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Use of quality improvement science to improve the accuracy of drug allergy status in pediatric patients after allergist assessments

This study outlines a process for accurately documenting drug allergy status in electronic medical records in hospital and community systems and ensuring consistency among those systems so that patients receive the correct medical treatment.

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ABSTRACT

Background: Documentation of drug allergy status (allergic versus not allergic) of pediatric patients following assessment by an allergist can vary among electronic medical record systems. Inaccurate documentation can affect future medication selection, and lead to suboptimal and potentially dangerous treatment being administered to the patient.

Methods: A prospective, single-centre quality improvement study of drug allergy labeling in children referred to the BC Children's Hospital Allergy Clinic was conducted. Electronic medical records of drug allergy status in two systems, BCCH Cerner and PharmaNet, were analyzed to capture hospital care and community settings, respectively. Current state analysis was performed to determine the proportion of patients who had an accurate drug allergy status in Cerner and PharmaNet. An aim statement was then created: the intent was to increase the percentage of patients who were assessed for a drug allergy and had an accurate allergy status on Cerner and PharmaNet within 30 days of being seen by an allergist to 90%. A series of iterative data collection, assessment, and improvement cycles was completed over 12 months. Data were analyzed using time series charts to assess progress and determine if changes made resulted in improvements in drug allergy labeling.

Results: Current state analysis showed drug allergy status after formal allergist assessment was correct in between 60% and 90% of the consults by month in Cerner and between 45% and 100% in PharmaNet at baseline. Sustained improvement in documentation of drug allergy status in the hospital electronic medical record was achieved, but there were challenges in improving documentation in the community electronic medical record because allergists do not have access to it.

Conclusions: Documenting drug allergy status in multiple electronic medical records results in difficulty in ensuring the records are up to date in all systems. More work needs to be done to ensure that the results of drug allergy assessments are documented in a centralized fashion and are clearly communicated among health care practitioners.

Background

Drug allergy assessments are an integral part of an allergist's clinical practice. Patients who are assessed formally by an allergist may have true drug allergies and should avoid the medication in question. Equally important is the assessment of patients who carry labels of drug allergy but are deemed not to be allergic and do not need to avoid the medication in question. For the

safety and optimal management of patients, it is important that drug allergy status is kept up to date. Electronic medical records (EMRs) are located in hospitals as well as community settings, such as pharmacies and family physician offices. In many cases, these records contradict one another, which leads to discrepancies in medical documentation. It then becomes the responsibility of health care providers and patients themselves to ensure there is clear communication with health care teams regarding drug allergy status. Braund and colleagues assessed electronic profiles of general medicine inpatients and found that 45.5% of 332 profiles were classified as having no known drug allergies/intolerances, but 15.0% of those patients had allergies documented in other electronic systems, and 9.0% were classified as having unknown allergy status; of those patients, 10.0% had allergies documented in another electronic system.[1]

Multiple studies have reported persistence of erroneous penicillin allergy labels after assessment by allergists.[2-6] Lachover-Roth and colleagues conducted a 56-month follow-up study after penicillin delabeling of patients: 51.4% of patients who were successfully delabeled still had a penicillin allergy label in their EMR.[3] Few studies have assessed the proportion of patients who were deemed truly allergic and had drug allergy status correctly updated in their EMR.

Although some reports in the literature highlight the discrepancy in drug allergy status between EMRs after allergist assessment, no quality improvement studies that address this problem have been published. We believed that if the allergy clinic team had a standardized process for assigning drug allergy status labels, there would be increased accuracy of drug allergy status in various EMRs after consultation and assessment, which would ultimately reduce unnecessary adverse drug reactions and improve future medication selection for patients. We sought to assess the current accuracy of drug allergy status in EMRs after assessment by an allergist at the British Columbia Children's Hospital (BCCH) Allergy Clinic and to test changes for improvement that could ultimately be implemented. We also sought to monitor for sustained improvement over time to ensure longevity of the implemented measures.

Methods

Context

This was a prospective, single-centre quality improvement study of drug allergy labeling in consecutive children referred to the BCCH Allergy Clinic between December 2016 and December 2019 for assessment of possible drug allergies. All children aged 6 months to 18 years old were included, regardless of medication or allergy type in question. Following patient assessment by a pediatric allergist in the clinic, EMRs of drug allergy status were updated in two systems: BCCH EMR, Cerner, and PharmaNet. The two systems were analyzed to capture both hospital and community care settings. The PharmaNet database was selected because it is used throughout British Columbia by community and hospital pharmacists and at BCCH for medication reconciliation for patients being admitted. The BCCH Research Ethics Board provided a waiver for this study.

During each allergist consult, baseline demographics, including sex and age, were recorded, along with drug allergy status and the suspected medication in question. The proportion of patients deemed allergic versus not allergic was

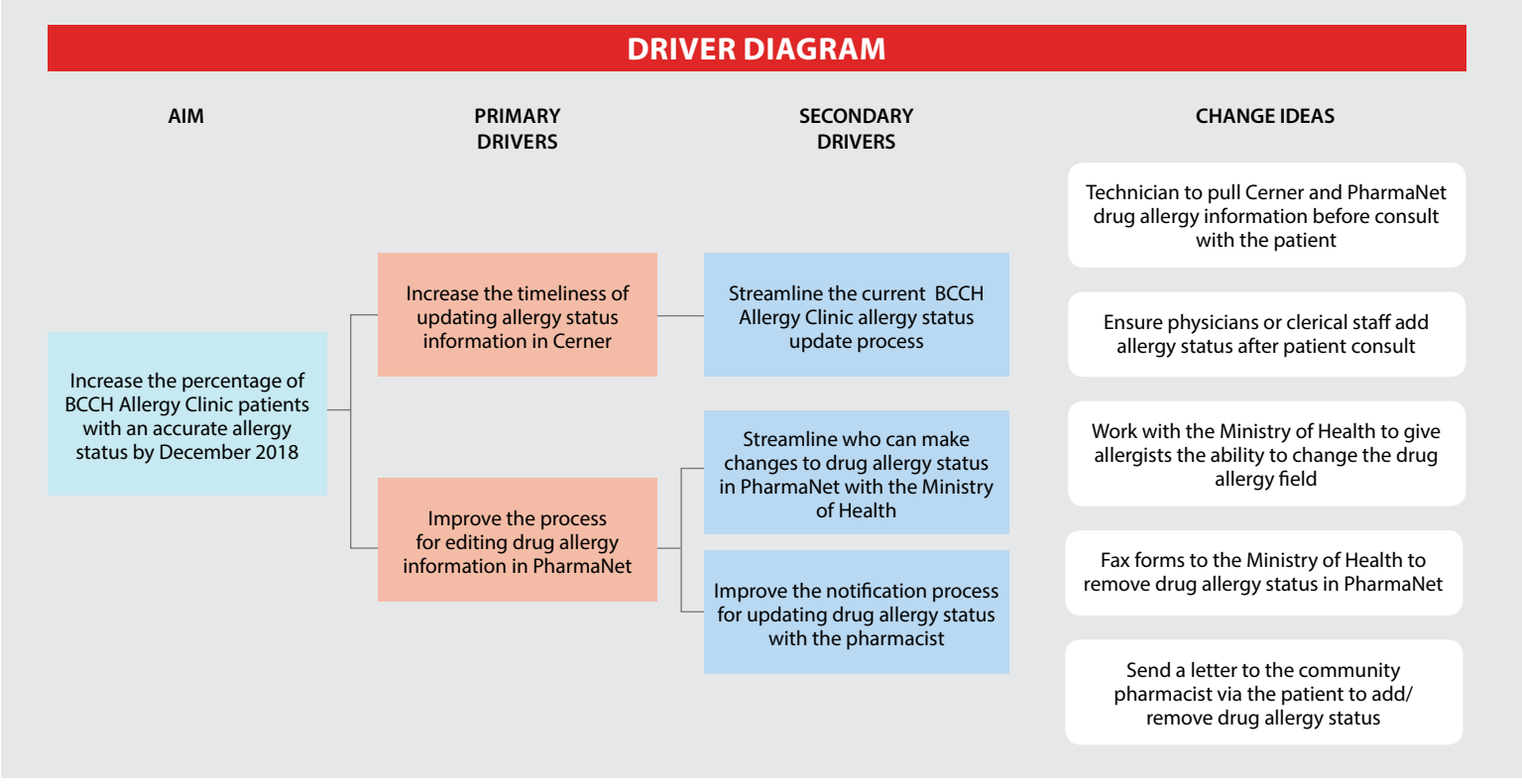

FIGURE 1. Process for improving the accuracy of documenting pediatric drug allergy status in electronic medical record systems.

calculated monthly and quarterly.

A current state analysis was conducted between December 2016 and May 2017 to determine the proportion of patients who had an accurate drug allergy status following assessment by a pediatric allergist. An aim statement was then created: the goal was to increase the percentage of patients who were assessed for a drug allergy at the BCCH Allergy Clinic and had an accurate allergy status on Cerner and PharmaNet within 30 days of being seen to 90% by December 2018. A driver diagram was developed to help guide tests of change in improvement **[Figure 1]**.

Interventions

We initially developed a standardized process in July 2017 in which allergists were responsible for providing handouts to the patient that indicated the result of their assessment, and for updating the patient's drug allergy status in the two EMR systems. In August 2017, reminder checklists for screening and updating drug allergy status, drug allergy challenge outcome letters, and Ministry of Health request forms to update PharmaNet were added to the patients' charts. In September 2017, we added a recommendation that allergists begin screening the patient's EMR for drug allergy status prior to their visit in order to improve efficiency. In November 2017, we changed the process again so that allergy technicians began assisting with screening and recording drug allergy status prior to patient visits. Within 1 month of each test of change intervention, we interviewed clinicians to assess their acceptability of the change, and to inform further tests of change and improvement. A series of iterative data collection, assessment, and improvement cycles was completed over 12 months. Over that period, data were collected monthly. Thereafter, monitoring of drug allergy status in both EMR systems was completed quarterly over an 18-month period.

Analysis

Data were analyzed using time series charts to assess progress and determine if changes resulted in improvements in the accuracy of drug allergy status documentation. P charts were used to assess the percentage of patients who had a correct EMR drug allergy status. Because the number of patients assessed varied over time, and incorrect drug allergy status documentation occurred infrequently, G charts were used to assess the number of patients seen between cases with an incorrect EMR drug allergy status. Improvements in the accuracy of drug allergy status documentation were assessed using standard rules for control charts: eight or more consecutive points above the mean, six or more consecutive points all trending upward, two of three consecutive points near a control limit, or a single point above the upper control limit.[7,8]

Results

The study included 270 children who were referred to the BCCH Allergy Clinic for assessment of possible drug allergy: 121 were female; 149 were male. Patients ranged in age from 6 months to 18 years old, with a mean age of 7.4 years. Most consults (90%) were for assessment of beta-lactam allergy. Some patients had multiple potential drug allergies assessed **[Table 1]**.

The current state analysis revealed that drug allergy status (allergic versus not allergic) after formal allergist assessment was correct in between 60% and 90% of the consults by month (mean = 78.4%) in Cerner **[Figure 2]**, and between 45% and 100% (mean = 90.0%) in

TABLE 1. Demographic and drug allergy assessment data.

Sex	**N (%)**
Male	149 (55)
Female	121 (45)
Total	270 (100)
Age	6 months to 18 years (mean 7.4 years)
Final assessment	
Allergic	41 (15%)
Not allergic	224 (83%)
Unconfirmed	5 (2%)
Total	270 (100%)
Drug in question*	
Beta-lactam	243
Nonsteroidal anti-inflammatory drug (NSAID)	15
Septra	12
Vancomycin	4
Valproic acid	2
Ondansetron	1
Local anesthetic	1
Clonidine	2

*Some patients had multiple potential drug allergies assessed.

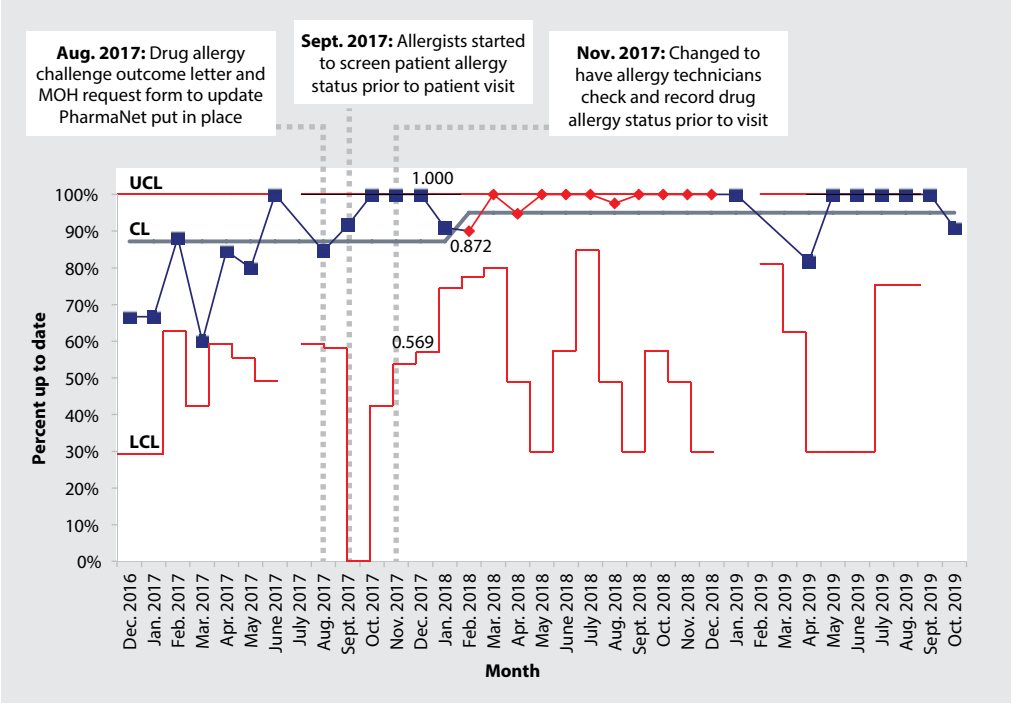

FIGURE 2. Percentage of patients with correct drug allergy status in Cerner (hospital electronic medical record): P chart. Blue lines and squares indicate that there is expected variability (i.e., no improvement); red lines and diamonds indicate there is special cause variation/nonrandom change outlined by Provost and Murray 2011 (UCL = upper control limit; CL = control limit; LCL = lower control limit; MOH = Ministry of Health).

PharmaNet [Figure 3]. The P chart for Cerner indicated that changes to the process accumulated between August and November 2017 and resulted in an improvement in correct drug allergy status, which was largely sustained for the remainder of the study [Figure 2]. The P chart for PharmaNet indicated that changes to the process accumulated between August and November 2017 and initially resulted in an improvement, but it was not sustained through the monitoring period [Figure 3]. Incorrect drug allergy status occurred less frequently over time in Cerner [Figure 4] but not in PharmaNet [Figure 5].

A subanalysis was conducted to compare categories of patients who did not have an up-to-date drug allergy status in the two EMR systems. Prior to the interventions, Cerner had 14 patients who did not have an up-to-date drug allergy status; PharmaNet had 17. After the changes were implemented, Cerner had 8 patients who did not have an up-to-date drug allergy status; PharmaNet had 37 [Table 2].

Discussion

This is the first known study to use quality improvement science to assess and develop changes within an allergy clinic to improve documentation of drug allergy status after assessment by an allergist. By assessing our current state prior to testing changes, we were able to determine what proportion of patients had an accurate record of drug allergy status, which informed our aim statement. Our study highlights internal and external factors that can either facilitate or be barriers to change. A strength of our study is that we were able to monitor drug allergy status for a prolonged period to ensure that the changes implemented were sustainable. We were also able to capture every patient who came through our clinic for drug allergy assessment and review their allergy status, even if their assessment required multiple visits and medication challenges.

We were successful in improving the proportion of accurate drug allergy status within our local hospital EMR Cerner [Figure 2] and the number of patients seen between those identified with inaccurate status [Figure 4].

The community EMR (PharmaNet) documentation was challenging to improve because

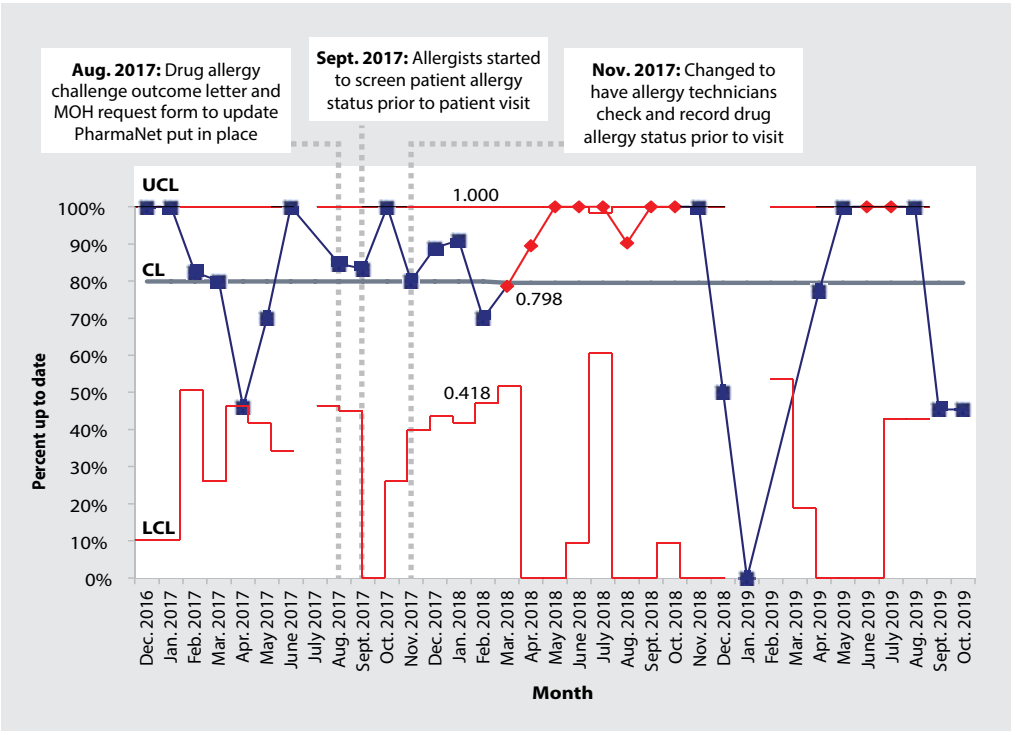

FIGURE 3. Percentage of patients with correct drug allergy status in PharmaNet (community electronic medical record): P chart. Blue lines and squares indicate that there is expected variability (i.e., no improvement); red lines and diamonds indicate there is special cause variation/nonrandom change outlined by Provost and Murray 2011 (UCL = upper control limit; CL = control limit; LCL = lower control limit; MOH = Ministry of Health).

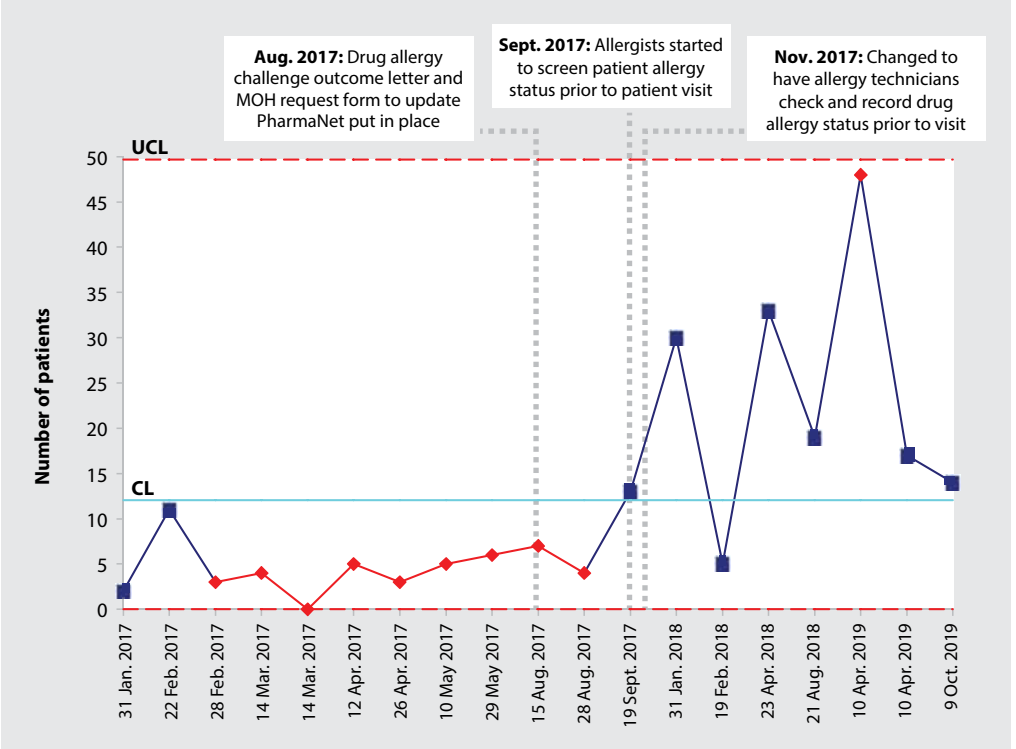

FIGURE 4. Number of patients seen between cases with incorrect drug allergy status in Cerner (hospital electronic medical record): G chart. Blue lines and squares indicate that there is expected variability (i.e., no improvement); red lines and diamonds indicate there is special cause variation/nonrandom change outlined by Provost and Murray 2011 (UCL = upper control limit; CL = control limit; MOH = Ministry of Health).

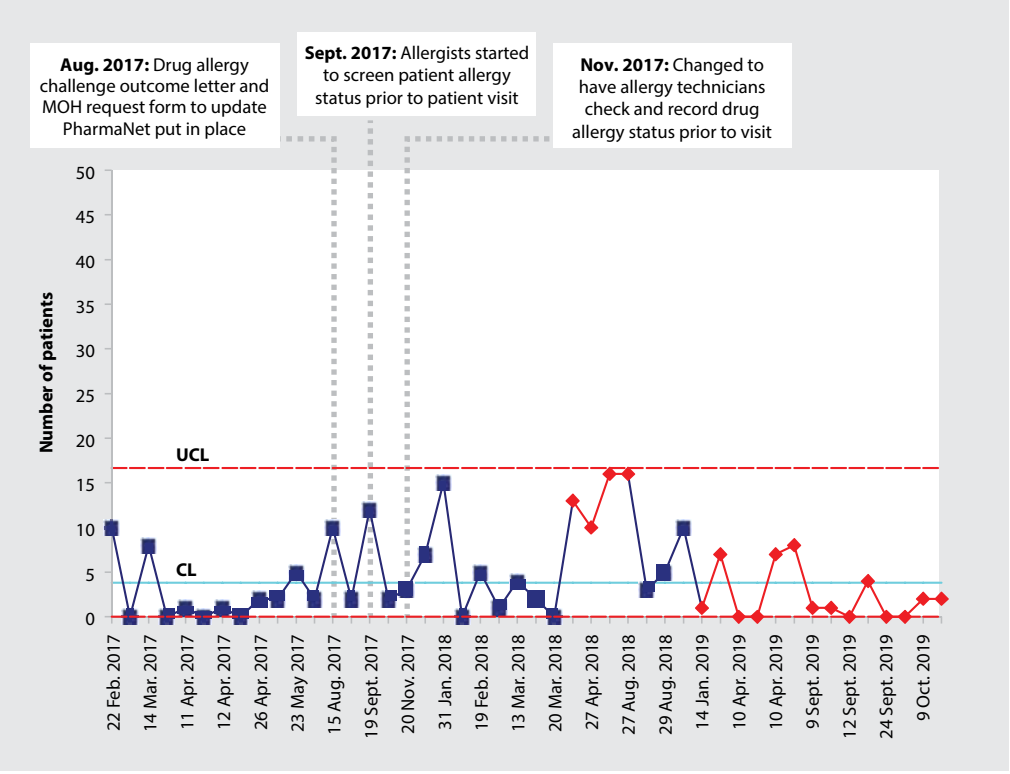

FIGURE 5. Number of patients seen between cases with incorrect drug allergy status in PharmaNet (community electronic medical record): G chart. Blue lines and squares indicate that there is expected variability (i.e., no improvement); red lines and diamonds indicate there is special cause variation/nonrandom change outlined by Provost and Murray 2011 (UCL = upper control limit; CL = control limit; MOH = Ministry of Health).

TABLE 2. Comparison of Cerner and PhamaNet categories of inaccurate allergy status.

	Cerner not up to date*		PharmaNet not up to date*	
	Current state analysis and during tests of change	After changes for improvement	Current state analysis and during tests of change	After changes for improvement
Allergic	7	5	7	30
Not allergic	7	3	7	6
Unconfirmed	0	0	3	1
Total	14	8	17	37

* Not up to date means "not accurate," as in the wrong label is applied (i.e., allergic when not actually allergic and vice versa), 1-month post allergist consult. The allergist's opinion is considered the "true" label.

allergists do not have access to it; only pharmacists can add a new drug allergy status to PharmaNet. We do not have a dedicated pharmacist in our clinic to provide direct patient care; thus, we are unable to make these changes. We provided allergy challenge outcome letters to families and had physicians complete the PharmaNet removal of adverse drug reaction form. It was evident from the results in Table 2 that most patients with incorrect drug allergy status in PharmaNet were those who were deemed to be truly allergic after assessment by an allergist. This is particularly concerning from a safety standpoint because patients may receive the same drug again, which puts them at high risk for future adverse drug reactions. The asynchronous nature of multiple EMR systems also remains a challenge for patients who have had their allergy delabeled. Allergists dictate a note to the referring physician as standard of care but cannot guarantee that the label will be removed from the family physician's EMR. We are still working with the managers of PharmaNet to improve this problem. With the rollout of Clinical & Systems Transformation (CST) to Provincial Health Services Authority hospitals, we will also be advocating for better drug allergy reconciliation.

This study highlights the importance of multidisciplinary collaboration in accepting new processes, testing changes for improvement, and implementing successful measures.

There are several limitations to this study. The scope was limited to pediatric patients in a local hospital setting; therefore, the logistical details of improvement may not be directly applicable to other centres. We did not assess or monitor drug allergy status in community physicians' offices, and this remains a gap in the medical literature in general. Finally, we did not assess for return of drug allergy status labels or drug use after patients were assessed by an allergist. This would be valuable information to have in the future to further inform improvements to the process.

Conclusions

This is a unique study on improving the accuracy of drug allergy status documentation in EMRs. It highlights the importance of multidisciplinary collaboration in accepting new processes, testing changes for improvement, and implementing successful measures. Monitoring for sustained improvement is important, even after the changes have been implemented. Challenges in improving accuracy of drug allergy status documentation remain when external factors cannot be easily monitored or changed widely, such as community EMRs, especially when there is no synchronization of

systems. More work needs to be done to ensure that the results of drug allergy assessments are documented in a centralized fashion and are clearly communicated so they are accurately retained in EMRs over the long term. Family physicians and pediatricians can take part in this improvement process by ensuring that drug allergy status is correctly documented in their own EMR, and by encouraging patients to alert their community pharmacist of known or delabeled drug allergies. ■

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More work needs to be done to ensure that the results of drug allergy assessments are documented in a centralized fashion and are clearly communicated so they are accurately retained in EMRs over the long term.

Competing interests

None declared.

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