The Effects of Patient Handoff Characteristics on Subsequent Care: A Systematic Review and Areas for Future Research

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Abstract

Purpose
To summarize the available evidence about patient handoff characteristics and their impact on subsequent patient care in hospitals.

Method
In January and February 2011, the authors searched the Cochrane Central Register of Controlled Trials, PubMed, Embase, CINAHL, PsycINFO, ERIC, ISI Web of Science, and the reference lists of relevant articles to carry out their systematic review. They selected articles that (1) had patient handoffs in hospitals as their explicit research focus and (2) reported at least one statistical test of an association between a handoff characteristic and outcome. They assessed study quality using 11 quality indicators.

Results
The authors identified 18 articles reporting 37 statistical associations between a handoff characteristic and outcome. The only handoff characteristic investigated in more than one study was the use of a standardized handoff sheet. Seven of those 12 studies reported significant improvements after introduction of the sheet. Four of the 18 studies used a randomized controlled trial design.

Conclusions
Published research is highly diverse and idiosyncratic regarding the handoff characteristics and outcomes assessed and the methodologies used, so comparing studies and drawing general conclusions about the field are difficult endeavors. The quality of research on the topic is rather preliminary, and there is not yet enough research to inform evidence-based handoff strategies. Future research, then, should focus on research methods, which outcomes should be assessed, handoff characteristics beyond information transfer, mechanisms that link handoff characteristics and outcomes, and the conditions that moderate the characteristics' effects.

Through the patient handoff, responsibility, authority, and information about patients are exchanged between care providers[1] to ensure the continuity of patient care during shift changes and transfers of patients from one unit to another. Because patient handoffs are organizational interfaces, they affect patient safety and service quality. Thus, there is a causal link between handoff characteristics, such as information completeness, and outcomes, such as adverse events.[2,3] As the literature on patient handoffs grows, we question what we know about this causal relationship. Specifically, we ask (1) which handoff characteristics researchers have proved to be related to which outcomes, and (2) whether their study designs allow for causal inference.

Several reviews on patient handoffs have been published recently.[4–9] Although these reviews provide valuable insights into the state of handoff research, an evidence-based overview of the causal relationships between handoff characteristics and outcomes is still lacking. Such an overview, however, is necessary for at least three reasons:

1. to make evidence-based decisions about which handoff characteristics should be changed to achieve the desired outcomes,
2. to document which aspects of handoffs have been studied and for which ones we lack understanding, and
3. to relate the examined handoff characteristics and outcomes to systematic theorizing on what characteristics are linked to which outcomes, by what mechanisms, and what conditions alter these relationships.[10,11]

The first aim of our systematic review was to update and complement the existing reviews by assessing the empirical evidence on the relationships between handoff characteristics and outcomes. We did so by including the previous reviews in our new search of seven common databases. The second aim was to identify recurring methodological problems in previous research by examining the studies' quality with particular regard to their potential for causal inference.

We focused on patient handoffs within hospitals, including those between paramedics and the emergency department. We made no restrictions on study design, handoff characteristics, or outcomes to achieve our goal of providing an overview of the published research. We defined a handoff outcome as anything that (1) occurs after completion of the handoff and (2) is related to the patients who are handed off or their treatment (e.g., preventable adverse events or physician information recall after handoff). Thus, we did not consider changes in the handoff process, such as the amount of information omitted during handoff, as outcomes. As handoff characteristics, we included

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anything that was present or happened during the handoff (e.g., the nature of the information transmission, characteristics of the patient handed off, or environmental conditions).

Method

In carrying out our review, we used the five-step protocol proposed by Karunananthan and colleagues[12] as a framework. We summarize the core process of our article search and selection in Figure 1.

Step 1: Defining aims, search terms, and inclusion/exclusion criteria

We first defined the aims of our search as stated in the introduction. We then defined a set of search terms by combining those from previous reviews[4,7–9] with two from Messam and Pettifer's[5] work and "transition of care" and "care transition." Our search then included the following search terms:

- handover,[4,7–9] hand-over[4,7,8];
- handoff,[4,7–9] hand-off[4,7–9];
- signout,[4,7–9] sign out,[4,7,8] sign-out[4,7–9];
- signover,[4,7,8] sign-over[4,7,8];
- shift change[9];
- shift report[5,8];
- intershift report[5,8];
- transition of care; and
- care transition.

Our inclusion criteria for article selection were that one of the search terms had to appear in the title, abstract, or text; patient handoff had to be the explicit, main research focus; and the studied handoff had to take place within a single hospital or between paramedics and the hospital. Our exclusion criteria were that the article dealt with handoff as only one aspect of a broader topic of interest or with handoff between organizations or in a psychiatric setting.

Step 2: Searching databases and selecting articles based on title and abstract

In January and February 2011, we searched the Cochrane Central Register of Controlled Trials, PubMed, Embase, CINAHL, PsycINFO, ERIC, and ISI Web of Science for peer-reviewed journal articles and proceeding papers published through December 31, 2010. We entered our search terms in the databases' "all fields" option and added a wildcard at the end of the search terms (e.g., handover*). We allowed search engines to include

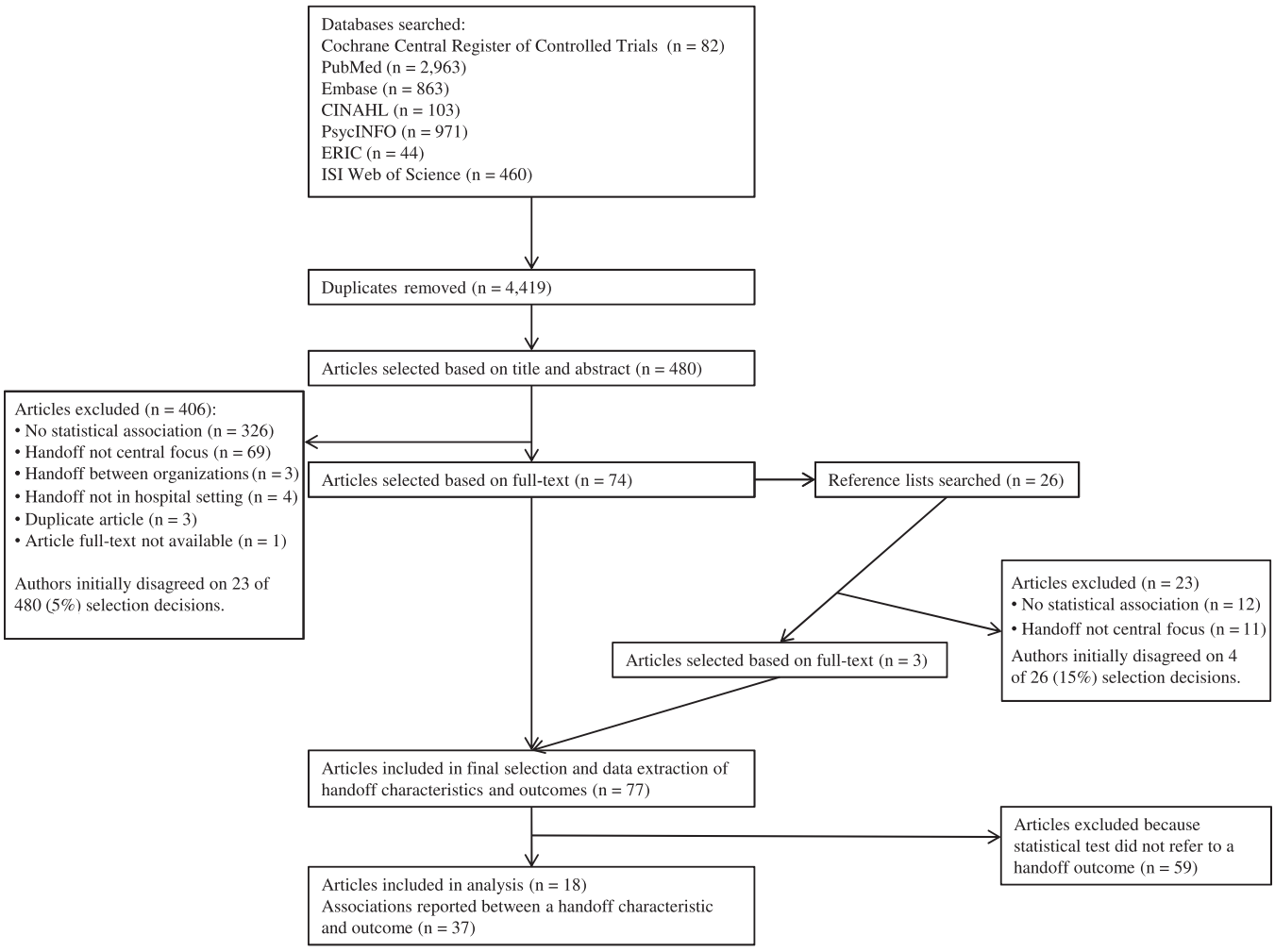

Figure 1 Flowchart of article search and selection process in a systematic review of patient handoff characteristics and outcomes research published through December 31, 2010. The authors used the Cochrane Central Register of Controlled Trials, PubMed, Embase, CINAHL, PsycINFO, ERIC, ISI Web of Science, and relevant reference lists to identify the articles included in their analysis.

their own search terms associated with ours, and we put search terms consisting of several words in quotation marks (e.g., "shift report"). We restricted our ISI Web of Science and PubMed searches to articles published in English.

Then, each author (S.F. and T.M.) independently selected a first group of articles based on title and abstract. We discarded only those articles that were rejected by both of us. Before starting the selection process, we calibrated our notion of the inclusion/exclusion criteria by jointly reviewing a random sample of 15 articles.

Step 3: Selecting articles based on full texts and identifying articles from reference list reviews

Next, we subjected the selected articles to a second round of selection based on the full text. To remove the vast number of anecdotal reports and comments in the handoff literature, we added an additional inclusion criterion: The article had to report at least one statistical test. We reviewed the full texts of the selected articles independently and used a consensus decision in case of disagreement.

After this second round of selection, we independently searched the reference lists of all the selected articles and of previous reviews.[4–9] We retained every reference that one of us deemed important.

Step 4: Selecting articles from reference list reviews

We then compared the articles from our reference lists review with those that we had previously identified to remove duplicates. Next, we repeated the process of full-text selection described above in Step 3 for these new articles.

Step 5: Selecting the final articles and extracting the data

Finally, we subjected all the previously selected articles to a final selection process, extracted the relevant study characteristics, and rated the studies' quality.

First, we extracted the handoff characteristics and outcomes from each article that were subjected to a test of statistical association, and we excluded those studies whose statistical tests did not refer to a handoff characteristic–outcome association. We chose an inductive approach to this extraction because we are not aware of an existing list of possible handoff characteristics, and a previous list of handoff outcomes was too broad for our analysis.[9] The first author (S.F.) completed the data extraction, and the second author (T.M.) cross-checked the results. As outlined in the introduction, to qualify as an outcome, a variable had to (1) occur after the completion of the handoff and (2) be related to the patient who was handed off. A handoff characteristic could be anything that was present or that happened during the handoff.

Second, we classified each handoff characteristic–outcome association according to the 11 indicators of study quality proposed by Buckley and colleagues.[13] We scored each association with either a "0," "0.5," "1," "unclear," or "does not apply." In addition, we extracted several study characteristics from each article, namely:

- the results for each tested association,
- the handoff sample,
- the study design,
- all variables statistically controlled for, and
- the dominant study purpose, as defined by Cook and colleagues[14] ("description study" describing an intervention or what was done, "justification study" testing whether an intervention worked, or "clarification study" explaining how and why an intervention works).

The first author (S.F.) performed the classification of each article and the data extraction, and the second author (T.M.) cross-checked the results.

Results

We included a total of 18 articles reporting 37 statistical associations between a handoff characteristic and an outcome. Most of the studies (16 of 18; 89%) were predominantly justification studies. More important, only 2 (11%) were clarification studies aimed at model building and theorizing.[15,16]

Handoff characteristics and outcomes

Our results reflect a high heterogeneity in handoff characteristics and outcomes. List 1 includes all the handoff characteristics that were linked to an outcomes measure. Appendix 1 includes a complete list of the final 18 articles and 37 statistical associations that we reviewed.

With the exception of standardized handoff sheets, other handoff characteristics were included in only one study each. Therefore, we could not summarize these results or draw general conclusions regarding these characteristics. We thus restricted the following summary to standardized handoff sheets. Because of the heterogeneity of the outcomes associated with handoff sheets, we did not perform a meta-analysis.

We classified all the studies of standardized handoff sheets in our analysis as justification studies. In 7 of the 12 justification studies, researchers found statistically significant improvements when comparing the outcomes of those handoffs that included a standardized handoff sheet with those that did not. These improvements included outcomes such as decreases in the number of dropped tasks,[17] patient care items lost within 24 hours of the handoff,[18] and patient information lost across consecutive handoffs[19,20]; increases in the retention of information by receiving clinicians[21] and prevention of adverse events[22]; and a change in the number of transferrer interventions required after handoff and in the number of first doses of medication administered in a timely fashion.[23] Researchers found these improvements in a variety of handoff situations, including shift handoffs between residents of various surgical services,[17] shift handoffs between teams in a trauma/surgical intensive care unit (ICU),[18] simulated ward shift handoffs between nurses,[19] shift handoffs between physicians in a mixed surgical/medical ICU,[21] shift handoffs between physicians in medical services,[22] handoffs from an oncology and hematology unit to critical care units,[23] and simulated otolaryngology ward shift handoffs between physicians.[20]

In addition, one study found a nonsignificant decrease in the number of postoperative, high-risk events after the handoff from the operating theater to the pediatric ICU.[24] Another study found a significant decrease in the number of dropped tasks as self-perceived by night

List 1

Overview of the Results of a Systematic Review of Studies Published Through December 31, 2010, That Linked a Handoff Characteristic to an Outcomes Measure

Overview of handoff characteristics that have been studied in relation to one of the below outcomes

- Use versus no use of a standardized handoff sheet (12 studies)[17–28]
- Use versus no use of a mnemonic standardizing the topics to be discussed during handoff (1 study)[29]
- Use of other information management interventions during handoff (3 studies)[30,32,33]
- Description of the information being transferred during handoff (3 studies)[15,20,33]
- Behavior of teams during handoff (1 study)[16]
- Characteristics of the receiving clinician during handoff (1 study)[21]
- Characteristics of the patient handed off (1 study)[33]
- Impact of shift day times (1 study)[21]

Overview of handoff outcomes that have been studied in relation to one of the above characteristics

- Loss of patient care items (failure to mention item in subsequent handoff or failure to execute item)[18–20]
- Information recall and retention after handoff[15,21,33]
- Quality of care plan written down after handoff[15]
- Dropped tasks[17,25]
- Surprises (unexpected changes in care), deviations from expected care, undesirable treatment actions, errors, preventable adverse events, high-risk events, and rate of intensive care unit transfers[17,22,24–27,29,32]
- Rate of readmission within 72 hours of handoff[30]
- Number of transferrer interventions necessary after handoff[23]
- Number of medication first doses administered on time[23]
- Time to first intervention by receiving clinician[28]
- Patient length of stay[28]
- 30-day patient outcomes[16]
- Total hospital cost per patient[30]

interns, and nonsignificant trends toward decreases in the numbers of dropped tasks and undesirable treatment actions by night interns as perceived by the day interns after reassuming responsibility for the patients.[25]

Besides these findings of improvements following the introduction of a standardized handoff sheet, one study failed to find any positive effects,[26] and another actually found a significant increase in the unexpected changes in care and the number of errors when practitioners used formal data summaries for handoffs.[27] Finally, one study found a significant decrease in patient length of stay but an almost significant increase in the time taken to the first medical intervention after handoff.[28]

Study quality

In general, the studies that we analyzed were heterogeneous, idiosyncratic, and not very well developed in methodological quality and study reporting. To achieve the second aim of our review—to examine the studies' potential for causal inference—we examined each for "control for confounding," which we subdivided into control by study design and control by statistical means.

Control by study design. Four of the 18 studies used a randomized controlled trial (RCT) design, 3 of them in a simulated setting[15,19,20] and 1 in a field experiment.[26] One study used a case–control design,[22] and another was a cohort study with a time delay between measurement of handoff characteristic and outcome.[16] Of the remaining 12 studies, 11 used a pre-/posttest design without a comparison group, and 1 was a cross-sectional study.[27] Of the 37 associations that we reviewed between a handoff characteristic and an outcome, 8 were tested through an RCT design.

Control by statistical means. Seven of the 14 non-RCT studies[17,22–24,28–30] and 2 of the 4 RCT studies[15,26] controlled for confounding through statistical means. Of the 6 pre-/posttest design studies that made use of statistical controlling, 4 did so by comparing confounders between treatment and control groups and ruling out a confounder when this test revealed no significant differences between the two groups.[23,24,28,29] However, this practice relies on the problematic assumption that a nonsignificant *P* value implies that there is no clinically relevant difference between groups.[31]

Besides controlling for confounding, data collection methods were also heterogeneous and tied to the setting of the study. Six of the 18 studies relied at least partly on subjective hindsight measures.[17,25–27,29,32] Studies using observer or reviewer data reported high variation in observer training, efforts to develop a systematic observation form, and pooling of observer judgments.[15,16,18–24,28,30,33] Three of the 12 observer-based studies reported reliability of measures.[15,16,22]

Discussion

In this systematic review, we searched seven common databases for handoff literature and provided an overview of the handoff characteristics and outcomes that have been reported in the literature to date. For studies on standardized handoff sheets, we summarized the results of our review. In addition, we assessed the methodological quality of the studies in our analysis with a particular focus on the potential for causal inference.

All in all, our overview of handoff characteristics and outcomes shows that handoff research is highly diverse and idiosyncratic, so a comparison of different studies is difficult. Accordingly, we had trouble drawing general conclusions from our findings. This state of affairs presents a serious challenge to handoff researchers and practitioners because it is unclear what they can gain with certainty from previous studies to use when designing future research and improvement initiatives.

Our results are not conclusive regarding the benefits of standardized handoff sheets. Despite several studies reporting positive results, others found mixed results or failed to find positive effects, and one actually found a negative

effect. We thus cannot offer hints on what would be an effective strategy for standardizing handoff sheets, because the studies that we reviewed each examined a separate sheet, and there were no clarification studies analyzing what makes a standardized handoff sheet (in) effective. In addition, we were unable to locate enough studies to compare the effects of handoff strategies other than standardized sheets (e.g., a mnemonic standardizing the topics to be discussed during handoff). Thus, we cannot provide clear, evidence-based guidance on effective handoff strategies based on our findings in this review.

However, our review did identify areas for future research in handoff outcomes. First, we found almost no clarification studies (with the exception of Dowding[15] and Mazzocco and colleagues[16]) aimed at both model building and theorizing about which handoff characteristics (including standardization) impact which outcomes, how and why they do so, and what boundary conditions alter these impacts. It is such studies, however, that deepen our understanding of the patient handoff and its impact on outcomes by initiating an iterative "cycle of observation, formulation of a model or hypothesis to explain the results, prediction based on the model or hypothesis, and testing of the hypothesis, the results of which form the observations for the next cycle."[14] Second, because handoffs are complex and multifaceted, researchers should not exclusively focus on information transfer.[34] Yet, this was the only characteristic for which we found more than one outcomes study.

We also found limitations to the methodologies in all the studies that we reviewed, echoing the concerns raised in previous reviews.[7,8,11] In particular, controlling for confounding was poorly developed, and data collection methods varied highly. As a result, not only is drawing general conclusions from handoff studies hampered by the diversity in characteristics and outcomes described previously, but such conclusions are also less reliable from a methodological point of view.

Limitations

Although we took care to carry out this review in a systematic manner, using extensive searches, there are several limitations to our study. First, the evidence that we summarize is mostly based on observational studies and studies without comparison groups. Therefore, our evidence summary for standardized handoff sheets may be limited by the lack of control in the reviewed studies. Second, although we included seven common databases, other databases may reveal further articles. Also, whereas we used an extensive set of search terms combined from previous reviews, we entered search terms in English only, and we restricted two searches (ISI Web of Science and PubMed) to English-language publications. Third, as in any review, there may be a publication bias toward positive results,[11] and, thus, the picture that emerged of standardized handoff sheets may be more positive than in reality. Finally, our review had a clear focus—excluding all studies not assessing a handoff outcome. This focus was well suited for our purposes, but there are important and interesting handoff studies that we did not include in our review because they did not assess an outcome, so readers should not conclude that the community knows nothing more about handoffs than we have included here. There are a number of studies tapping into the complex nature of the handoff process,[34–38] uncovering important dynamics that deserve future study.

Areas for future research

Several recommendations follow from our review. First, handoff characteristics other than standardized handoff sheets should be linked to outcomes. In particular, we recommend studying

- mnemonics standardizing the topics to be discussed during handoff instead of information content,[29]
- the relative importance of general medical facts versus case-specific assessments, such as anticipatory guidance[39] and overall judgments of the patient,
- the characteristics of receiving clinicians,[21] in particular their clinical expertise,
- the case complexity of patients handed off (e.g., triage status,[33] diagnosis, severity of illness,[22] comorbidities), and
- the nature of the interactions of the health care team.[35,40]

Second, handoff research should start with systematic theorizing and conducting clarification studies, as already recommended in the field of medical education research.[14] This includes determining which outcomes are likely to be affected, by which handoff characteristics, through which mechanisms, and what moderating conditions are likely to alter the effects of handoff characteristics.[10] For example, a standardized handoff sheet may decrease the number of laboratory tests and the number of consults required by increasing the completeness of the receiving clinician's patient knowledge. At the same time, this positive effect may be observed in more experienced clinicians only, as they benefit from complete information while simultaneously being able to separate relevant from irrelevant information. Conversely, for less experienced clinicians, the handoff sheet could simply result in information overload.[41] We can think of at least three classes of outcomes for such interventions that should be studied:

- clinical outcomes, such as preventable adverse events and patient complications,
- efficiency outcomes, such as total cost per patient, patient length of stay, or number of laboratory tests performed,[42] and
- the quality of the receivers' mental models after handoff, including knowledge of the patient's current condition and history, knowledge of possible problems and complications, and plans for future care.

Finally, we recommend addressing some methodological issues concerning study designs and statistical control. Regarding justification studies and studies testing specific causal hypotheses derived from previous research, we need more studies using RCT designs and comparison groups. Researchers may consider using full-scale patient simulators to study handoff dynamics in a controlled and standardized way[43] and pretest handoff sheets before changing field practices. Regarding clarification studies, future research should draw on the full range of research methods to tap into the complex nature of handoff characteristics and their impacts on subsequent care.[14] We still see a need for qualitative and

observational studies describing how and why handoff characteristics impact particular outcomes. Such studies provide the basis for deriving and testing specific causal hypotheses and for designing informed interventions.

As a means of statistical control, we recommend using multivariate techniques, such as multiple regression. Such techniques not only effectively control for confounding but also reveal how variables, such as the patient's condition or physician's expertise, impact the outcome relative to handoff effects. At least two classes of control variables—the transferring and receiving clinicians' expertise and the patients' conditions such as type of diagnosis, severity of illness, and comorbidities—are likely to be important across a variety of handoff situations.

Conclusions

Handoff research is highly diverse, so drawing general conclusions from the published literature is a difficult endeavor. In addition, the quality of the published research on the topic is rather preliminary, and there is not yet enough evidence to inform evidence-based handoff strategies. Future research, then, should pay more attention to research methods, which handoff outcomes should be assessed, handoff characteristics beyond information transfer, mechanisms that link handoff characteristics and outcomes, and the conditions that moderate the characteristics' effects.

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Appendix 1

Comparison of 37 Statistical Associations Between Patient Handoff Characteristics and Outcomes Reported in 18 Studies Identified in a Systematic Review of the Literature Published Through December 31, 2010

Study	Handoff characteristic	Handoff outcome	Handoff sample	Study result	Effect size; *P* value*	Study quality score (out of 12)†	No. of unclear indicators†	No. of "does not apply" indicators†
Standardized handoff sheet								
Bhabra et al, 2007[20]	Standardized handoff sheet versus verbal (without note taking) versus written (verbal + note taking)	Number of data points retained after the fifth (of 5) consecutive handoff	5 simulated otolaryngology ward shift handoffs between senior house officers; each handoff covered 12 patients.	Standardized handoff sheet produced almost-complete information retention (79 of 80; 98.75%), whereas written handoff led to information loss (68.5 of 80; 85.6%), and verbal handoff led to an almost-complete loss of information (2 of 80; 2.5%).	Sheet versus note taking: OR = 13.26 (1.68–104.99), $P < .05$; sheet versus verbal only: OR = 3081 (273.75– 34676.27), $P < .001$	8	0	1
Coutsouvelis et al, 2010[23]	Standardized handoff sheet with verbal delivery	Number of transferring pharmacist interventions required after handoff	52 between-units handoffs from an oncology and hematology unit to critical care units (30 handoffs before an intervention, 22 after). Patients were handed off from clinical pharmacists to critical care medical staff.	Reduction of specific transferrer interventions necessary from 30 of 30 (100%) cases before standardization and 15 of 22 (68%) after.	Cramer V = 0.46 (0.19–0.73), $P = .001$	6.5	1	0
				Total number of required specific transferrer interventions dropped from 144 to 26 after standardization.	$P < .0001$			
				Mean numbers of required specific transferrer interventions per handoff dropped from 4.80 to 1.18 after standardization.	$P < .0001$			
				At the same time, the rate of other interventions not covered in the handoff sheet did not change.				

(*Appendix Continues*)

Appendix 1, continued

Study	Handoff characteristic	Handoff outcome	Handoff sample	Study result	Effect size; *P* value*	Study quality score (out of 12)†	No. of unclear indicators†	No. of "does not apply" indicators†
Coutsouvelis et al, 2010[23]	Standardized handoff sheet with verbal delivery	First dose of medication administered on time	52 between-units handoffs from an oncology and hematology unit to critical care units (30 handoffs before an intervention, 22 after). Patients were handed off from clinical pharmacists to critical care medical staff.	Preintervention, 22 of 30 (73%) patients had at least 1 specific therapy administered more than 6 hours after it was due; only 2 of 22 (9%) patients had such a delay after standardization.	OR = 27.5 (5.21–145.16), $P < .0001$	6.5	1	0
Petersen et al, 1998[22]	Standardized sign-out sheet	Number of preventable adverse events	Shift handoffs in medical services (general medicine, intensive care unit [ICU], cardiology), including interns and residents. Preventable adverse events, not handoffs, in 6,893 patients are sampled.	Cross-coverage significantly increased the likelihood of a preventable adverse event during the baseline period but not significantly after the introduction of the computerized sign-out sheet.	Baseline period: OR = 5.2 (1.5–18.2), $P < .01$; intervention period: OR = 1.5 (0.2–9.0), $P = .68$	7	1	0
Philibert, 2009[27]	Formal data summary	Number of surprises (unexpected changes in care) as reported by the clinician who received the patient at the end of shift	Shift handoffs among residents from internal medicine, obstetrics–gynecology, pediatrics, and surgery. 86 residents completed 426 surveys as receivers in shift handoffs.	Use of summaries was associated with increased OR for surprises. The association disappeared, however, when surgery residents, who reported few errors and used no data summaries, were excluded from the analysis.	OR = 7.16 (1.87–27.31), $P = .001$	6	1	0
Philibert, 2009[27]	Formal data summary	Number of errors attributed to handoff as reported by the clinician who received the patient at the end of shift	Shift handoffs among residents from internal medicine, obstetrics–gynecology, pediatrics, and surgery. 86 residents completed 426 surveys as receivers in shift handoffs.	Use of summaries was associated with increased OR for errors. The association disappeared, however, when surgery residents, who reported few errors and used no data summaries, were excluded from the analysis.	OR = 7.68 (2.49–23.63), $P < .001$	6	1	0

(*Appendix Continues*)

Appendix 1, continued

Study	Handoff characteristic	Handoff outcome	Handoff sample	Study result	Effect size; *P* value*	Study quality score (out of 12)†	No. of unclear indicators†	No. of "does not apply" indicators†
Pickering et al, 2009[21]	Standardized handoff sheet	Patient information (physiological status, diagnosis) retained by the clinician who received the patient within 1 hour of handoff (using all notes and reference materials gathered during handoff)	137 shift handoffs in a mixed surgical/ medical ICU, involving specialist registrars, registrars, fellows, senior house officers, and consultants.	Percentage of information points correctly retained increased significantly after standardization (median percentage 79.07 versus 83.72, range of percentages 27.91–97.67 versus 51.16–100).	$r = 0.17$, $P < .05$	6	1	0
Pickering et al, 2009[21]	Standardized handoff sheet	Patient information about physiological status retained by the clinician who received the patient within 1 hour of handoff (using all notes and reference materials gathered during handoff)	137 shift handoffs in a mixed surgical/ medical ICU, involving specialist registrars, registrars, fellows, senior house officers, and consultants.	3 of 21 points of physiological status information (white blood cell, chest radiograph, and rhythm) were significantly better retained after standardization.	White blood cell: $P < .05$ Chest radiograph: $P < .001$ Rhythm: $P < .001$	5	2	0
Pickering et al, 2009[21]	Standardized handoff sheet	Patient information about diagnosis (admission diagnosis, reason for referral, ICU diagnosis, acquired diagnosis) retained by the clinician who received the patient within 1 hour of handoff (using all notes and reference materials gathered during handoff)	137 shift handoffs in a mixed surgical/ medical ICU, involving specialist registrars, registrars, fellows, senior house officers, and consultants.	Significantly more diagnosis information was correctly retained after standardization.	Cramer V = 0.14 (0.00 – 0.23), $P = .027$	6.5	1	0
Pothier et al, 2005[19]	Standardized handoff sheet versus verbal (without note taking) versus written (verbal + note taking)	Data lost after the fifth (of 5) consecutive handoff	5 simulated ward shift handoffs between nurses; each handoff covered 12 patients.	Standardized handoff sheets had less data loss (0 of 84) than written (58 of 84).	Cramer V = 0.73 (0.58–0.88), $P < .001$	7	1	1
				Standardized handoff sheets had less data loss (0 of 84) than verbal (84 of 84).	Cramer V = 1.00 (0.85–1.00), $P < .001$			

(*Appendix Continues*)

Appendix 1, continued

Study	Handoff characteristic	Handoff outcome	Handoff sample	Study result	Effect size; *P* value*	Study quality score (out of 12)†	No. of unclear indicators†	No. of "does not apply" indicators†
Ryan et al, 2011[28]	Standardized handoff sheet	Patients' lengths of stay	88 shift handoffs among surgical teams, comprising surgical consultants, registrars, and senior house officers, in an accident and emergency department (47 handoffs before an intervention, 41 after).	Patients' lengths of stay were significantly shorter after introduction of the standardized handoff sheet.	$P = .047$	5.5	2	0
Ryan et al, 2011[28]	Standardized handoff sheet	Time taken until first intervention (CT scan is the only intervention considered)	88 shift handoffs among surgical teams, comprising surgical consultants, registrars, and senior house officers, in an accident and emergency department (47 handoffs before an intervention, 41 after).	No significant difference in time taken to first intervention. The trend, however, was in the opposite direction (mean of 21.2 hours before versus 28.2 hours after standardization).	Cohen d = 0.12, $P = .059$	4	2	0
Salerno et al, 2009[25]	Standardized sign-out sheet	Night interns' self-perceptions of at least 1 dropped task after end of shift	Shift handoffs in a general medicine ward; 34 interns from internal medicine, psychiatry, and family medicine residencies, and a transitional internship completed 186 handoff surveys before an intervention and 130 after.	Nonsignificant trend toward fewer dropped tasks from 16% of sampled shifts before to 8% after standardization.	$P = .21$	7.5	0	0
Salerno et al, 2009[25]	Standardized sign-out sheet	Day interns' perceptions, after retaking over a patient who had been handed off the day before, of night interns' actions as undesirable on 1 or more patients	Shift handoffs in a general medicine ward; 34 interns from internal medicine, psychiatry, and family medicine residencies, and a transitional internship completed 186 handoff surveys before an intervention and 130 after.	Nonsignificant trend toward fewer undesirable actions by night interns from 19% of sampled shifts before to 8% after standardization.	$P = .14$	7	0	0

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Appendix 1, continued

Study	Handoff characteristic	Handoff outcome	Handoff sample	Study result	Effect size; *P* value*	Study quality score (out of 12)†	No. of unclear indicators†	No. of "does not apply" indicators†
Salerno et al, 2009[25]	Standardized sign-out sheet	Day interns' perceptions, after retaking over a patient who had been handed off the day before, that the night intern dropped at least 1 task	Shift handoffs in a general medicine ward; 34 interns from internal medicine, psychiatry, and family medicine residencies, and a transitional internship completed 186 handoff surveys before an intervention and 130 after.	Significantly fewer tasks dropped by night interns from 27% of sampled shifts before to 9% after standardization.	$P = .001$	8	0	0
Stahl et al, 2009[18]	Standardized handoff checklist	Number of patient care items lost in the 24 hours after handoff (failure to mention item in subsequent handoff or failure to execute item)	Shift handoffs in a trauma/surgical ICU among teams consisting of interns, residents, fellows, and 1 attending trauma surgeon; not stated how many teams participated or how many of the existing teams were studied.	Percentage of lost items (information; execution) decreased from 20.1% before standardization (61 of 303 observed items) to 3.6% after (14 of 386).	OR = 6.70 (3.67–12.24), $P = .0001$	6	1	0
				Same result recorded for several subcategories of patient care items.	OR = 4.10–12.99, $P = .0001$– .043			
Van Eaton et al, 2010[26]	Introduction of a computerized sign-out system (with printed sign-out sheets)	Number of deviations from expected care during cross-coverage	Shift handoffs among residents within internal medicine and general surgery teams in 2 different hospitals. In a total of 1,365 handoff sessions, 8,018 handoffs were carried out in the intervention group and 7,579 in the control group. Unit type not mentioned.	No significant differences found between control and intervention groups (mean number of incidents per team was 6.0 for control group and 6.6 for intervention group).	Cohen d = –0.18, $P = .66$	8.5	1	0

(*Appendix Continues*)

Appendix 1, continued

Study	Handoff characteristic	Handoff outcome	Handoff sample	Study result	Effect size; *P* value*	Study quality score (out of 12)†	No. of unclear indicators†	No. of "does not apply" indicators†
Van Eaton et al, 2010[26]	Introduction of a computerized sign-out system (with printed sign-out sheets)	Number of medical errors (subset of deviations from expected care during cross-coverage)	Shift handoffs among residents within internal medicine and general surgery teams in 2 different hospitals. In a total of 1,365 handoff sessions, 8,018 handoffs were carried out in the intervention group and 7,579 in the control group. Unit type not mentioned.	No significant differences found between control and intervention groups (mean number of errors per team was 2.6 for control group and 2.8 for intervention group).	Cohen d = –0.08, *P* = .86	8.5	1	0
Van Eaton et al, 2010[26]	Introduction of a computerized sign-out system (with printed sign-out sheets)	Number of adverse drug events	Shift handoffs among residents within internal medicine and general surgery teams in 2 different hospitals. In a total of 1,365 handoff sessions, 8,018 handoffs were carried out in the intervention group and 7,579 in the control group. Unit type not mentioned.	No significant differences found between control and intervention groups (control: 39 of 84 [46%]; intervention: 45 of 84 [54%]).	OR = 1.10 (0.69 – 1.74), *P* = .70	9.5	1	0
Wayne et al, 2008[17]	Standardized handoff sheet	Number of tasks clinician should have completed by previous shift	Intershift handoffs between surgery residents in 12 services (transplant, vascular surgery, trauma, cardiothoracic surgery, gastrointestinal surgery, endocrine surgery, surgical oncology, breast surgery, 2 colorectal, and 2 general surgery services). 184 completed surveys.	Taken together, day, night, ICU, and non-ICU mean ratings of dropped tasks decreased from 0.97 before standardization to 0.6 after.	*P* = .05	4	2	0

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Appendix 1, continued

Study	Handoff characteristic	Handoff outcome	Handoff sample	Study result	Effect size; *P* value*	Study quality score (out of 12)†	No. of unclear indicators†	No. of "does not apply" indicators†
Zavalkoff et al, 2011[24]	Standardized handoff sheet	Number of postoperative high-risk events (HREs)	36 between-units handoffs from operating theater to pediatric ICU, 15 before an intervention and 16 after. Staff included senior residents, fellows, advanced nurse practitioners, and staff physicians from the departments of pediatric cardiac anesthesia, intensive care, and cardiac surgery (distribution to units not stated).	Nonsignificant trend toward fewer high-risk events in the postintervention group (1 of 15 patients had no HREs preintervention; 5 of 16 had no HREs post intervention).	OR = 6.36 (0.65–62.70), *P* = .1	7	0	0
Handoff mnemonic								
Rüdiger-Stürchler et al, 2010[29]	Handoff mnemonic with 5 topics to be discussed (dINAMO)	Number of preventable adverse events due to wrong or missing information during handoff	Shift handoffs in the emergency department (ED) between ED physicians. 519 single handoffs before an intervention, 492 after (clustered within a total of 61 handoff sessions).	Number of preventable adverse events due to missing or wrong information during handoff decreased after intervention.	*P* < .0001	6	0	0
Other information management intervention								
Hess et al, 2010[30]	Introduction of a verbal handoff (in addition to an existing written handoff summary sheet)	Rate of readmissions within 72 hours after discharge from the respiratory acute care unit	362 between-units handoffs from a respiratory acute care unit to another facility (151 handoffs before an intervention, 211 after). Care providers included physicians or nurse practitioners, nurses, and respiratory therapists in the respiratory acute care unit, and physicians, nurses, and therapists in the receiving facilities.	Nonsignificant trend toward lower rate of readmissions after intervention (from 14 of 151 [9.3%] to 10 of 211 [4.7%]).	OR = 0.42 (0.17–1.04), *P* = .06	5.5	1	0

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Appendix 1, continued

Study	Handoff characteristic	Handoff outcome	Handoff sample	Study result	Effect size; *P* value*	Study quality score (out of 12)†	No. of unclear indicators†	No. of "does not apply" indicators†
Hess et al, 2010[30]	Introduction of a verbal handoff (in addition to an existing written handoff summary sheet)	Total hospital cost for each patient	362 between-units handoffs from a respiratory acute care unit to another facility (151 handoffs before an intervention, 211 after). Care providers included physicians or nurse practitioners, nurses, and respiratory therapists in the respiratory acute care unit, and physicians, nurses, and therapists in the receiving facilities.	Significant reduction in total hospital cost per patient from a median of $148,574 before to a median of $111,723 after intervention.	$P = .002$	5.5	1	0
Horwitz et al, 2009[32]	Voicemail instead of oral communication; semistructured sign-out format	Perception of the occurrence of at least 1 adverse event relating to transfer from ED	Between-units handoffs from ED (residents or physician assistants) to internal medicine teaching services (house staff) or internal medicine nonteaching services (attending hospitalists). 117 clinicians responded to the survey before an intervention, 113 after.	Percentage of internists reporting at least 1 perceived adverse event relating to transfer from ED decreased a nonsignificant 10% from pre- to post intervention (32 of 72 [44%] to 23 of 67 [34%]).	OR = 1.53 (0.77–3.04), $P = .148$	7	1	0
				Percentage of ED physicians reporting at least 1 perceived adverse event relating to transfer from ED decreased a nonsignificant 11% from pre- to post intervention (5 of 37 [14%] to 1 of 37 [3%]).	OR = 5.63 (0.62–50.73), $P = .1$			

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Appendix 1, continued

Study	Handoff characteristic	Handoff outcome	Handoff sample	Study result	Effect size; *P* value*	Study quality score (out of 12)†	No. of unclear indicators†	No. of "does not apply" indicators†
Horwitz et al, 2009[32]	Voicemail instead of oral communication; semistructured sign-out format	Rate of ICU transfers (rate of patients admitted to an inpatient unit from ED, then transferred to ICU within 24 hours)	Between-units handoffs from ED (residents or physician assistants) to internal medicine teaching services (house staff) or internal medicine nonteaching services (attending hospitalists). Samples included ICU transfers within 24 hours in the periods of April 1 to June 30, 2007, and April 1 to June 30, 2008.	No change in the rate of ICU transfers before (65 of 6,147 [1.1%]) versus after intervention (70 of 6,263 [1.1%]).	OR = 0.95 (0.67–1.33), *P* = .75	7	2	0
Scott et al, 2003[33]	Web-based training of paramedics in giving a succinct and memorable handoff	Information recall of ED physicians following completion of patient care inside the trauma bay	43 between-units handoffs from paramedics to ED, 14 before an intervention and 29 after. Care providers included paramedics, trauma and emergency medicine residents from the ED. Exclusion criteria included: green triage patients, transferring paramedics not from 1 of 3 paramedic services under study, trauma conducted by nonconsenting paramedics or physicians, and interview with physician more than 60 minutes after handoff.	No significant change in information recall (33% preintervention versus 37% post intervention).	*P* = .16	4	1	0

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Appendix 1, continued

Study	Handoff characteristic	Handoff outcome	Handoff sample	Study result	Effect size; *P* value*	Study quality score (out of 12)†	No. of unclear indicators†	No. of "does not apply" indicators†
Description of information transferred during handoff								
Dowding, 2001[15]	Retrospective (task oriented) versus prospective (patient centered) information display; schema consistent versus schema inconsistent information display	Free recall of information handed off	48 simulated ward shift handoffs with registered nurses from general medical and general surgical wards.	Whereas there was almost no difference between consistent and inconsistent information displays in a retrospective information display, consistent information produced greater recall in prospective information display than inconsistent information (34.2% recalled versus 20.1%). No main effect of retrospective versus prospective information display.	$P = 0.003$	9	0	0
Dowding, 2001[15]	Retrospective (task oriented) versus prospective (patient centered) information display; schema-consistent versus schema-inconsistent information display	Quality of care plan written down after handoff	48 simulated ward shift handoffs with registered nurses from general medical and general surgical wards.	Retrospective information display produced significantly higher-quality care plans (40.1 points of 114) than prospective (26.9 of 114).	$P = .002$	9.5	0	0
				No effect of consistent versus inconsistent information display.	$P = .4$			
				No interaction effect.	$P = .8$			
Bhabra et al, 2007[20]	Importance of data point for patient safety	Number of data points retained after the fifth (of 5) consecutive handoff	5 simulated otolaryngology ward shift handoffs between senior house officers; each handoff covered 12 patients.	Important data points were not more likely to be retained than less important data points.	$P > .05$	6.5	0	1

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Appendix 1, continued

Study	Handoff characteristic	Handoff outcome	Handoff sample	Study result	Effect size; *P* value*	Study quality score (out of 12)†	No. of unclear indicators†	No. of "does not apply" indicators†
Scott et al, 2003[33]	Information topic (crash scene versus patient info versus prehospital care given)	Information recall of ED physicians following completion of patient care inside the trauma bay	43 between-units handoffs from paramedics to ED, 14 before an intervention and 29 after. Care providers included paramedics, trauma and emergency medicine residents from the ED. Exclusion criteria included: green triage patients, transferring paramedics not from 1 of 3 paramedic services under study, trauma conducted by nonconsenting paramedics or physicians, and interview with physician later than 60 minutes after handoff.	Crash scene information was recalled better than patient information and pre-hospital-care information (46% accurate recall for crash scene, 34% for patient information, 30% for pre-hospital-care information).	$P = .007$	4	2	0
Behavior of teams during handoff								
Mazzocco et al, 2009[16]	Risky team behavior during handoff (low frequency of the following team behaviors during handoff: briefing, information sharing, inquiry, and vigilance and awareness)	30-day patient outcomes (minor complications, major complications, and death/disability versus 1 or more indicators of potential harm and no complication)	300 between-units handoffs from the operating rooms of 2 medical centers and 2 ambulatory surgical centers to any next level of care, involving surgeons, anesthesiology providers, nurses, technicians, and others.	A low briefing score during handoff increased the risk for complication, disability, or death.	OR = 2.34 (1.23–4.46)	6	2	0
				A low information-sharing score during handoff increased the risk for complication, disability, or death.	OR = 2.21 (1.18–4.16)			

(*Appendix Continues*)

Appendix 1, continued

Study	Handoff characteristic	Handoff outcome	Handoff sample	Study result	Effect size; *P* value*	Study quality score (out of 12)†	No. of unclear indicators†	No. of "does not apply" indicators†
Characteristics of the receiving clinician during handoff								
Pickering et al, 2009[21]	Receiver grade, before and after standardization (senior house officer/ registrar; specialist registrar (SpR); fellow)	Patient information (physiological status, diagnosis) retained by the clinician who received the patient within 1 hour of handoff (using all notes and reference materials gathered during handoff)	137 shift handoffs in a mixed surgical/ medical ICU, involving specialist registrars, registrars, fellows, senior house officers, and consultants.	SHOs/registrars had lower handoff scores (percentage of retained data points) than SpRs and fellows. This pattern was nonsignificant before standardization and significant after standardization. Median percentage of points retained before: SHOs/registrars = 69.78, SpRs = 81.01, fellows = 80.23. Median after: SHOs/ registrars = 74.42, SpRs = 83.72, fellows = 83.72.	Before: $P = .08$ After: $P = .03$	5	2	0
Pickering et al, 2009[21]	Receiver directly versus indirectly responsible for patient (indirectly indicated clinician is present during ward round but had no clinical responsibility for the patient), before and after standardization	Patient information (physiological status, diagnosis) retained by the clinician who received the patient within 1 hour of handoff (using all notes and reference materials gathered during handoff)	137 shift handoffs in a mixed surgical/ medical ICU, involving specialist registrars, registrars, fellows, senior house officers, and consultants.	Whereas directly responsible clinicians retained significantly more information before standardization (median percentage 81.4 versus 72.09), this was not the case after standardization (median percentage 83.72 versus 83.72).	Before: $P = .03$ After: $P = .32$	5	2	0
Pickering et al, 2009[21]	Receiver present during day versus night shift, before and after standardization	Patient information (physiological status, diagnosis) retained by the clinician who received the patient within 1 hour of handoff (using all notes and reference materials gathered during handoff)	137 shift handoffs in a mixed surgical/ medical ICU, involving specialist registrars, registrars, fellows, senior house officers, and consultants.	No significant differences either before or after standardization. Median percentage before: day = 80.62, night = 69.76. Median after: day = 83.72, night = 83.72.	Before: $P = .12$ After: $P = .77$	5	2	0

(*Appendix Continues*)

Appendix 1, continued

Study	Handoff characteristic	Handoff outcome	Handoff sample	Study result	Effect size; *P* value*	Study quality score (out of 12)†	No. of unclear indicators†	No. of "does not apply" indicators†
Characteristics of the patient handed off								
Scott et al, 2003[33]	Triage status of patient handed off	Information recall of ED physicians after completion of patient care inside the trauma bay	43 between-units handoffs from paramedics to ED, 14 before an intervention and 29 after. Care providers included paramedics, trauma and emergency medicine residents from the ED. Exclusion criteria included: green triage patients, transferring paramedics not from 1 of 3 paramedic services under study, trauma conducted by nonconsenting paramedics or physicians, and interview with physician later than 60 minutes after handoff.	Physicians recalled less patient information with "red" triage status (most severe) than with "yellow" triage status (34% accurate recall for red triage status versus 40% for yellow status).	$P = .02$	5	1	0
Impact of shift day times (morning versus afternoon versus evening)								
Pickering et al, 2009[21]	Type of round (morning versus afternoon versus evening), before and after standardization	Patient information (physiological status, diagnosis) retained by the clinician who received the patient within 1 hour of handoff (using all notes and reference materials gathered during handoff)	137 shift handoffs in a mixed surgical/medical ICU, involving specialist registrars, registrars, fellows, senior house officers, and consultants	Whereas there was at least 1 significant difference between types of rounds before standardization, there was no significant difference after. Median percentage of retained scores before: morning = 81.40, afternoon = 83.72, evening = 69.77. Median after: morning = 75.58, afternoon = 83.72, evening = 83.72.	Before: $P = .03$ After: $P = .07$	5	2	0

*We calculated effect sizes when possible. We calculated ORs for two-way contingency tables; Cramer V if one cell of a contingency table had a frequency of 0 or if one dimension of the table had more than two categories; and Cohen d to compare the means of two groups. We converted *Z* scores of Wilcoxon rank-sum tests to *r*. OR indicates odds ratio (confidence interval).

† We scored each statistical association on the 11 indicators of study quality,[13] dividing one indicator into two parts, for a maximum quality score of 12. We then subtracted the number of indicators that we could not judge from the study text ("unclear") and the number of indicators that did not apply to the association ("does not apply") for the study quality score.