Effectiveness of barcoding for reducing patient specimen and laboratory testing identification errors: a Laboratory Medicine Best Practices systematic review and meta-analysis


CRD summary
The authors concluded that bar-coding systems for specimen labelling and point-of-care test bar-coding effectively reduced patient specimen and laboratory testing identification errors in diverse hospital settings. Despite potential limitations of included studies, the wide evidence base of large studies showed consistent findings of significant benefit. The authors’ conclusions reflect the findings and seem reliable.

Authors' objectives
To assess the effectiveness of bar-coding practices for reducing patient specimen and laboratory testing identification errors.

Searching
PubMed, EMBASE, and CINAHL were searched for articles published in English between 1995 and 2012. Search terms were reported. Reference lists of relevant sources were manually searched and experts in the field were contacted for further relevant data. In addition, unpublished quality improvement studies were sought from submissions to the Laboratory Medicine Best Practices Initiative.

Study selection
Eligible for inclusion were studies that assessed effectiveness of bar-coding practices or point-of-care testing in all patients or their specimens in healthcare settings. Bar-coding practices were defined as laboratory test bar-coding systems using bar-coded patient identification linked to specimen labels. Eligible studies had to compare bar-coding to non-bar-coding identification systems for patients, specimens and laboratory tests. The outcome of interest was specimen and/or laboratory testing identification error rates.

Included study time period ranged from 1999 to 2011, where reported. Patients were seen in acute care community hospitals, emergency departments, surgical departments and a paediatric oncology hospital. Patient specimens were tested in hospital settings (including teaching hospitals), clinical pathology or surgical/anatomic pathology laboratories. Specimens included blood, tissue and body fluid; all point-of-care test bar-coding studies were glucose tests.

Two reviewers independently screened studies for inclusion, with discrepancies resolved through consensus.

Assessment of study quality
Two reviewers independently assigned one of three quality ratings (good, fair or poor) to each study and rated the overall strength of the body of evidence (high, moderate, suggestive or insufficient). Studies of poor study quality were excluded from the review.

Any discrepancies were resolved through consensus.

Data extraction
Two reviewers independently extracted rates or percentages of correct patient specimen and/or test identifications versus misidentifications to calculate odds ratios and 95% confidence intervals. Effect sizes were rated as substantial (odds ratio greater than 2.0 with a lower 95% confidence interval greater than 1.0), moderate or minimal/none.

Discrepancies were resolved through consensus.

Methods of synthesis
A random-effects model was used to combine odds ratio and 95% confidence intervals. Statistical heterogeneity was assessed using $I^2$; studies considered too different compared to other studies were excluded from meta-analyses.
Separate analyses were performed for bar-coding systems and point-of-care test bar-coding systems and evidence-based recommendations were provided (recommend, no recommendation for or against, recommend against). Subgroup analyses were undertaken by quality rating.

Results of the review
Seventeen before-and-after observational studies were included in the review (where reported, sample sizes ranged from 462 to 724,465 patients).

Bar-coding system (10 studies): Six studies were rated as good quality and four as fair quality; seven studies showed substantial effect sizes and three reported moderate effect sizes. Bar-coding statistically significantly reduced the error rate compared to rates before the introduction of bar-coding practices (OR 4.39, 95% CI 3.05 to 6.32; nine RCTs) with modest heterogeneity (I²=24.8%). Subgroup analyses indicated that studies of good quality resulted in greater reductions in error rates (OR 5.14, 95% CI 3.41 to 7.74; six studies; I²=10.5%) compared to studies of fair quality (OR 2.43, 95% CI 1.10 to 5.39; three studies; I²=15.9%).

Point-of-care test bar-coding (seven studies): Five studies were good quality, two were fair quality; six studies reported substantial effect sizes, one reported a moderate effect size. Point-of-care test bar-coding statistically significantly reduced error rates compared to rates prior to the introduction of this practice (OR 5.93, 95% CI 5.28 to 6.67; seven studies) with evidence of statistical heterogeneity (level not reported). Subgroup analyses indicated similar results for good and fair quality studies.

Authors’ conclusions
Bar-coding systems for specimen labelling and point-of-care test bar-coding effectively reduced patient specimen and laboratory testing identification errors in diverse hospital settings.

CRD commentary
The review question was clear and inclusion criteria were broadly stated. The literature search included a search for unpublished data, but as the search was limited to English, language bias could not be ruled out. Each stage of the review process was performed in duplicate, which reduced potential for reviewer error and bias. Study quality was assessed, but only overall quality ratings were reported and all studies were before/after observational studies which had inherent limitations.

Most included studies had very large sample sizes. Detailed patient and study characteristics were reported in appendices for several studies, but these studies could not be consolidated with those included in the review. It was also unclear how error rates were detected.

The authors acknowledged that studies were from single centres and that this may have introduced site-specific differences, also bar-coding processes may have been very different and have varied for different specimens. Despite potential limitations of included studies, the sample sizes were large and effect sizes were generally large and consistent in showing improvements. The authors' conclusions reflect the findings and appear to be reliable.

Implications of the review for practice and research
Practice: The authors stated that bar-coding systems for specimen labelling and point-of-care test bar-coding were recommended as best practices to reduce identification errors and improve accuracy of patient specimen and laboratory testing identification in hospital settings.

Research: The authors stated that standardised outcome measures and measurement methods were needed to reliably detect identification errors. Further studies were needed in ambulatory and non-hospital settings, as well as surgical pathology and settings with higher error rates. Cost effectiveness studies were also needed. The authors also stated that research on other benefits and harms of bar-coding was needed.

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