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The integration of barcode scanning technology into Canadian public health immunization settings☆

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ABSTRACT

Background: As part of a series of feasibility studies following the development of Canadian vaccine barcode standards, we compared barcode scanning with manual methods for entering vaccine data into electronic client immunization records in public health settings.
Methods: Two software vendors incorporated barcode scanning functionality into their systems so that Algoma Public Health (APH) in Ontario and four First Nations (FN) communities in Alberta could participate in our study. We compared the recording of client immunization data (vaccine name, lot number, expiry date) using barcode scanning of vaccine vials vs. pre-existing methods of entering vaccine information into the systems. We employed time and motion methodology to evaluate time required for data recording, record audits to assess data quality, and qualitative analysis of immunization staff interviews to gauge user perceptions.
Results: We conducted both studies between July and November 2012, with 628 (282 barcoded) vials processed for the APH study, and 749 (408 barcoded) vials for the study in FN communities. Barcode scanning led to significantly fewer immunization record errors than using drop-down menus (APH study: 0% vs. 1.7%; $p = 0.04$) or typing in vaccine data (FN study: 0% vs. 5.6%; $p < 0.001$). There was no significant difference in time to enter vaccine data between scanning and using drop-down menus (27.6 s vs. 26.3 s; $p = 0.39$), but scanning was significantly faster than typing data into the record (30.3 s vs. 41.3 s; $p < 0.001$). Seventeen immunization nurses were interviewed; all noted improved record accuracy with scanning, but the majority felt that a more sensitive scanner was needed to reduce the occasional failures to read the 2D barcodes on some vaccines.
Conclusion: Entering vaccine data into immunization records through barcode scanning led to improved data quality, and was generally well received. Further work is needed to improve barcode readability, particularly for unit-dose vials.

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1. Introduction

Barcode scanning technology enhances patient safety, reduces errors involving drug administration, and increases the timeliness and accuracy of medication-related documentation [1–5]. Since 10–60% of immunization records are missing important information or contain errors [6–9], possibly due to the small print used for lot number and expiry date on vaccine vials, the value of barcode scanning may extend to vaccines. In 1999, Canada's National Advisory Committee on Immunization (NACI) recommended placing barcodes on vaccine products to automate the recording of vaccine-related data in electronic systems [10].

The Public Health Agency of Canada (PHAC) leads the Automated Identification of Vaccines Project Advisory Task Group (AIVP ATG), which includes representation from the vaccine industry, healthcare professional organizations, and barcode standard-setting organizations. With a mandate of providing leadership and support for developing and implementing vaccine barcodes in Canada [11], AIVP ATG reached a consensus on vaccine barcode standards in 2009. These include placing two-dimensional (2D) barcodes, with unique Global Trade Item Number (GTIN) and lot number, and optional expiry date, on primary packaging (Fig. 1) [11]. Based on the GS1 System of Standards, the GTIN is a global standard for product identification. It is the foundation for electronic processes such as data synchronization and barcode scanning, with resultant improvement in operational efficiencies, cost reduction, and patient safety [12]. Canadian vaccine manufacturers have committed to adhering to the barcode standards by 2016 [13].

To support barcode scanning feasibility studies, a collaborative was formed among AIVP ATG, the PHAC/Canadian Institutes of Health Research Influenza Research Network (PCIRN), PHAC, and Sanofi Pasteur Ltd. We previously studied barcode scanning of influenza vaccine vials for recording inventory in mass immunization clinics and found high barcode readability and favorable user perceptions [14]. However, we observed no improvement in record accuracy, likely because most clinics used a single influenza vaccine lot; the benefits of barcode scanning may be more apparent in settings where multiple vaccines are being used, resulting in a greater potential for errors. The objective of this study was to compare barcode scanning with manual electronic approaches for recording individual-level immunization data for a variety of vaccines administered in public health settings.

2. Methods

2.1. Study design

We conducted intervention-control feasibility studies in two public health settings. The intervention involved scanning the following vaccines labeled with 2D barcodes containing GTIN, lot number, and expiry date: Pediacel® (Diphtheria, Acellular Pertussis, Tetanus, Polio, *Haemophilus influenzae* type b), Quadracel® (Diphtheria, Tetanus, Acellular Pertussis, Polio), Adacel® (Tetanus, Diphtheria, Acellular Pertussis), Td Adsorbed (Diphtheria, Tetanus), Adacel®-Polio (Tetanus, Diphtheria, Acellular Pertussis, Polio), and Vaxigrip® (Influenza). All vaccines used are listed in Table 1.

We compared the collection of vaccine data (vaccine name, lot number, and expiry date) by: (1) barcode scanning of vaccine vials with 2D barcodes (listed above); and (2) existing methods of entering vaccine information into the electronic systems for non-barcoded vials. We used post-immunization chart audits, time-and-motion studies, observation recording, and telephone interviews to compare the data collection approaches.

We received ethics approval from the Health Sciences Research Ethics Board at the University of Toronto, Canada.

Table 1
Vaccines used at study sites.

Vaccine name	Manufacturer	Packaging
Barcoded vaccines		
Adacel®	Sanofi Pasteur	Single-dose vial
Adacel-Polio®	Sanofi Pasteur	Single-dose vial
Pediacel®	Sanofi Pasteur	Single-dose vial
Quadracel®	Sanofi Pasteur	Single-dose vial
Td Adsorbed®	Sanofi Pasteur	Single-dose vial
Vaxigrip®*	Sanofi Pasteur	Multi-dose vial
Non-barcoded vaccines		
Boostrix ®	GlaxoSmithKline	Pre-filled syringe
Engerix B®	GlaxoSmithKline	Single-dose vial
Gardasil®	Merck	Single-dose vial
Havrix®	GlaxoSmithKline	Pre-filled syringe
Imovax Polio ®	Sanofi Pasteur	Pre-filled syringe
Ixiaro®	Novartis	Pre-filled syringe
Menactra®	Sanofi Pasteur	Single-dose vial
Pneumovax®	Merck	Single-dose vial
Prevnar®	Pfizer	Pre-filled syringe
Recombivax	Merck	Single-dose vial
Rotarix®	GlaxoSmithKline	Pre-filled syringe
Twinrix ®	GlaxoSmithKline	Pre-filled syringe
Typherix®	GlaxoSmithKline	Pre-filled syringe
Typhim Vi®	Sanofi Pasteur	Pre-filled syringe
Vivaxim®	Sanofi Pasteur	Pre-filled syringe

* Used at Study Site 2 only.

2.1.1. Study Site 1: Algoma Public Health, Ontario

The study was performed in Algoma Public Health (APH), one of the 36 local public health units in Ontario, Canada. APH serves a population of 115,870 (2011) [15], delivering the majority of vaccines in Sault Ste. Marie, Ontario and the surrounding area through two general weekly immunization clinics (~100 to 160 vaccines administered per week) (personal communication, Susan Berger, APH). Routine childhood and adult vaccines are given as well as travel-related vaccines. We recruited Intrahealth Canada Ltd., a British Columbia-based electronic medical record (EMR) vendor who added barcode scanning functionality to their *Profile* software system so that their client APH could participate (*Profile* immunization screen shown in Fig. 2) [16].

For barcoded vaccines, the immunizers scanned the vial to populate the client's record with the vaccine information (name, lot number, expiry date). For non-barcoded vaccines, the immunizers used *Profile*'s conventional method of recording vaccine information using drop-down menus that included all vaccines in inventory.

Immunization staff were provided with scanners (DS4208-HC Scanner, Motorola Ltd., United States, $260 CAD) with stands (Intellistand for DS42xx series, Motorola Ltd., United States, $39), and each nurse was trained on a one-on-one basis using dummy vials by an APH staff member who was experienced with barcode scanning.

2.1.2. Study Site 2: First Nations communities, Alberta

Our second study site was First Nations (FN) communities in Alberta. Those belonging to First Nations are Aboriginal people in Canada who are neither Inuit nor Metis (having Aboriginal and European heritage) [17]. Research agreements were developed with four First Nations communities to conduct full or partial data collection: Siksika Nation (on-reserve population [2011], 2858), Stoney First Nations (on-reserve population, 407), Kehewin First Nation (on-reserve population, 900), and Cold Lake First Nations (on-reserve population, 1235) [18]. OKAKI Health Intelligence is an Alberta-based immunization data collection software vendor that provides the *Community Health and Information Program* (*CHIP*) software to >30 First Nations communities. They upgraded their system in spring 2012 to include barcode scanning functionality