, for this patient	Keep

5.2.2.2 Construct of "clinical relevance"

I asked specific questions about the relevance construct, specifically the perception of participants with respect to the item "partially relevant". Nine participants interpreted "partially relevant" as follows; they may have read information that covers some aspect of the patients'

condition, or they have a patient who does not exactly fit the provided piece of information. Four participants said that it means nothing, and for them this item can be interpreted as either relevant or not relevant. One participant interpreted "partially relevant" as "relevant", while another participant interpreted it as "not relevant". Nine participants' perception of the "clinical relevance" construct was concordant with our definition, while six participants provided a different meaning. Having said this, the quantitative results showed high relevance of the "partially relevant" item (R ratio 36%), and the final decision was to keep the whole construct including the items.

5.2.2.3 Participants' recommendations to improve educational emails

follows:

1. To make modifications in educational emails for older users (e.g. to use larger font, to highlight the important parts of the text, to use active buttons more than links).
2. To add a description of the reviewers' and writers' affiliations.
3. To have a summary and a link to the article.
4. To use high quality validated research
5. To keep up to date and more relevant information to the clinical practice.
6. Avoid sponsorship by pharmaceutical companies
7. To briefly describe the pathophysiology of the condition
8. To shorten the questionnaire after the article (e.g. IAM questionnaire)
9. To add a link to the old (archived) topics included in previous emails.
10. To maintain the continuity and regularity of the educational programs by email.

11. Reduce the price

12. Avoid highly specialized technical issues

13. Send comprehensive emails that has everything related to the article

14. Add a link to a discussion board on the same topic

15. To receive it at a specific time of the day

16. To clarify the subscription procedure

17. Add a way by which readers can ask questions or send inquiries

18. Concentrate on Canadian issues and relate to the Canadian system.

19. To change the style (appearance) from commercial email.

20. To avoid complex graphics and make it very simple text

21. The IAM questionnaire should be fillable offline then synchronize when connected

22. To have conclusion, synopsis, summary in a separate section

23. To add a printable one page summary

24. To send a reminder email as feedback after a few month.

Based on results from part 2, all of the IAM-v2011 items were deemed representative and no item was deleted. A draft for IAM-V2014 was then created based on the qualitative data analysis (see box 3).

Box 3: IAM-V2014 draft based on the results of part 2

Construct: Cognitive Impact

A) Positive cognitive impact items:

1. I learned something new.
2. I'm motivated to learn more.
3. This information confirmed I did (am doing) the right thing.
4. I am reassured.
5. I am reminded for something I already knew.

B) Negative cognitive impact items:

1. I am dissatisfied.
2. There is a problem with the presentation of this information.
3. I disagree with the content of this information.
4. This information is potentially harmful.

Construct: Applications

1. As a result of this information I will manage this patient differently.
2. I had several options for this patient and I will use this information to justify a choice.
3. I thought I knew what to do, and I will use this information to be more certain about the management of the patient.
4. I will use this information to better understand a particular issue related to this patient.
5. I will use this information in discussion with this patient or with other health professionals about this patient.
6. I will use this information to persuade this patient, or to persuade other health professionals to make a change for this patient

Construct Health Benefits

1. This information will help to improve this patient's health status, functioning or resilience (i.e. ability to adapt to significant life stressors)
2. This information will help to prevent a disease or worsening of disease for this patient.
3. This information will help to avoid unnecessary or inappropriate treatment, diagnostic procedures, preventive interventions or a referral of a patient.

Construct: Clinical Relevance

1. Totally relevant
2. Partially relevant
3. Not relevant

5.3 Results from Part 3 (integration of quantitative and qualitative results)

In this part**,** I integrated the results of quantitative and qualitative data analyses from part 1 and part 2. A matrix that contains the IAM-v2011 items, their relevance, representativeness and a final decision was created (see table 10). A priority was given to the quantitative data because it included feedback from thousands of users, while the qualitative part included data from 15 interviews. Two items with a low relevance ratio (PCI#[1] and IU#[3]) were deleted. All the remaining items were deemed representative after a prolonged discussion with my supervisors and other members of the Information Technology Primary Care Research Group (ITPCRG). No new items were added to the new version of IAM (IAM-V2014). The clarity and the language of all items were discussed and reviewed by my supervisors and ITPCRG members, who are expert in the IAM.

Table 11: The combination and integration matrix

CONSTRUCT **COGNITIVE IMPACT**	**Quantitative results**	**Qualitative results**	**Final decision**
A) Positive cognitive impact items:	**Relevance**	**Representativeness**	**Decision**
1. My practice will be changed and improved.	Delete	Keep	Delete
2. I learned something new.	Keep	Keep	Keep
3. I am motivated to learn more.	Keep	Keep	Keep
4. This information confirmed I did (am doing) the right thing.	Keep	Keep	Keep
5. I am reassured.	Keep	Keep	Keep
6. I am reminded for something I already knew.	Keep	Keep	Keep
B) Negative cognitive impact items:	**Relevance**	**Representativeness**	**Decision**
7. I am dissatisfied.	Keep	Keep	Keep
8. There is a problem with the presentation of this information.	Keep	Keep	Keep
9. I disagree with the content of this information.	Keep	Keep	Keep
10. This information is potentially harmful.	Keep	Keep	Keep
APPLICATION	**Relevance**	**Representativeness**	**Decision**
11. As a result of this information I will manage this patient differently.	Keep	Keep	Keep
12. I had several options for this patient and I will use this information to justify a choice.	Keep	Keep	Keep
13. I did not know what to do, and I will use this information to manage this patient.	Delete	Delete	Delete

14. I thought I knew what to do, and I used this information to be more certain about the management of the patient.	Keep	Keep	Keep
15. I will use this information to better understand a particular issue related to this patient.	Keep	Keep	Keep
16. I will use this information in a discussion with this patient or with other health professionals about this patient.	Keep	Keep	Keep
17. I will use this information to persuade this patient, or to persuade other health professionals to make a change for this patient	Keep	Keep	Keep
HEALTH BENEFITS	**Relevance**	**Representativeness**	**Decision**
18. This information will help to improve this patient's health status, functioning or resilience (i.e. ability to adapt to significant life stressors)	Keep	Keep	Keep
19. This information will help to prevent a disaese or worsining of disease for this patient.	Keep	Keep	Keep
20. This information will help to avoid unnecessary or inappropiate treatment, diagnostic procedures, preventive interventions or a referral for this patient.	Keep	Keep	Keep
CLINICAL RELEVANCE			
21. Totally relevant	Keep	Keep	Keep
22. Partially relevant	Keep	Keep	Keep
23. Not relevant	Keep	Keep	Keep

Based on calculating relevance of each item in the quantitative part and studying the representativeness of each item in the qualitative part of the study, we identified 21 items for IAM-V2014 that showed acceptable relevance and representativeness (see box 4). In addition, the IAM-V2014 push questionnaire is presented in Appendix 10.

Box 4: The IAM-V2014

Cognition Construct

A. Positive cognitive impact items
   1. I learned something new.
   2. I am motivated to learn more.
   3. This information confirmed I did (am doing) the right thing.
   4. I am reassured.
   5. I am reminded for something I already knew.

B. Negative cognitive impact items
   1. I am dissatisfied.
   2. There is a problem with the presentation of this information.
   3. I disagree with the content of this information.
   4. This information is potentially harmful.

Application construct
   1. As a result of this information I will manage this patient differently.
   2. I had several options for this patient and I will use this information to justify a choice.
   3. I thought I knew what to do, and I will use this information to be more certain about the management of the patient.
   4. I will use this information to better understand a particular issue related to this patient.
   5. I will use this information in a discussion with this patient or with other health professionals about this patient.
   6. I will use this information to persuade this patient, or to persuade other health professionals to make a change for this patient

Health Benefits construct
   1. This information will help to improve this patient's health status, functioning or resilience (i.e. ability to adapt to significant life stressors)
   2. This information will help to prevent a disease or worsening of disease for this patient.
   3. This information will help to avoid unnecessary or inappropriate treatment, diagnostic procedures, preventive interventions or a referral for this patient.

Relevance construct
   1. Totally relevant
   2. Partially relevant
   3. Not relevant

Note: See the IAM-V2014 push questionnaire in Appendix 10

DISCUSSION

Our results have produced a content validated version of the IAM for push technology (IAM-V2014, Appendix 10). We conducted a mixed methods study to assess the ecological content validity of the IAM-v2011. Mixed methods research is appropriate to address a research question about a 'real life' issue (90), such as routine rating of educational emails. First, we used quantitative methods to measure the relevance of IAM items; second, we employed qualitative methods to assess the representativeness of these items; third, we integrated results from the quantitative and the qualitative parts.

Table 12: Rules for content validation

Recommendations from the literature	Our content validation study
Careful definition of the main construct and its items subjected to content validation of the assessment instrument.	The main constructs were defined in the interview guide outlining their purpose
Use population (ecological) and expert (logical) sampling for validation of the assessment instrument.	We interviewed 15 family physicians (end-users) and discussed our results with ITPCRG members who are experts in IAM.
Subject all constructs and items of an assessment instrument to content validation.	We measured the relevance and assessed the representativeness of all items
Use multiple judges (users and experts) of content validity and quantify judgments.	We discussed the IAM-V2014 with users and experts
Review for technical quality by measurement specialists.	We received some comments regarding the technical quality of the IAM-v2011 and discussed it with experts
Report the results of content validation when publishing a new assessment instrument.	We will report the results of this study at NAPCRG and publish the outcome (IAM-V2014)
Examine the proportional representation of items.	We interviewed users working in different settings in addition to the experts
Use subsequent psychometric analyses for instrument refinement.	The IAM-V2014 PUSH questionnaire will be implemented in ongoing projects involving more than 10,000 Canadian physicians and pharmacists, which will allow future validation work

Such content validation work is typically a mixed methods research endeavour (91, 92). Utilizing multiple methods (e.g., quantitative and qualitative), and integrating the results obtained by using these methods enhance the final study outcomes (27). In our study, qualitative

data usually supported the decisions regarding each item. In case of divergence, we gave more weight to the quantitative results with respect to decisions such as keeping or deleting an item, because the quantitative sample was so much larger. In addition, our content validation study followed the recommendations suggested in the literature (7, 8, 49) (see table 11).

In part 1 of our study (quantitative), we analysed 234,194 ratings received from 5,596 users of IAM-v2011. Results showed that 21 items of IAM-v2011 are relevant, while two items were deemed irrelevant (items #1 and #13). The irrelevant items were removed from the new version; IAM-V2014. We measured the relevance of each item in relation to its main construct, and calculating the R2 ratio helped us to make a decision regarding two items (item #10 and #17), i.e. to keep them.

In part 2 of our study (qualitative), we interviewed 15 family physicians working in different settings. Most of the participants were familiar with the IAM-v2011 questionnaire; this gave us a chance to discuss the four constructs and their items in detail. Eight participants were working in academic health science centres and had research experience; one of them had a special interest in designing questionnaires, psychometric assessment tools and validity; this gave us valuable information regarding the IAM-v2011 questionnaire. During the process of qualitative data analysis we observed three kinds of patterns: (i) user related pattern, (ii) construct related pattern, and (iii) item related pattern. We used the "item-related" pattern for our analysis and final results as we were mainly interested in studying the IAM-v2011 items. With regard to the qualitative data analysis, we started with four initial themes (deductive phase): (i) addition of a new item, (ii) deletion of an item, (iii) modification of an item, and (iv) no change.

The, four additional themes emerged during the analysis (inductive phase): (i) merging two or more items, (ii) merging two or more items and adding a new part, (iii) keeping the main item and deleting sub-items, (iv) keeping the main item and adding a new sub-item. The qualitative part of our study suggested the 21 items were representative of their constructs.

In part 3 with the ITPCRG members, we reviewed the data analyses and results of part 1 and part 2 separately; then, we combined and integrated the results from part 1 and part 2, and discussed them with experts. Our final results allow us to refine IAM-v2011: two items deleted, no item modified, and no item added. This led us to draft a content validated version of the IAM that we call IAM-V2014 (see appendix 10). The IAM-V2014 contains 23 items: (i) nine items for Cognitive Impact, (ii) six items for Information Use for a Specific Patient, and (iii) three items for Patient Health Benefit, in addition to (iv) three items for Clinical Relevance.

6.1 Limitations of the Study

Limitations of this study will be discussed under two sections: (i) limitations of study design, and (ii) limitations of data analysis.

6.1.1 Limitations of study design

In general, mixed methods design implies some limitations (101) as follows:

1) Mixed methods designs are time consuming and expensive: in our case, data collection took around four months which is reasonable for a Master's thesis.
2) Researchers who do not have experience in both qualitative and quantitative research have to master multiple methods besides knowing how to mix results of those methods:

this challenge provided me with a good opportunity to learn both quantitative and qualitative methods and the integration process.

In addition, the mixed methods research design has specific and separate limitations associated with quantitative and qualitative parts.

6.1.2 Limitations of the quantitative part

Because of a selection bias, our results cannot be generalized. Though our quantitative data included 234,194 questionnaires completed by 5,596 physicians in 2012, the respondents constitute a convenience sample that is not representative of the population of Canadian physicians. For example, participants were more likely familiar with computers and the internet. In addition, there were two minor issues. System errors may produce some ratings collection problems. To our knowledge, there was one system error that appeared in February 2012, when the CMA first implemented IAM-v2011. For a time period of 33 days beginning on February 8, a bug in the online questionnaire caused the CMA to disable the rating of POEMs for a period of 33 days. As a result, POEMs distributed in this time window had about 50% fewer ratings than expected. Finally, the ratings were not collected using a uniform visualization of the IAM questionnaire as the questionnaire was viewed on different platforms and web browsers. However, to our knowledge this did not influence how the questionnaire items were presented to the physician, as the items were the same whatever the platform.

6.1.3 Limitations of the qualitative part

While focus groups are sufficient for content validation (9), we chose to conduct face-to-face interviews for two reasons: (i) we were mainly interested in the participants' individual experience regarding IAM and educational emails, and (ii) it is very difficult to arrange focus group meetings with family physicians given their busy schedule. We faced some difficulties to arrange the interviews, and it took more time than expected. In addition, four participants were able to reply to all interview questions, but had limited time for the interview, which reduced the richness of the qualitative data. The period between the last use of the IAM-v2011 questionnaire and the interview ranged from a few days to a few months, which may affect the qualitative data, but 14 interviewees were familiar with the IAM-v2011 questionnaire items.

6.1.4 Data analysis limitations

In part 1, we chose an R ratio (R1&R2) of less than 10% as our cut-off to question the relevance of IAM items in line with Sridhar et al, 2013 (94). Since there is no agreement upon the relevance ratio to measure content validity in the literature, the adequacy of content validity depends on an appeal to reason of the relevance of items in a particular assessment context (6).

We identified two items (Item#10 (NCI#[4]) and Item#17 (IU#[7])) with border-line R1 ratio (9.8% and 8.5% respectively). For those items we calculated the mean of R1 and R2 and considered the relevance ratio to be 10.6% and 10.4 respectively. The final decision for these items was to keep both in the new version; IAM-V2014.

In part 2, three patterns were discovered during the data analysis: (i) item-related pattern, (ii) construct-related pattern and (iii) participant-related pattern. We used the item-related pattern in our final results, as we proposed to assess the ecological content validity of the IAM-v2011

items and other patterns (construct-related and participant-related) were not considered in our final results.

In part 3, we combined and integrated the quantitative and the qualitative results. We gave more weight to the quantitative results when we observed discordance between the quantitative and the qualitative findings, as qualitative results were based on the analysis of ratings collected from 5,596 physicians, compared to the qualitative results based on the analysis of 15 interviews. To avoid bias we tabulated quantitative and qualitative results for each item, and we discussed it with the ITPCRG members who are experts in the IAM. Thus our final draft (IAM-V2014) was based on: (i) quantitative and, qualitative results, (ii) users' opinions, and (iii) expert discussion. This is ideal for the ecological content validation process.

6.2 Strengths of the study

6.2.1 Comprehensive literature review

In our process of content validation we conducted a comprehensive literature review to update our knowledge regarding the levels of outcome associated with educational emails. We looked at whether the four levels of outcome used in the IAM theoretical model (ACA-LO) were addressed and if there were any existing new levels of outcome reported in the literature. We used "citation tracking" to broaden our search strategy for potentially relevant references, beside our personal searches. Three literature reviews and the five studies used for the most recent review conducted by my supervisor (PP) guided our search. We synthesized 13 relevant references. We conducted inductive-deductive thematic analysis for the 13 relevant references looking for the four levels of outcome of IAM (cognitive impact, information use, clinical

relevance, and health benefits). Thus, this review ensured that the four levels of outcome of IAM have been addressed. In addition, no new levels of outcome have been reported in the literature.

6.2.2 Strengths of the quantitative part

The strength of our study was mainly the size of the quantitative data set comprised of 234,194 completed IAM questionnaires. The data set was provided by my co-supervisor (RG) in Microsoft Excel. We divided the data in four parts (e.g. ratings of "cognitive impact", "information use", "clinical relevance", and "health benefits") to save time, and to facilitate the analysis. Using a big sample allowed us to overcome a limitation of the previous study (Bindiganavile Sridhar et al., 2013), and is ideal for content validation (9).

6.2.3 Strengths of consulting members of the target population

The IAM target population or end-users (health professionals) were consulted in this study, as we interviewed 15 family physicians. Participants were familiar with IAM items as they respond to the IAM questionnaire regularly in continuing education programs. The interviews were conducted in the participants' work settings, which is a real world setting for routine clinical practice. The routine use of the IAM questionnaire helped the users (ecological experts) to provide a better perspective on IAM items. According to Haynes et al., (1995), a carefully structured, open-ended interview with a member of the target population can increase the chance that items are content valid for their intended purpose. In addition, we were mainly interested in the users' personal experience, so we conducted face-to-face interviews with the participants instead of the focus groups.

6.2.4 Use of mixed methods research

A three-part mixed methods research convergent design was followed. We used quantitative methods to measure the relevance and qualitative methods to assess the representativeness of IAM items. Mixed methods research addresses 'real life' questions (90), such as our research question. Mixing methods such as longitudinal web-based questionnaires (quantitative) and in-depth face to face exploratory interviews (qualitative), and integrating the results of these methods usually enhance the final outcome of research studies (27). In fact, content validation is a typical mixed methods endeavor (27).

6.2.5 Strengths of the Expert panel discussion

The final steps of data analysis and the draft of IAM-V2014 were discussed with IAM experts, namely ITPCRG members who are researchers on the value of clinical information. Expert panel discussion is a core component (logical content validity) of the Content Validation Guidelines (7). Discussing end-user (ecological content validity) and expert opinions (logical content validity) regarding the IAM items promoted heterogeneity in judgement and helped to capture different interpretations of representativeness of each item.

6.3 Contribution to Continuing Medical Education

Our ecological content validation of the IAM for push technology will lead to three major contributions when IAM-V2014 is implemented. At the individual knowledge user level, physicians and pharmacists will use a validated method to assess the clinical information they receive through email alerts in accredited educational programs (e.g., Daily POEMs and e-Therapeutics+ Highlights). At the organizational information provider level, the analysis of all

IAM-V2014 ratings will be based on a validated method. For information science, our work validated a unique method that operationalizes the ACA-LO theoretical model.

In addition, there are many advantages of using a validated questionnaire such as the IAM-V2014: (i) researchers save resources as they do not need to go through a time-consuming development and validation process, (ii) they can compare their results with those from other studies using the same questionnaire, and (iii) they simply need to report the validated questionnaire and corresponding references when they write up their own work.

CONCLUSION

7.1 In a Nutshell

This MSc thesis assessed the ecological and logical content validity of the IAM in the push context, as a part of ongoing continuing education programs such as Daily POEM alerts and e-Therapeutics+ Highlights. The IAM-V2014 has a documented content validity and will be used as a feedback system to link the user with the information providers. For example, the CPhA produces e-Therapeutics Highlights and uses the IAM to collect ratings and feedback comments submitted by physicians and pharmacists, which are analysed and used to improve the informational content. In addition, the IAM-V2014 can be used to evaluate information in in the context of research.

7.2 Knowledge Translation (KT) plan

A knowledge translation plan was conducted throughout the research process. First, I worked in partnership with the CPhA (organizational knowledge user). Second, I presented my research protocol at NAPCRG (North American Primary Care Research Group) an international conference. This presentation provided a platform to interact with other researchers interested in studying the value of clinical information. Third, we will publish this work to increase awareness about IAM 2014 among health professionals and information providers.

7.3 Looking Ahead with IAM-V2014

We followed six of the eight usual rules for content validation (see Background section #2.5) : (i) we carefully defined the constructs (levels of outcome); (ii) we used population

(ecological) and expert (logical) sampling for the generation of items; (iii) we content validated the items; (iv) we used multiple judges of content validity and quantify our assessment of the relevance of the items; (v) we reviewed the items for technical quality with experts (e.g., for grammar and wording); and (vi) we reported the results of content validation in the present thesis (forthcoming paper). Future research will be needed to examine the proportional representation of items, and use psychometric analyses for questionnaire refinement.

For instance, content validity is an integral component of construct validity. Construct validity is the degree to which an assessment tool measures the targeted construct (7). Construct validity for the IAM constructs of *Information Use* and *Patient Health Benefit* has not been assessed in the context of information delivery (push). Future research should be done to examine the construct validity of the IAM-V2014 in the context of information delivery (push). IAM-V2014 can be used by physicians and other health professionals (e.g. pharmacists and nurses), and in turn, their feedback can help to improve EKRs. In the future, IAM-V2014 can be integrated into systems of continuing education to help in the creation of reflective learning portfolios for health professionals.

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Appendix (1): Glossary of Psychometric Terms

1.	Accuracy	Refers to the correctness of the mean value (how close it is to the true population value).
2.	Concurrent validity	If a similar measure is administered at the same time, the degree of association is termed concurrent validity.
3.	Construct Validity	Extent to which performance of a test fits into a theoretical model of the attributes the test attempts to measure. Refers to the ability of a measurement tool (e.g., a survey or a test) to actually measure the concept being studied. In other words, does it properly measure what it's supposed to measure? For example, if we want to know our height we would use a tape measure and not a balance because height measurements are expressed in inches and not in pounds.
4.	Content validity	Refers to the extent to which a measure represents all facets of a given social construct.
5.	Convergent validity	Agreement between instruments that measure same construct. Correlation with similar scales available.
6.	Criterion-related Instrumental Validity	Reflects the use of a criterion to create a new procedure to measure the construct of interest. The criterion and the new measurement procedure must be theoretically related.
7.	Cronbach's alpha	It is generally used as a measure of reliability of an instrument. Alpha coefficient ranges in value from 0 to 1.
8.	Discriminant validity	Divergence between two scales measuring different constructs. Differentiates from unrelated theoretical concepts.
9.	Ecological Validity	The extent to which the behaviors observed and recorded in a study reflect the behaviors that actually occur in natural settings. In addition, ecological validity is associated with "generalizability". Essentially this is the extent to which findings (from a study) can be generalized (or extended) to the "real world". In virtually all studies there is a trade-off between experimental control and ecological validity. For example, ecological validity is low when experts control all aspects of a study, and results may not be generalizable.

		When we take people out of their natural environment and study them in a lab, experts are exerting control over them and, as a result, possibly limiting how much they can generalize the findings to all people in natural settings.
10.	Logical content validity	Refers to the extent to which the logic and the verbal composition of the items are appropriate from the experts' viewpoint. Can be assessed by consulting experts regarding each item logic and verbal composition.
11.	Experimental validity	Refers to sensitivity to change. Shows difference in results when an intervention is carried out to modify the measured domain.
12.	External Validity	This refers to the extent to which the results of a study can be generalized or extended to other settings. For example, if a study on a drug is only conducted on white, middle aged, overweight, women with diabetes, can the results of the study be generalized to the rest of the population? Are the results only valid to the population studied? Researchers go to great lengths to select a group of people for the study (a sample) that is representative so that their results can be applicable to most people.
13.	Face Validity	This is a very basic form of validity in which it is determined by experts if a measure appears (on the face of it) to measure what it is supposed to measure. For example, if we were going to measure anxiety, do experts agree that our measure looks like something that can assess anxiety? If yes, it has face validity. Face validation can be the first step in determining validity of an instrument.
14.	Incremental validity	What the test adds to the predictive validity already provided by other measures How is the test better than scales already available.
15.	Internal Validity	Occurs when a researcher controls all extraneous variables and the only variable influencing the results of a study is the one being manipulated by the researcher. This means that the variable the researcher intended to study is the one affecting the results and not some other confounding variable.
16.	Precision	The degree to which a calculated central value (e.g., mean) varies with repeated

		sampling (the narrower the variation the more precise the value).
17.	Predictive validity	Whether test results accurately predict something. The relationship between test scores and later performance on a knowledge, skill or ability. For example, Scholastic Assessment Tests (SAT) have predictive validity; SAT scores are associated to students' performance in college.
18.	Reliability	Refers to the accuracy, consistency and stability of test scores across situations. 1) Inter-Rater or Inter-Observer Reliability. 2) Test-Retest Reliability. 3) Parallel-Forms Reliability. 4) Internal Consistency Reliability (Cronbach's alpha).
19.	Validity	The extent to which a test measures what it is supposed to measure. All tests are designed to measure something specific. If a validation study shows that the test does somewhat measure what it is intended to measure, then it is validated.

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Appendix (2): Internet use by individuals, by type of activity (internet users at home)

Activities	2005	2007	2009
Internet users at home	% of individuals		
E-mail	91.3	92.0	93.0
Participating in chat groups or using a messenger	37.9	..	..
Use an instant messenger	..	49.9	44.8
Searching for information on Canadian municipal, provincial or federal government	52.0	51.4	56.5
Communicating with Canadian municipal, provincial or federal government	22.6	25.5	26.9
Searching for medical or health related information	57.9	58.6	69.9
Education, training or school work	42.9	49.5	50.3
Travel information or making travel arrangements	63.1	66.1	66.2
Paying bills	55.0	..	..
Electronic banking	57.8	..	..
Search for employment	..	32.3	34.9
Electronic banking or paying bills	..	62.5	66.7
Researching investments	26.2	25.5	27.1
Playing games	38.7	38.7	42.1
Obtaining or saving music	36.6	44.5	46.5
Obtaining or saving software	31.8	32.5	35.0
Viewing the news or sports	61.7	63.7	67.7
Obtaining weather reports or road conditions	66.6	69.8	74.6
Listening to the radio over the internet	26.1	28.1	31.8
Downloading or watching television	8.5	15.7	24.7
Downloading or watching a movie	8.3	12.5	19.8
Researching community events	42.3	44.3	50.0
General browsing (surfing)	84.0	76.0	77.7
Research other matters (family history, parenting)	..	69.5	72.7
Contribute content (blogs, photos, discussion groups)	..	20.3	26.7
Make telephone calls	..	8.7	13.8
Sell goods or services (through auction sites)	..	8.9	13.4
Other internet activity	10.9	1.5	7.8

Source: Statistics Canada, CANSIM, table 358-0130.

Last modified: 2010-05-10.

Appendix (3): Internet use by individuals, by selected characteristics, any location

Characteristics	2005	2007	2009
All internet users	67.9	73.2	80.3
Household type			
Single family households with unmarried children under age 18	80.9	86.4	91.1
Single family households without unmarried children under age 18	62.5	67.5	76.4
One-person households	48.7	53.0	63.1
Multi-family households	78.8	80.6	86.4
Sex			
Males	68.0	74.1	81.0
Females	67.8	72.3	79.7
Age			
34 years and under	88.9	93.1	96.5
35 to 54 years	75.0	79.8	87.8
55 to 64 years	53.8	60.8	71.1
65 years and over	23.8	28.8	40.7
Level of education			
Less than high school	31.2	43.2	50.7
High school or college	72.0	76.8	83.4
University degree	89.4	92.5	94.7
Personal income quartile			
Lowest quartile	58.7	68.8	76.2
Second quartile	56.9	60.7	69.9
Third quartile	71.3	75.5	83.1
Highest quartile	83.2	87.9	92.1

Source: Statistics Canada, CANSIM, tables 358-0123, 358-0124, 358-0125 and 358-0126.

Last modified: 2010-05-10.

Appendix (4): An example of Daily POEMs

Sputum purulence and CRP predict poor prognosis with COPD exacerbation

Clinical question

Is it possible to identify exacerbations of mild to moderate chronic obstructive pulmonary disease that do not require antibiotic treatment?

Bottom line

Among patients with an exacerbation of mild to moderate chronic obstructive pulmonary disease (COPD), those with a C-reactive protein (CRP) level greater than 40 mg/L and those with sputum purulence are at increased risk for treatment failure without antibiotics. Other patients are unlikely to benefit from antibiotics and would be candidates for symptomatic therapy and close follow-up. (LOE = 1b)

Reference

Miravitlles M, Moragas A, Hernández S, Bayona C, Llor C. Is it possible to identify exacerbations of mild to moderate COPD that do not require antibiotic treatment? Chest 2013;144(5):1571-1577.

Study design

Cohort (prospective)

Funding

Industry + govt

Allocation

N/A

Setting

Outpatient (any)

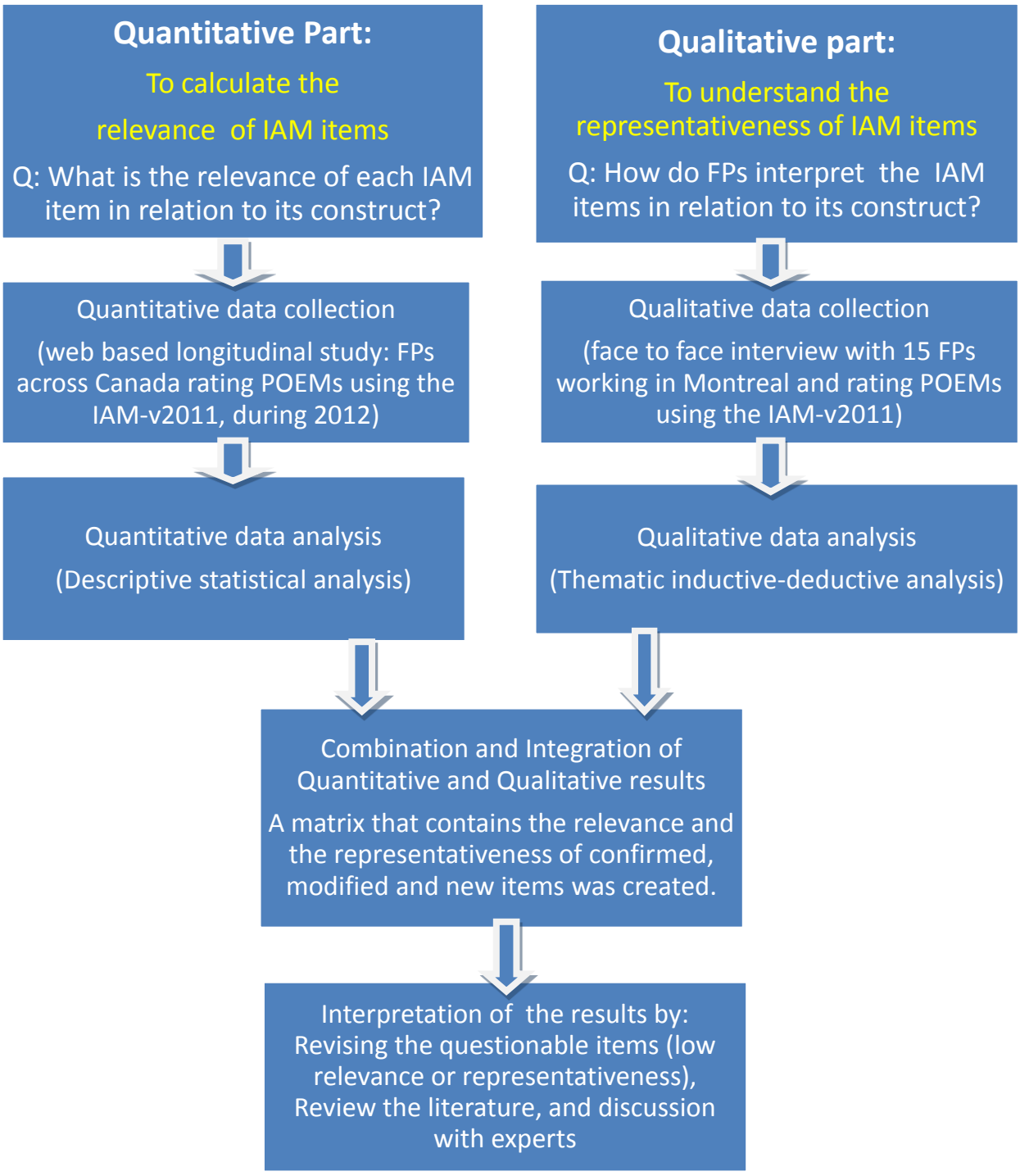
Synopsis

A recent randomized controlled trial compared amoxicillin/clavulanate with placebo in 310 patients with an exacerbation of mild to moderate COPD (Am J Respir Crit Care Med 2012; 186: 716-23). Clinical failure was defined as incomplete resolution, persistence, or worsening of symptoms on days 9 to 11 that required additional treatment. In that trial, 19% in the placebo group and 10% in the antibiotic group were classified as clinical failures (number needed to treat = 9). In this study, the authors looked only at those who had received placebo (n = 152), all of whom had experienced either increased dyspnea, increased sputum volume, and/or increased sputum purulence as inclusion criteria for the study. Patients with increased dyspnea and/or sputum volume had a 5.6% failure rate, those with sputum purulence alone or sputum purulence with increased dyspnea or sputum volume had a 20.3% failure rate, and those with all 3 symptoms had a 33% failure rate. Patients with a CRP level of less than 40 mg/L had a 12.4% failure rate, compared with a 65% failure rate for those with CRP levels of 40 mg/L or higher. A multivariate analysis found that CRP levels equal to or greater than 40 mg/L (odds ratio [OR] = 13.4; 95% CI, 4.6 - 39) and increased sputum purulence (OR = 6.1; 1.5 - 25) were independent predictors of treatment failure.

Discuss this InfoPOEM

Appendix (5): Summary of mixed methods design

Mixed methods convergent triangulation design



Appendix (6): Interview Guide and Consent Form

INTERVIEW GUIDE

Introduction

To begin, I would like to explain briefly the context of our interview. To our knowledge, no studies have assessed the content validity of IAM linked to email "pushed" to family physicians, for example: Daily POEMs and Highlights.

One example of a paper-based Daily POEM, Highlight, and IAM questionnaire will be shown to interviewees to facilitate recall.

The interview will be conducted in two steps (1) we will explore the advantages and disadvantages of educational email alerts, (2) we will assess the ecological content validity of IAM by assessing the representativeness of IAM items and their suitability to the construct. The interview will last between 30 minutes and one hour depending on our interaction and time available.

- Before we start, do you have any questions?

Demographic questions:

In this part, the interviewees will be asked demographic questions regarding the kind of their practice and years in this practice.

In the beginning, I would like to ask you some demographic questions.

Q1- Would you like to describe yourself as a:

1- Family physician
2- Other speciality physician?

Q2- How long have you been working in your speciality?

Q3- Is your practice focused in any of the following areas?

1- Non

2- Addiction medicine
3- Chronic non-cancer pain
4- Developmental disabilities
5- Child and adolescent health
6- Emergency medicine
7- Family practice anesthesia
8- Global health
9- Health care of the elderly
10- Hospital medicine
11- Maternity and newborn care
12- Mental health
13- Occupational medicine
14- Palliative care
15- Prison health
16- Respiratory medicine
17- Sport and exercise medicine
18- Other, please specify?

Q4- What best describes your work settings? Check all that apply.

1- Private office/clinic (excluding free standing walk-in-clinics)
2- Community clinic/community health centre
3- Free standing walk-in-clinic
4- Academic health sciences centre (AHSC)
5- Non-AHSC teaching hospital
6- Community hospital
7- Other hospital
8- Emergency department (in community hospital or AHSC)
9- Nursing home/long term care facility/seniors' residence
10- University
11- Research unite
12- Free-standing lab/diagnostic clinic
13- Administration office/corporate office

14- Other, please specify?

The first part of our interview contains two baseline question sets to explore your perception of the advantages and disadvantages of educational email alerts (appendix 9):

First, I would like to ask you some baseline questions about emails and educational email alerts**.**

Q1- Please, describe your daily experience with emails? Probes: Is there a specific reason for that? Can you give me an example? Does this routine experience influence your utilization of InfoPOEMs or Highlights?

Q2- What do you usually feel (good or bad) about emails, e.g., welcoming, disliking, feeling overwhelmed or unsecured, or anything else? Probes: Is there a specific reason for that? Can you give me an example? Does this usual attitude influence your utilization of InfoPOEMs or Highlights?

Q3- What do you usually do when you receive emails, e.g., reading, deleting, flagging, ignoring, saving, classifying, or anything else? Is there a specific reason? Could you give me an example of that?

Q4- Does this usual behaviour influence your utilization of InfoPOEMs or Highlights?

Second, I would like to ask you three general questions regarding your CME experience and preference:

Q1- Can you tell me about your CME activities?

Q2- What kind of CME activities do you prefer?

Q3- What are the advantages and disadvantages of educational email alerts compared to other CME activities?

The second part of our interview contains some questions about the IAM items and construct. For each construct, I will explain its purpose. We will read the corresponding items, and I will ask you whether these items belong to the construct?

CONSTRUCT ONE: COGNITION

First, we will discuss the impact of educational email alerts on your practice. We will discuss the 'cognition' construct which aims to assess the family physicians' absorption, understanding and integration of the information received from these email alerts. In this section we have ten items;

six items to assess the positive cognitive impact and four items to assess the negative cognitive impact.

Interviewer to present the following items (italics):

Question: What is the impact of this information on you or your practice?

Items:

C) *Positive cognitive impact items:*
   1- *My practice will be changed and improved.*
   2- *I learned something new.*
   3- *I'm motivated to learn more.*
   4- *This information confirmed I did (am doing) the right thing.*
   5- *I'm reassured.*
   6- *I'm reminded for something I already knew.*

D) *Negative cognitive impact items:*
   1- *I'm dissatisfied.*
   2- *There is a problem with the presentation of this information.*
   3- *I disagree with the content of this information.*
   4- *This information is potentially harmful.*

Now I will ask you some questions about the items of this construct:

Q1- If you had the option to add new items, what would you like to add?
PROBE: Could you give me an example?
Q2- If you had the option to remove items, which ones would you like to remove?
PROBE: Why?
Q3- If you had the option to modify items, which ones would you like to modify?
PROBES: Why? How?

CONSTRUCT TWO: APPLICATION

Second, we will discuss the application of the information, for example, the use of information you receive from educational email alerts. We will discuss the 'application' construct of IAM

which aims to determine if and how the information are used in clinical practice. For this construct we have seven items:

Interviewer to present the following items (italics):

Question: Will you use this information for a specific patient? If Yes,

Items:

1. *As a result of this information I will manage this patient differently.*
2. *I had several options for this patient and I will use this information to justify a choice.*
3. *I did not know what to do, and I will use this information to manage this patient.*
4. *I thought I knew what to do, and I used this information to be more certain about the management of the patient.*
5. *I used this information to better understand a particular issue related to this patient.*
6. *I will use this information in discussion with this patient or with other health professionals about this patient.*
7. *I will use this information to persuade this patient, or to persuade other health professionals to make a change for this patient*

Now I will ask you some questions about the items of this construct:

Q1- If you had the option to add new items, what would you like to add?
PROBE: Could you give me an example?
Q2- If you had the option to remove items, which ones would you like to remove?
PROBE: Why?
Q3-If you had the option to modify items, which ones would you like to modify?
PROBES: Why? How?

CONSTRUCT THREE: HEALTH OUTCOMES

Third, we will assess the "health outcome" construct which aims to identify the patient health outcome associated with the application of this information received from educational email alerts. For this construct we have three items.

Interviewer to present the following items (italics):

Question: For this patient, do you expect any health benefits as a result of applying this information? If yes,

Items:

1. *This information will help to improve this patient's health status, functioning or resilience (i.e. ability to adapt to significant life stressors)*
2. *This information will help to prevent a disaese or worsining of disease for this patient.*
3. *This information will help to avoid unnecessary or inappropiate treatment, diagnostic procedures, preventive interventions or a referral of a patient.*

Now I will ask you some questions about the items of this construct:

Q1- If you had the option to add new items, what would you like to add?
PROBE: Could you give me an example?
Q2- If you had the option to remove items, which ones would you like to remove?
PROBE: Why?
Q3- If you had the option to modify items, which ones would you like to modify?
PROBES: Why? How?

RELEVANCE CONSTRUCT

Fourth, we will assess the "relevence" construct which aims to identify the relevence of the information received from educational email to at least one of your patients. This construct has one questions and three items

Interviewer to present the following items (italics):

Question: Is this information relevant for at least one of your patients?

Items:

4- Totally relevant
5- Partially relevant
6- Not relevant

Now I will ask you some questions about these items

Q1- What does partially relevant mean for you?

Q2- Could you give me an example; under what circumstances do you typically select partially relevant??

CONCLUDING QUESTION

Based on your experience with educational email alerts, do you have recommendations to improve the service in general?

PROBE: could you give me an example for each recommendation?

Conclusion:

Finally, I thank you very much and I would ask you if you have any comment about our study, the data collection process or the interview.

CONSENT FORM

Consent form to participate in research study entitled:

Content Validation of the Information Assessment Method for Email Alerts (Push Technology):

An exploratory qualitative study with family physicians

Principal investigators: Pierre Pluye MD PhD, and Roland Grad MDCM MSc CCFP

Department of Family Medicine, McGill University

Introduction

Email alerts constitute an opportunity to engage family physicians in online continuing education. Specifically, email alerts can improve family physicians' use of research-based clinical information. In turn, this can improve the quality of health care. The Information Assessment Method (IAM) allows family physicians to report the relevance, cognitive impact, use and patient health benefits associated with clinical information delivered by email alerts. IAM is a unique tool for knowledge translation which is used by more than 10,000 physicians and pharmacists across the country within accredited continuing education programs. The problem is that IAM-v2011 is not validated yet for email alerts. The use of assessment instruments that lack content validity can lead to invalid conclusions as well as the misapplication of findings to practice and treatment.

Study procedures

If you participate, you will be asked a few general questions about your experience in terms of continuing medical education, e-mail and e-learning. Then, you will be asked to provide your opinion regarding four key elements of IAM (four constructs). For each construct, you will read IAM items, and you will listen to a detailed explanation. Then, you will be asked about your opinion regarding the items in relation to their construct. You will have the option to recommend adding, modifying or deleting items to each construct.

Benefits and risks

Your participation in the study will allow you to participate in a contest, in which one randomly selected participant will win a $100 gift card. Other benefits of study participation include contributing to knowledge on CME, and the impact of educational email alerts. There are no risks. Your answers will be managed by a graduate student (the interviewer) who will replace all names with aliases, and transform any information that may establish a link with a person or a particular location in relationship to you and your clinical practice.

Withdrawal from Study

Your participation is strictly voluntary, and you may choose not to participate. You can withdraw from the study at anytime without penalty.

Compensation

No financial compensation for participation is offered.

Confidentiality

Only anonymous data (aliases) will be used in research presentations and publications. Except for the interviewer and principal investigators, no one will be able to link your answers to you or any other individual person.

Contact

For further information, please email Dr. Pierre Pluye pierre.pluye@mcgill.ca or Dr. Roland Grad roland.grad@mcgill.ca

Consent form - Version May 4th, 2013

Signature

The study has been explained to me and my questions have been answered to my satisfaction. A copy of this form will be provided to me for my records.

After reviewing the above information, I agree to participate in this study.

Signature of participant

Please print your name

Date

Signature of principal investigator

Appendix (7): The code manual

The code manual

N	Code	Description	Definition	comment
Theoretical model-based themes				
1	PCI	Positive Cognitive impact	Items specified to measure the positive aspects of information absorption, understanding, and integration	
2	NCI	Negative Cognitive impact	Items specified to measure the negative aspects of information absorption, understanding, and integration	
3	IU	Information use	Items associated with the use of newly understood and cognitively processed information	
4	HB	Health benefit	Items used to evaluate the health outcomes associated with the information use	
Interview guide-based themes				
5	K	Keep	Keep the item in the new version	
6	D	Delete	Delete the item from the new version	
7	M	Modify	Modify the item in the new version	
8	P	Participant	The family physicians who agreed to participate in the study	FP (family physician) was modified to P (participant) based on the ITPCRG recommendations
9	NRI	New recommended item	The new item recommended by the participants	
Emerging themes				
10	MR	Merge	Merging two items or more in one item	
11	KD	Keep and delete sub-items	Keep the main item and delete the sub-items	
12	MRA	Merge and add	Merge two items or more and add additional information	
13	KA	Keep and add	Keep the item and add additional information	

Appendix (8): Description of the included studies

First author Year Country Study title	Study design Setting Participants Data collection Data analysis	Intervention	Relevant outcomes	Reported Level of outcome
Evaluation of email alerts in practice: Part 2 – validation of the information assessment method, (Pluye et al., 2010)(19), Canada	Design: Mixed Methods sequential explanatory Data collection: A daily educational email to 1007 family doctors who submitted 61 493 ratings of 'cognitive impact' Participants: 12 800 doctors (QUAN) and Forty-six doctors were interviewed (QUAL). Setting: Canada (QUAN), McGill academic setting (QUAL) Data analysis: descriptive statistical analysis (QUAN) and deductive thematic analysis (QUAL)	Educational emails And Face to face interview	IAM contribute to: (1) Research for systematically assessing and comparing the relevance, cognitive impact, use and expected health outcomes associated with email alerts (2) Continuing professional development for documenting brief individual e-learning activities; and (3) Two-way knowledge exchange between information providers and clinicians for improving email alerts.	Cognitive impact Clinical relevance Information use Health benefits
Do Family Physicians Retrieve Synopses of Clinical Research Previously Read as Email Alerts? (Grad et al., 2011) (14), Canada	Design: Mixed methods Participants: 41 family physicians. Settings: 9 different provinces of Canada Intervention: IAM linked to POEM emails and searches in Essential Evidence Plus. Data collection: QUAN: Pull, from PDA, Push, from IAM of POEMS. QUAL: Interview Analysis: QUAN: Descriptive statistics, QUAL: Thematic	Educational emails And Face to face interviews	Family physicians purposefully retrieved a synopsis they had previously read as email. Factual knowledge from brief reading of email alerts of synopses may be simply forgotten. The ability of family physicians to remember synopses they previously read declined over time	Cognitive impact
Feasibility of a Knowledge Translation CME Program: Courriels Cochrane, (Pluye et al., 2012) (21), Canada	Design: A longitudinal evaluation (qualitative) study Data collection: participants received weekly e-mail, rating it using the (IAM). Participants: 985 family physicians French Setting: Canada Data analysis: statistical data analysis	Educational emails And IAM questionnaire	Of 1109 completed questionnaires: (1) 87.7% reported positive cognitive impact. (2) 75.3% reported the information was clinically relevant. (3) 53.7% reported that information use. (4) 51.3% of ratings contained reports of information use was associated with health benefits	Cognitive impact Clinical relevance Information use Health benefits
Features of Effective Medical Knowledge Resources to Support Point of Care Learning: A Focus Group Study, (Cook et al., 2013) (83), Australia	Design: Qualitative study Intervention and setting: 11 focus groups at an academic medical center. Participants: 50 primary care and subspecialist internal medicine and family physicians. Data analysis: comparative inductive thematic	Focus group interview	Features that influence users selection of knowledge resources: 1- comprehensiveness 2- search ability and brevity 3- Integration with clinical workflow 4- Credibility 5- User familiarity 6- Capacity to identify a human expert 7- Reflection of local care processes 8- Optimization for the clinical question (e.g., diagnosis, treatment Options, drug side effect), and Currency 9- Ability to support patient education	Cognitive impact Information use Clinical relevance Health benefits
Top 20 Research Studies of 2011 for Primary Care Physicians, (Ebell & Grad, 2012) (84), Canada	Design: A longitudinal web-based summary of the 20 most relevant, practice-changing POEMs from 2011 as determined by raters using IAM-2008	Review	Based on IAM user ratings, 20 POEMs were identified as the most clinically relevant in 2011.	Cognitive impact Clinical relevance
Top 20 Research Studies of 2012 for	Design: A longitudinal web-based summary of the 20 most relevant,	Review	The IAM addresses cognitive impact, clinical relevance, use in practice, and, if implemented,	Cognitive impact

	Primary Care Physicians, (Ebell & Grad, 2013) (85), Canada	practice-changing Poems of 2012 as determined by raters using IAM-2012		expected health benefits	Information use Clinical relevance Health benefits
	The Clinical Relevance of Information Index (CRII): assessing the relevance of health information to clinical practice, (Galvao et al., 2013) (69), Canada	Design: A longitudinal web-based (quantitative) Data collection: web based ratings from family physicians using IAM linked to educational emails. CRII was applied to 4574 relevance assessments of 194 POEMs sent by email Participants: 41 family physicians in 2008. Data analysis: descriptive statistical analysis	Educational emails	The CRII is only weakly correlated with the number of citations received by a study and the level of evidence of the study. The CRII captures aspects of information not considered by other indices used by information providers, institutions, editors, as well as health and information professionals targeting knowledge translation.	Clinical relevance
	Facilitating knowledge transfer through the McMaster PLUS REHAB Project: Linking rehabilitation practitioners to new and relevant research findings, (Law et al., 2008) (81), Canada	Design: A longitudinal web-based (qualitative) study. Setting: Mac-PLUS REHAB project, Canada Participants: 1,000 practicing occupational therapists and physiotherapists Data collection: e-mail alerts about new evidence, tailored to the user's interest profile allow them to interact and submit feedbacks data analysis: statistical data analysis	Educational emails	PLUS REHAB: 1- Help occupational health professionals access and uptake of information 2- Speeds up the knowledge transfer process 3- Support practice and knowledge share 4- Evaluate the effect of push-out technology on uptake and use of evidence-based knowledge. 5- Makes knowledge accessible by individualizing alerts, providing a credibly rated and trustworthy system of relevant articles and saving many valuable hours.	Cognitive impact Information use Clinical relevance
	A Reflective Learning Framework to Evaluate CME Effects on Practice Reflection, (Leung et al., 2010) (16), Canada	Design: Qualitative multiple-case Participants: 473 practicing family physicians commented on research-based synopses (POEMs) after reading and rating them as an on-line CME activity. Data collection: Physician comments formed 2029 cases from which cognitive tasks were extracted. Data analysis: Thematic analyses, and cross-case analysis.	Online (push) educational activities	Four cognitive processes and 12 cognitive tasks were supported. Reflective learning was defined as 4 interrelated cognitive processes: 1- Interpretation 2- Validation 3- Generalization 4- Change. Reflective learning performances of family physicians were evaluated.	Cognitive impact
	A single email to clinicians may improve short-term prescribing for people with coronary artery disease and raised LDL cholesterol, (McMullin & Singh, 2006) (86), USA	Design: Randomised trial. Participants and settings: 14 US primary care physicians in Academically affiliated practice. Data collection: Physicians were blinded to group allocation. Intervention and data collection: intervention group received a single e-mail provided decision support, and facilitated 'one-click' actions such as prescriptions, updating charts, and mailing out educational materials. Data analysis: descriptive statistical analysis	Educational emails	The intervention group were more likely than controls to change their prescription. Median time to the first medication adjustment was earlier in the intervention group LDL; cholesterol levels for people with baseline levels greater than 130 mg/dl were significantly lower in the intervention group (119 vs 138.0 mg/dl). It took physicians less than one minute to process each email. A single email to primary care physicians could influence prescribing and may improve hyperlipidemia management in the short term.	Information use Health outcome
	Impact of Interactive Web-Based Education With Mobile and Email-Based Support of General Practitioners on Treatment and	Design: Randomized controlled Participants: General practitioners from all over Norway Intervention: a Web-based course on atopic dermatitis with guidance via email from specialists. Data collection: 46 physicians: 24 doctors were allocated to the	Educational emails	There were no statistically significant differences in the duration of topical steroid treatment or number of treatment modalities between the groups. The lack of effect on the primary outcome may be due to attrition as 54% of the participants did not complete the course. 42% (10/24) of physicians sent at least one educational request	Information use Health benefit

	Referral Patterns of Patients with Atopic Dermatitis: Randomized Controlled Trial, (Schopf & Flytkjaer, 2012)(87), Norway	intervention group and 22 doctors to the control group. Data analysis: descriptive Statistical analysis		via email. While 11% (8/73) of treatment reports in the intervention group were referred to a medical specialist (e.g., dermatologist or pediatrician)	
	Updating clinical knowledge: An evaluation of current information alerting services, (Strayer et al., 2010) (88), USA	Design: Web-based qualitative study Data collection: A 7-item checklist (push tools) based on evidence-based medicine was created and assessed content validity and face validity Participants: practicing clinicians, clinician researchers and experts. Data analysis: Descriptive statistics analysis	Educational emails information assessment tool	A checklist was created and can be used to reliably assess the quality of clinical information updating (push) tools. This tool will improve the application of basic evidence-based medicine principles to new medical information in order to increase their usefulness to clinicians.	Cognitive impact Information use
	The cognitive impact of research synopses on physicians: a prospective observational analysis of evidence-based summaries sent by email, (Wang et al., 2009) (89), Canada	Design: Prospective observational study Intervention and data collection: Research synopses sent by emails for 9 months. Each synopsis was classified as either positive or negative based on physician-reported cognitive impact. A total of 1960 Canadian physicians submitted 159 442 ratings on 193 synopses. Each synopsis was assessed on average by 826 physicians. Participants and setting: physicians of Canada Data analysis: descriptive statistical analysis and logistic regression).		There were 28.3 negative ratings per research synopsis, 146.3 neutral, and 656.2 positive. Out of the seven characteristics (number of characters, research design, study setting, number of types of patient populations studied, number of comparisons, number of outcomes, and number of results) analysed, only the number of comparisons had a statistically significant influence on physician ratings. An increase in the number of comparisons or the number of results decreased the likelihood of a negative impact. Characteristics of the synopses appear to influence cognitive impact, and there might be lexical patterns specific to these factors.	Cognitive impact

Appendix (9): IAM-v2011(Push)

IAM 2011 (PUSH)

Q1. What is the impact of this information on you or your practice? ***Please check all that apply***

Note: You can check more than one type of impact.
Note to programmer: **MUST check at least one**

My practice is (will be) changed and improved ○

If Yes, what aspect is (will be) changed or improved?

- *Diagnostic approach?* ○
- *Therapeutic approach?* ○
- *Disease prevention or health education?* ○
- *Prognostic approach?* ○

I learned something new ○

I am motivated to learn more ○

This information confirmed I did (am doing) the right thing ○

I am reassured ○

I am reminded of something I already knew ○

I am dissatisfied ○

There is a problem with the presentation of this information ○

If Yes, what problem do you see?

- *Too much information?* ○
- *Not enough information?* ○
- *Information poorly written?* ○
- *Too technical?* ○
- *Other?* **If 'Yes', TEXT BOX with mandatory comment. Instruction:** ***Please describe this problem.*** ○

I disagree with the content of this information ○

This information is potentially harmful ○

If 'Yes', TEXT BOX with mandatory comment. Instruction: ***Please describe how this information may be harmful***

Q2. Is this information relevant for at least one of your patients?

☐ Totally relevant

☐ Partially relevant

☉ Not relevant

Answering "No" will disable question 3

Q3. Will you use this information for a specific patient?	Yes	No	Possibly
	○	◉	○

Answering "No" or "Possibly" will disable items of 'use' and question 4

If YES: ***Please check all that apply***

Note: You can check more than one type of use. Note to programmer: **MUST check at least one**

As a result of this information I will manage this patient differently	○
I had several options for this patient, and I will use this information to justify a choice	○
I did not know what to do, and I will use this information to manage this patient	○
I thought I knew what to do, and I used this information to be more certain about the management of this patient	○
I used this information to better understand a particular issue related to this patient	○
I will use this information in a discussion with this patient, or with other health professionals about this patient	○
I will use this information to persuade this patient, or to persuade other health professionals to make a change for this patient	○

Q4. For this patient, do you expect any health benefits as a result of applying this information?	Yes	No
Answering "No" will disable items of 'health benefit'	○	◉

If YES: Check all that apply. You may check more than type of health benefit

Note to programmer: **MUST check at least one**

This information will help to improve this patient's health status, functioning or resilience (i.e., ability to adapt to significant life stressors)	○
This information will help to prevent a disease or worsening of disease for this patient	○
This information will help to avoid unnecessary or inappropriate treatment, diagnostic procedures, preventative interventions or a referral, for this patient	○

Comment on this information or this questionnaire.

Appendix (10): IAM-V2014 Draft

Construct: Cognitive Impact

A) Positive cognitive impact items:

6. I learned something new.
7. I'm motivated to learn more.
8. This information confirmed I did (am doing) the right thing.
9. I am reassured.
10. I am reminded for something I already knew.

B) Negative cognitive impact items:

5. I am dissatisfied.
6. There is a problem with the presentation of this information.
7. I disagree with the content of this information.
8. This information is potentially harmful.

Construct: Application

7. As a result of this information I will manage this patient differently.
8. I had several options for this patient and I will use this information to justify a choice.
9. I thought I knew what to do, and I used this information to be more certain about the management of the patient.
10. I used this information to better understand a particular issue related to this patient.
11. I will use this information in discussion with this patient or with other health professionals about this patient.
12. I will use this information to persuade this patient, or to persuade other health professionals to make a change for this patient

Construct: Health Benefits

4. This information will help to improve this patient's health status, functioning or resilience (i.e. ability to adapt to significant life stressors)
5. This information will help to prevent a disease or worsening of disease for this patient.
6. This information will help to avoid unnecessary or inappropriate treatment, diagnostic procedures, preventive interventions or a referral of a patient.

Construct: Clinical Relevance

4. Totally relevant
5. Partially relevant
6. Not relevant

Appendix 11: IBR Ethical Approval for the quantitative part of the study

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Fax/Télécopieur: (514) 398-3696

November 13, 2012

Dr. Roland Grad
Department of Family Medicine
515-517 Pine Avenue West
Montreal QC H2W 1S4

RE: **IRB Study Number A11-E25-05A**
Impact of clinical computer mediated communication on health professionals

Dear Dr. Grad,

Thank you for submitting an application for Continuing Review for the above-referenced study.

The study progress report underwent review and full Board re-approval of the study was provided on **November 12, 2012**. The ethics certification renewal (enclosed) is valid until **November 11, 2013.**

If any study modifications or unanticipated study developments occur prior to the next annual review, including study terminations, please notify the IRB promptly. Regulation does not permit the implementation of study modifications prior to IRB review and approval.

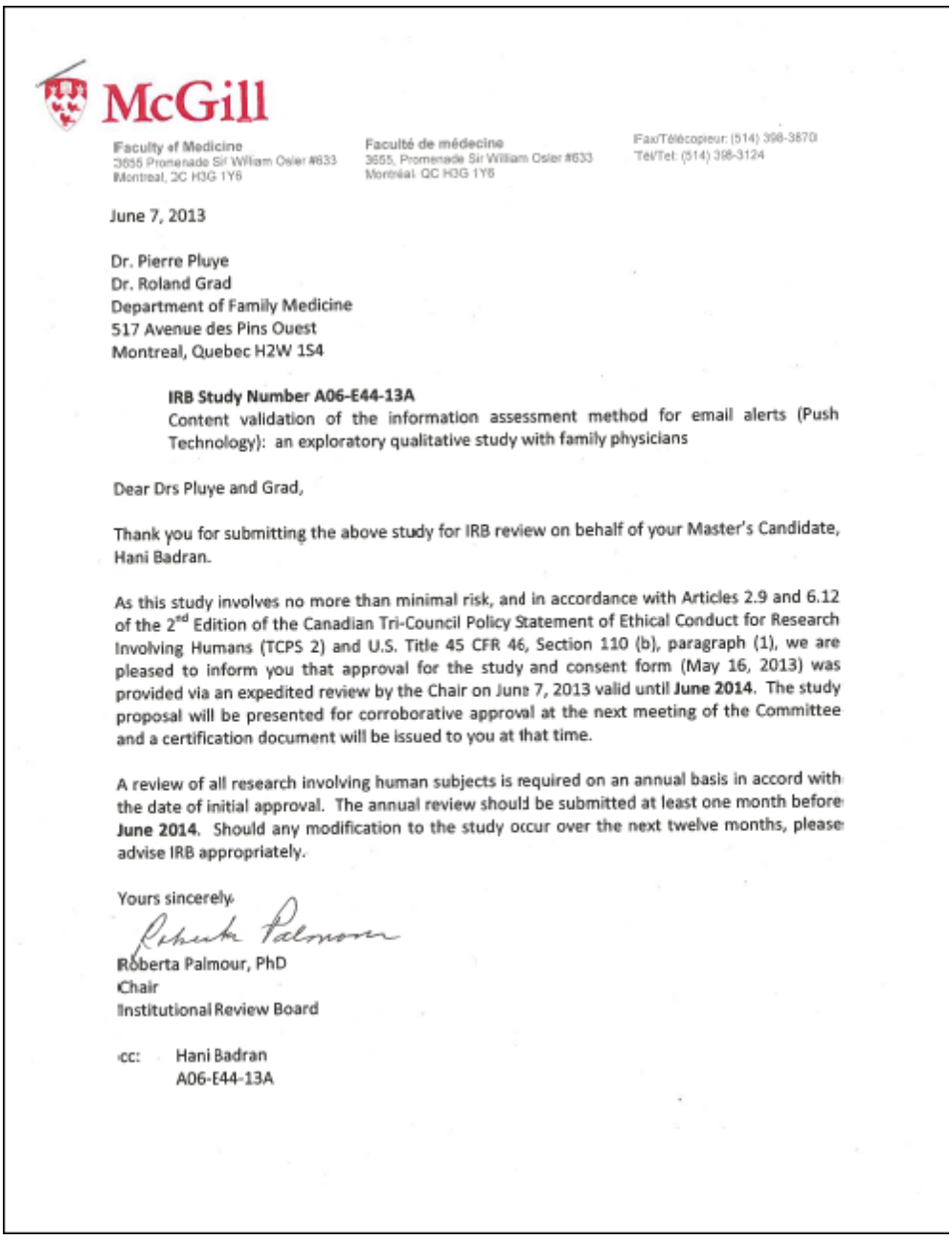
Yours sincerely,

Roberta Palmour

Roberta Palmour, PhD
Co-Chair
Institutional Review Board

Cc: A11-E25-05A

Appendix 12: IBR Ethical Approval for the qualitative part of the study



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June 7, 2013

Dr. Pierre Pluye
Dr. Roland Grad
Department of Family Medicine
517 Avenue des Pins Ouest
Montreal, Quebec H2W 1S4

IRB Study Number A06-E44-13A
Content validation of the information assessment method for email alerts (Push Technology): an exploratory qualitative study with family physicians

Dear Drs Pluye and Grad,

Thank you for submitting the above study for IRB review on behalf of your Master's Candidate, Hani Badran.

As this study involves no more than minimal risk, and in accordance with Articles 2.9 and 6.12 of the 2nd Edition of the Canadian Tri-Council Policy Statement of Ethical Conduct for Research Involving Humans (TCPS 2) and U.S. Title 45 CFR 46, Section 110 (b), paragraph (1), we are pleased to inform you that approval for the study and consent form (May 16, 2013) was provided via an expedited review by the Chair on June 7, 2013 valid until **June 2014**. The study proposal will be presented for corroborative approval at the next meeting of the Committee and a certification document will be issued to you at that time.

A review of all research involving human subjects is required on an annual basis in accord with the date of initial approval. The annual review should be submitted at least one month before **June 2014**. Should any modification to the study occur over the next twelve months, please advise IRB appropriately.

Yours sincerely,

Roberta Palmour

Roberta Palmour, PhD
Chair
Institutional Review Board

cc: Hani Badran
A06-E44-13A

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CERTIFICATION OF ETHICAL ACCEPTABILITY FOR RESEARCH INVOLVING HUMAN SUBJECTS

The Faculty of Medicine Institutional Review Board (IRB) is a registered University IRB working under the published guidelines of the Tri-Council Policy Statement, in compliance with the Plan d'action ministériel en éthique de la recherche et en intégrité scientifique, (MSSS, 1998) and the Food and Drugs Act (17 June 2001); and acts in accordance with the U.S. Code of Federal Regulations that govern research on human subjects. The IRB working procedures are consistent with internationally accepted principles of good clinical practice.

At a full Board meeting on June 10, 2013, the Faculty of Medicine Institutional Review Board, consisting of:

John Breitner, MD	Patricia Dobkin, PhD
Anita Gagnon, PhD	Catherine Gardner, B.Sc.
Daniel Mastine, BNS, MA	Wilson Miller, MD/PhD
Robert L. Munro, BCL	Scott Owen, MD
Roberta Palmour, PhD	Lucille Panet-Raymond, BA
Blossom Shaffer, MBA	John Storring, MD

Margaret Swaine, BA

Hani:

Examined the research project **A06-E44-13A** titled: *Content validation of the information assessment method for email alerts (Push technology): an exploratory qualitative study with family physicians*

As proposed by: Dr. Pierre Pluye (Applicant) to _____ (Granting Agency, if any)

And consider the experimental procedures to be acceptable on ethical grounds for research involving human subjects.

10 June 2013 (Date) — Roberta Palmour (Chair, IRB) — M. Leeuwenburgh (Dean of Faculty)

Institutional Review Board Assurance Number: FWA 00004545