Big Data Analytics and Visualization Break QI Silos and Empower Precision Targeting of Interdisciplinary QI: The INFECTALYTICS Project

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What might the attendee be able to do after being in your session?

Conceptualize the clinical laboratory quality improvement process as a collaborative effort amenable to Big Data analysis and visualization; apply CDW-derived retrospective and near-real-time data analyses to improve clinical QI project outcomes.

Description of the Problem or Gap

Traditional analyses of laboratory utilization create silos separating "analytic" errors (in-lab) from the clinical processes and decisions before samples arrive and after reports leave. The advent of integrated clinical data warehouses (CDWs) permits a holistic, Big Data approach to tracking multifactiorial influences on lab-related quality metrics. The analysis silos are mirrored by quality team silos, where cooperation is hampered by differing metric definitions, divergent analysis foci, and limited perception of options for intervention.

Methods:

We developed a data analysis and visualization platform, INFECTALYTICS, to address the need for holistic clinical laboratory quality data analytics. A SQL-based resource database using a simplified homebrew ontology accepted de-identified (scrambled MRN) input from both the local CDW (Cerner PowerInsight, Kansas City, MO) and from clinical-lab-generated, CSV-formatted ancillary source files. A graph-network analysis approach was taken to both analyze and visualize relationships between three or more clinical metrics and an associated quality metric. Agile development combined with close interdisciplinary collaboration proved vital to assuring clinical relevance and user-friendly graphical and interface design. Data analytics continued during intervention phases to monitor results and provide targeted and personalized performance feedback.

Blood culture contamination, a confounder for treating sepsis and cause of unnecessary treatments and healthcare resource waste, was chosen as a target quality metric during a recent spike in contamination rates at our main facility. Blood culture weight (as a proxy for sample volume) was included as a secondary metric. Analysis of blood culture contamination rates included correlations with data elements associated with patients (age, sex, BMI, ZIP code, etc.); with providers (ordering clinician, collecting provider, frequency of collection, number of samples collected); with lab personnel (accepting personnel, testing personnel); and with testing-associated factors (time of day, location of collection, time since arrival/admission, time from collection to incubation, time of incubation).

Results:

Analysis results indicated three clusters of factors correlating with increased contamination rates: (A) sample volume + samples/patient; (B) sample volume + collector ID + total samples by collector; (C) total samples by collector + time of day. Root cause analysis with clinical personnel identified the clinical correlates to these clusters: (A) patients with poor vascular access; (B) wide variation in collector skill and training, largely due to high [40% per month] turnover in emergency collection personnel; (C) overburdening of collection staff during peak operating hours.

A series of phased interventions was developed in collaboration between Emergency Department (ED) senior staff, Nurse Education, Infection Prevention, the Clinical Microbiology Laboratory, and the data analysis team. Initial data-directed investigations into collection practices revealed a variety of deviations from best practices among ED personnel. Further iterative interventions reinforced collection training with personalized feedback updated monthly, highlighting both high performers ("champions") and struggling personnel. Champions were encouraged to enact peer-to-peer mentoring and to be resources for cases involving poor vascular access ("difficult sticks"). A continuous cycle of training was undertaken to address the challenge of high staff turnover and to alleviate overburdening of "champions" and senior staff during peak hours.

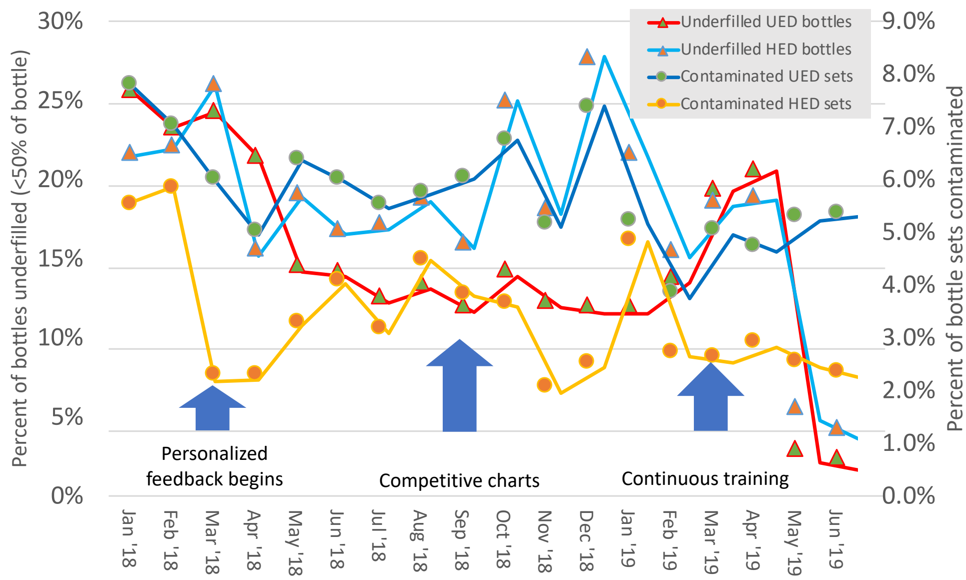

Figure 1. Effect of phased interventions on blood culture contamination rates (circles) and occurrence of underfilled bottles (triangles) at two intervention sites (UED, University Hospital ED; HED, Highlands Hospital ED). Cumulative intervention effects reduced underfilling to <5% at both sites and provided a sustained 3% decrease in blood culture contamination rates.

Discussion of Results

The broad perspective enabled by the INFECTALYTICS analytical approach provided both a unified framework for hospital-wide quality improvement collaboration as well as providing novel insights into unconsidered factors causing poor quality outcomes in our institution. Data-driven targeted root cause analysis and intervention allowed clinical personnel to tailor quality interventions both in terms of institutional procedure development and staff education, but also to personalized feedback and data-driven teambuilding. An unexpected development was the request for data products supporting a "competitive" work environment, with a large chart of performance by provider posted in the staff lounge for both individual and collective motivational inspiration.

Close collaboration was invaluable at all stages of software and intervention development. Combining agile developer practices with interdisciplinary consultation resulted in rapid design iterations in visualization graphics, culminating in products that displayed complex data relationships in a form readily interpretable by clinical staff without informatics training.

Conclusion

Combining Big Data analytics with interdisciplinary collaboration in clinical settings can empower quality improvement teams to address previously neglected factors affecting clinical quality metrics.

Attendee's Take-away Tool