How to run an effective journal club: a systematic review

Y. Deenadayalan BPT IMMP BEHM (MBA), K. Grimmer-Somers PhD MMedSci BPhty, M. Prior BPhty (Hons) and S. Kumar PhD MPT BPT

1Researcher, Centre for Allied Health Evidence, University of South Australia, City East Campus, Adelaide, Australia
2Director, Centre for Allied Health Evidence, University of South Australia, City East Campus, Adelaide, Australia
3Deputy Director, Centre for Allied Health Evidence, University of South Australia, City East Campus, Adelaide, Australia

Abstract

Background Health-based journal clubs have been in place for over 100 years. Participants meet regularly to critique research articles, to improve their understanding of research design, statistics and critical appraisal. However, there is no standard process of conducting an effective journal club. We conducted a systematic literature review to identify core processes of a successful health journal club.

Method We searched a range of library databases using established keywords. All research designs were initially considered to establish the body of evidence. Experimental or comparative papers were then critically appraised for methodological quality and information was extracted on effective journal club processes.

Results We identified 101 articles, of which 21 comprised the body of evidence. Of these, 12 described journal club effectiveness. Methodological quality was moderate. The papers described many processes of effective journal clubs. Over 80% papers reported that journal club intervention was effective in improving knowledge and critical appraisal skills. Few papers reported on the psychometric properties of their outcome instruments. No paper reported on the translation of evidence from journal club into clinical practice.

Conclusion Characteristics of successful journal clubs included regular and anticipated meetings, mandatory attendance, clear long- and short-term purpose, appropriate meeting timing and incentives, a trained journal club leader to choose papers and lead discussion, circulating papers prior to the meeting, using the internet for wider dissemination and data storage, using established critical appraisal processes and summarizing journal club findings.

Keywords
effectiveness, evidence-based, format, health, journal club, processes
evidence, after a series of steps, we included in our review those papers which reported on comparative studies and/or controlled trials of the journal club activity, which established measures of its effectiveness. We extracted information from these papers on how journal clubs were conducted, with the aim of developing recommendations regarding the process of running an effective and sustainable journal club in a health setting.

**Search strategy**

The search was formulated using the following broad parameters:

- **Population**: health practitioners of any discipline
- **Intervention**: any form of journal club
- **Comparison**: any comparator
- **Outcomes**: any outcome measure relating to journal club effectiveness, including but not limited to, knowledge, attitudes, skill acquisition, practice behaviours, satisfaction.

**Databases and search terms**

We searched all available health databases in an attempt to identify relevant journal club literature. These included CINAHL, PsycINFO, PsychARTICLES, ERIC, Medline, AMED, Embase, AARP ageline, Google. For the search we used variations on keywords including ‘Journal club’, ‘health’, ‘effectiveness’ and ‘Evidence-based’.

**Inclusion criteria**

No date limit was set for the search. Articles included in the review were primary research only, available in full text, and written in English. Included papers should reflect the processes of running a health-based journal club (as opposed to journal clubs conducted in other settings), they should report on the health discipline(s) involved in the club as well as the methods/processes by which the journal club was conducted.

**Hierarchy of evidence**

We searched initially for any article of any research design to establish the size and strength of the body of evidence in this area. We used the CEBM (Oxford Centre for Evidence-based Medicine Levels of Evidence) hierarchy of evidence for intervention studies [4]. We then narrowed our search to only those experimental studies which directly and concurrently compared outcomes from journal club activities with outcomes from other forms of education, or to quasi-experimental or comparative studies which assessed outcomes pre- and post journal club inception.

**Search validation**

Potentially relevant articles were independently assessed by the authors, who then met to agree on article inclusion.

**Additional references**

We searched the reference lists of identified articles for other pertinent references that had not been identified during the primary search (Pearling). If secondary evidence was found, the reference list of included primary research papers would be used rather than the individual secondary evidence reference.

**Table 1 Criteria for analysis**

<table>
<thead>
<tr>
<th>Participants</th>
<th>Number of participants</th>
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<td>Field of health of participants</td>
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<td>Intervention</td>
<td>Group leader</td>
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<td>Preparation (pre-reading)</td>
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<td>Frequency of meeting</td>
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<td>Setting</td>
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<td>Article choice</td>
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<td>Structured evaluation processes</td>
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<td>Faculty supervised</td>
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<td>Results</td>
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<td>Specific outcomes tested</td>
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<tr>
<td>Statistical significance</td>
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</table>

**Analysis of the selected articles**

The included articles were critically appraised with the McMaster University instrument [5]. This is a generic critical appraisal instrument relevant to any quantitative study. Equally weighted scores are given to 14 criteria, providing a quality rating reflecting how well the authors considered internal and external validity issues in their study design, and reporting.

A purpose-built analytical instrument was then constructed for the review, seeking details on the processes of conducting the journal club, and how the effectiveness of the journal club had been evaluated. This instrument was collated using the range of information found on journal club processes when reading the identified studies in this area. The components of the analytical instrument are provided in Table 1. This instrument underpinned data extraction, as well as a secondary quality evaluation of the included studies. Each element listed in Table 1 was given an equally weighted score, thus studies which reported in detail on journal club processes and evaluation were rated more highly than studies that reported few details.

**Results**

**Search findings**

The search yielded 101 articles in the first step of the review. All these articles came directly from searching the listed library databases, and all but one article [6] reflected primary research evidence. This article was a review paper [6] which was not directly relevant to the objective of this review; however, its reference list contained four of the primary articles which had already been identified in our search.
Table 2 Papers excluded at Step 2, as not being relevant to the review criteria

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>Level of evidence</th>
<th>Reason for exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afifi, Y., Davis J., Khan, K., Publicover, M. (2006) The journal club: a modern model for better service and training. The Obstetrician and Gynaecologist, 8, 186–189.</td>
<td>Level 5</td>
<td>Dealt mainly with the advantages and disadvantages of journal club</td>
</tr>
</tbody>
</table>

Of the articles identified in the first step of the review, 32 were potentially relevant based on title, abstract or methods. The most common reasons for exclusion of articles from this review after Step 1 were that the articles did not relate to a health field, and they did not provide sufficient (any) detail on the processes of running a journal club. The references excluded at Step 2 and the reasons for exclusion, are reported in Appendix 1.

The second step of the review was independent consideration by the research team of the 32 potentially relevant articles, of which 21 articles entered the review process. Reasons for further exclusion of articles at Step 2 were that the potentially relevant articles were unavailable in full text, they did not include information on the methods by which journal clubs were conducted (despite appearing appropriate at Step 1), or they did not report on health settings. As examples of articles excluded for this reason, Brill [7] reported on a biology journal club, and Pearce-Smith [8] reported a journal club in which librarians took part. Table 2 lists the references excluded at Step 2 and the reasons for exclusion.

Figure 1 demonstrates the process of article inclusion for this review.

The 21 included papers report journal club interventions for most major medical specialties, and nursing, thus providing a broad overview of journal clubs across health fields. The health disciplines of journal clubs included in the review comprised Obstetrics and Gynaecology, Clinical Epidemiology and Biostatistics, Internal Medicine, General surgery, Emergency medicine, Mental Health, Psychiatrist, Nurse and Geriatric Medicine. Of note was the number of relevant articles published in the 1980s, indicating the longevity of interest in effective journal club processes.

The studies fell into two distinct groups in the research hierarchy, with 12 of the 21 articles (57%) being relevant to further analysis (experimental or comparative studies) (Hierarchy levels 1b or 2b) and the remainder being experiential, personal opinion or programme reports (Hierarchy levels 4 or 5). All 21 papers included for this review are reported in Table 3 in chronological order. Level 1b or 2b hierarchy papers were consistently published over the review time period, highlighting the lengthy interest in journal club effectiveness.

Critical appraisal of the included articles

Scores for critical appraisal of methodological quality ranged from four [9] to 12 [10]. The average quality for the 12 included articles...
approximated 56% of the total quality criteria (mean 8; SD 2.4). There was no significant difference between the methodological quality scores for levels 1b and 2b articles, as determined by independent t-tests (P > 0.05). Table 3 includes the type of research design and the hierarchy of evidence of each paper and the critical appraisal scores for the included articles.

Table 3 Included papers, hierarchy of evidence in chronological order, and critical appraisal scores of included articles

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>Type of paper/study design</th>
<th>Level of evidence</th>
<th>Critical appraisal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woods &amp; Winkel (1982)*</td>
<td>Report</td>
<td>level 5</td>
<td></td>
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<tr>
<td>Joorabchi (1984)*</td>
<td>Report</td>
<td>level 5</td>
<td></td>
</tr>
<tr>
<td>Linzer et al. (1988) [10]</td>
<td>Randomized, controlled educational intervention trial</td>
<td>level 1b</td>
<td>12</td>
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<tr>
<td>Thurnau &amp; Fishburne (1989)*</td>
<td>Report</td>
<td>level 5</td>
<td></td>
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<tr>
<td>Markert (1989)*</td>
<td>Cohort study</td>
<td>level 4</td>
<td></td>
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<tr>
<td>Langkamp et al. (1992) [15]</td>
<td>Controlled prospective trial</td>
<td>level 1b</td>
<td>7</td>
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<tr>
<td>Kitching (1992)*</td>
<td>Report</td>
<td>level 5</td>
<td></td>
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<tr>
<td>Burstein et al. (1996) [16]</td>
<td>Unblinded interventional study</td>
<td>level 1b</td>
<td>7</td>
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<tr>
<td>Sandifer et al. (1996)*</td>
<td>Cohort study</td>
<td>level 4</td>
<td></td>
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<tr>
<td>Bazarian et al. (1999) [18]</td>
<td>Prospective case controlled trial</td>
<td>level 2b</td>
<td>8</td>
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<tr>
<td>Khan et al. (1999) [12]</td>
<td>Feasibility study – prospective</td>
<td>level 1b</td>
<td>9</td>
</tr>
<tr>
<td>Fu et al. (1999)*</td>
<td>Experimental trial</td>
<td>Level 4</td>
<td></td>
</tr>
<tr>
<td>Owen et al. (2001)*</td>
<td>Report</td>
<td>level 2b</td>
<td>4</td>
</tr>
<tr>
<td>Mazurky et al. (2002)*</td>
<td>personal experience based on JC conducted in a tertiary Palliative care unit</td>
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<td></td>
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<tr>
<td>Struck et al. (2005) [19]</td>
<td>Curriculum-based study</td>
<td>level 2b</td>
<td>7</td>
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<tr>
<td>Mukherjee et al. (2006) [20]</td>
<td>Pilot study</td>
<td>level 2b</td>
<td>7</td>
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</tbody>
</table>

JC, Journal club; RCT, randomized controlled trial
*See separate reference list after main references at the end of this paper.

Aims of the included papers

All included papers had similar site-specific or participant-specific aims. The most frequent improvement sought from journal club intervention was in knowledge of biostatistics and/or epidemiology, or critical appraisal skills. All but one of the...
papers was explicitly curriculum (training)-based [11]. Overall, the included papers reported journal club objectives which aimed to improve participants’ reading habits, skills in critical appraisal skills, knowledge of current medical literature, research methods and statistics. None of the papers reported that the journal clubs aimed to directly translate research evidence into clinical practice. Two papers [11,12] made use of computers or the internet to modify the traditional journal club meeting approach. Use of computers provided a permanent storage tool and also an opportunity to readily access research information. Mac Rae [11] reported that the journal club articles were emailed to participants (surgeons) prior to the journal club. This assisted organizers to contact busy surgeons in different parts of Canada quickly and effectively. The primary aims of the included papers comprised:

Linzer & Hupart (1987) [13]
- determine whether a journal club process improved understanding of biostatistical and epidemiological principles;
- establish the impact of journal club on house staff members’ reading behaviours
Linzer et al. (1988) [10]
- determine whether a journal club improves medical house-staff reading habits, knowledge of epidemiology and biostatistics and critical appraisal skills
Seelig (1991) [14]
- investigate whether a limited adult education intervention could change staff residents’ attitudes, behaviours and knowledge of critical appraisal
Langkamp et al. (1992) [15]
- improve paediatric residents’ knowledge of clinical epidemiology, biostatistics and critical appraisal
Burstein et al. (1996) [16]
- improve overall satisfaction with journal club activities in a group of emergency medicine residents
Spillane & Crowe (1998) [17]
- determine the success of a journal club activity in developing critical appraisal skills of registrars, relating to recent important articles in surgical literature;
- provide a convivial social gathering to support the previous aim
Bazarian et al. (1999) [18]
- compare the performance of an evidence-based medicine approach and a traditional approach to teaching critical appraisal skills to emergency medicine residents
Khan et al. (1999) [12]
- assess the feasibility of a new educational programme to teach critical appraisal of medical literature to postgraduate trainees
Letterie & Morgenstern (2000) [9]
- develop a curriculum in epidemiology and biostatistics for instruction of medical residents, and assess participants’ response to this format
Mac Rae et al. (2004) [11]
- evaluate whether an internet-based intervention would lead to enhanced critical appraisal skills in practicing surgeons
Struck et al. (2005) [19]
- assess the impact of a mandatory 4-week geriatric medicine clerkship on third year students in three areas: knowledge, skills and attitude using a pre- and post knowledge test, student satisfaction survey and written comments

**Participants**

The number of study participants ranged from 12 to 135. Most participants were students enrolled in university courses or post-graduation medical programmes run in training hospitals. Undergraduates, graduates undertaking clinical training and clinicians were involved. Also reported were studies involving post-graduation participants (general surgeons or staff in public health medicine departments).

**Preparation for journal club**

There was considerable variability in the expected preparation for journal clubs, from compulsory reading, compulsory training and attendance, through to voluntary attendance and no preparation. Although most articles mentioned attendance of journal club members and the requirement of pre-preparation of articles, only Burstein [16] mentioned measuring compliance with pre-preparation and attendance.

The processes of preparation for journal club differed widely. Variations included the presenter seeking group input for article selection, articles chosen for relevance to current programmes of clinical study, clinical cases and provision of structured work sheet to help with data extraction and critical appraisal. Preparation time for those who attended the journal club varied. In some articles this was not mentioned at all. In others, although preparation was mentioned, the articles did not mention the amount of preparation time or when the article was distributed to the participants prior to journal club meeting. Evaluation of journal club processes also varied, and included evaluation of the actual process of the club, through to evaluation of the learning from journal club.

**Effectiveness of journal club**

Of the 12 experimental or comparative papers included in the review, 10 reported significant differences in a number of learning outcomes (83% papers), indicating that journal club activities made a significant impact on at least one outcome measure when compared with a control activity (such as lectures or general reading) or before and after the journal club activity. Significant improvements were reported in knowledge of biostatistics and research design or in critical appraisal skills. Of the two papers which did not report significant findings, one did not report on statistical tests [18], although it reported benchmark information on the amount of reading and critical thinking which could be produced by a journal club intervention. The other reported no significant difference in outcomes between journal club and a control educational group [15]. A range of outcome measures were reported papers, many of which were purpose-built. Few mentioned the psychometric properties of the instruments/assessment methods for the outcome measures used to test the effectiveness of journal club. Table 4 reports on the key outcomes reported in the included papers, and indicate the papers which reported significant differences in these outcomes (compared with a control group, or compared pre–post within the
same group of participants). Further details of the outcomes assessed in the studies are provided in Appendix 2. Table 5 reports on the elements of the assessment processes used to determine the significance of impact of journal club, and highlight the salient features of instrument development and construction.

Using the criteria outlined in Table 1, the critical evaluation of the journal club processes reported in the included papers is outlined in Table 6. The highest scoring paper regarding description of journal club processes was Burstein [16], with 15/19 criteria reported, and the lowest scoring paper was Letterie [19], with only 8/19 criteria reported. There was moderate correlation between the scores from the process evaluation and the critical appraisal of methodological quality (Pearson $r = 0.51$). Letterie (2000) [19] scored lowest on both methodological quality and process reporting. Langkamp [15], the only paper not reporting a significant effect of a journal club intervention, had similar methodological critical appraisal scores and process reporting scores (7 and 12 respectively) compared with the other 11 papers, and thus it was unlikely that the non-significant findings were related to either methodological quality or reported journal club processes.

### Journal club processes

The journal club processes which were reported by all included papers were field of health of participants, the setting in which journal club took place, the structured evaluation processes of journal club and description of outcomes which were evaluated. Having a clear journal club leader and a nominated supervisor of the journal club activities was reported in 11 papers (92%), and statistical significance of the comparisons between outcomes, and the number of participants involved in the journal club studies was reported in 10 papers (83%). The frequency of journal club meetings was reported in nine papers [9–13,15–18] (75%) as weekly or monthly (with monthly predominating), and eight papers reported on who initiated the choice of papers, the actual processes by which journal clubs were conducted and specific evaluation/comparison results (66.7%). The initiator of choice of papers was mostly the facilitator who generally held a respected leadership role in the group (consultant, academic leader or author of the paper under discussion). Journal club peers were reported as being involved in choosing papers for discussion in only two articles [13,19]. Six papers [10,12,13,16–18] (50%) reported chosen papers for the journal club having a direct clinical focus with only one paper reporting on presentations directly linked to clinical cases. In all other cases the chosen papers were for methodological or research design reasons. Five papers [10,11,13,15,16] (42%) reported on journal clubs having pre-reading sent out at variable (and mostly unnoted) times, which could be up to 10 days prior to the meeting. Two papers [11,12] reported on mandatory attendance or use of the internet (17.7%) and one paper [17] reported on the availability of food to increase the conviviality of the learning experience (8%). The timing of journal club was only reported explicitly in three papers – lunchtime [12,15] and evening [17].

### Discussion

This review found a surprising number of experimental or comparative studies written over the past 25 years which described different journal club models across a range of health disciplines. This suggests that participation in journal clubs is a well-accepted...
### Table 5  Elements of outcome measures

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<tr>
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<td>Seeigel (1991) [14]</td>
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<td>Spillane &amp; Crowe (1998) [17]</td>
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<td>Mukherjee et al. (2006) [20]</td>
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### Table 6  Processes of journal club reported in the included papers

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mechanism for demonstrating commitment to evidence-based practice; however, there is little information on the most effective way of conducting a journal club to gain the most educational benefit from it. There is no standard method for conducting journal clubs, evaluating knowledge uptake as a result of participation in journal clubs or tracking knowledge uptake through to knowledge implementation.

Although there was consistent statistical evidence of the effectiveness of journal clubs in improving knowledge, there was little evidence of longevity of evidence-uptake or application. This would seem to be an area for further research, particularly in light of knowledge acquisition half-life, and the half-life of published research in different fields [13]. The common use of purpose-built, self-reported and non-validated outcome measures raises issues of the believability of the reported impact of journal club, and the generalizability of journal club formats to other journal club situations.

Struck [19] is the only paper which clearly mentioned additional educational interventions to the journal club. These researchers used a 4-week clerkship programme where students participated in interactive lectures, problem-based learning with a faculty facilitator in addition to the journal club sessions. The findings reported by Struck suggest that this barrage of learning opportunities increased participants’ exposure to knowledge acquisition, and hence the likelihood of sustainability of learning.

Only three papers [12,18,19] mentioned the journal club format being based on learning related to clinical cases. This would appear to be an important component when bridging the gap between theory and practice of evidence, in order to assist the implementation of evidence into clinical practice [2]. Four articles only [13,16–18] described providing initial assistance for participants in choosing relevant articles for journal club, and supporting them to make their own choices as they gained more experience in conducting journal clubs. Article selection and its relevance to the attendees would appear to be a key element of a successful journal club in order to improve reading and critical appraisal skills and knowledge, and to encourage knowledge uptake to improve patient care [3].

Participant preparation appears to be a key factor to facilitate healthy and meaningful discussion during journal club sessions. Only one paper [16] followed through in evaluating this component until the end of the study. Distribution of the journal club reading to participants varied from up to 10 days prior to the meeting, to the start of journal club session. Compliance with being prepared for journal club was rarely reported, although this would appear to be critical to full participation in discussions and learning opportunities.

The optimum frequency of journal club meetings has not been established. Most articles mentioned that journal clubs were conducted monthly [9,11,15–18], noted that journal clubs, if conducted too often, diminished participant interest in attending. Based on the frequency with which monthly journal clubs were reported, it seems that this time period could be recommended.

Few articles reported on when journal club was best conducted, and with what incentives. Langkamp [15] discussed the relationship between the timing of the journal club, incentives to attend and the attendance rate. They suggested that journal club conducted during lunch time with no provision of food may be a reason for low attendance, and they suggest provision of food as one method to attract participants to attend journal club and contribute to discussions. Bazarian [18] concurred, reporting that informal sessions with food provision impacted significantly on attendance rates.

Only two articles [11,12] reported the use of the internet to support journal clubs. Both authors report positive findings. Given the dramatic increase in the use of the internet over even the past 5 years it is not surprising that there are few papers regarding this phenomenon. The use of the internet could significantly enhance traditional methods of journal club. Thus, we could expect future journal clubs to be conducted using electronic media.

Conclusion

This paper provides a synthesis of the scant published literature regarding the processes of conducting an effective journal club in a health setting. While the literature included in this review varied in terms of participants, processes of journal club interventions and evaluation processes, there were consistent findings regarding the effectiveness of journal clubs in health settings to improve knowledge and skills. The literature provides sound underpinnings from which to make recommendations about best practices when establishing a new health journal club. There are common elements that seem to be important when organizing and conducting a journal club that have the potential to significantly influence participants’ attendance and uptake of new knowledge and skills. We recommend a number of broad questions that should be asked prior to establishing the journal club, and sub-questions that may assist in establishing an effective, sustainable journal club.

Journal club attendance
• Establish a journal club group of members of the same discipline, or similar interests within a clinical specialty.

Journal club purpose
• Have an established and agreed overarching goal for the long term journal club intervention. The overarching journal club purpose should be reviewed regularly, and agreed by participants
• Establish the purpose of each journal club meeting, and link this to the paper being read, or the skill acquisition being addressed.

Structure of an effective journal club
• Regular attendance should be expected and recorded. Attendance may be mandatory, particularly if the journal club has a curriculum-based format
• Conduct journal clubs at regular predictable intervals (suggest monthly)
• Conduct journal club at an appropriate times of the day for all participants
• Provide incentives to attend such as food (which is shown to increase attendance as well as the conviviality of the occasion).

Leading journal club
• Journal clubs appear to be more effective if they have a leader. The journal club leader should be responsible for identifying relevant articles for discussion, however the final choice needs to be decided by the journal club members

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How to run an effective journal club

Y. Deenadayalan et al.

• Train the leader/facilitator of the journal club in relevant research design and/or statistical knowledge so as to appropriately direct group discussions and assist the group to work towards its goals.
• The leader can change from meeting to meeting, however he/she needs to have the skills to present the paper under discussion and lead the group adequately. It is a fine balance between choosing a leader of high academic standing whose expertise may stifle discussion, or choosing a leader from peers who may not have the requisite understanding of the paper under discussion.
• Provide access to a statistician to assist the leader in preparing for journal club, and to answer questions that may arise from the journal club discussion.

Choosing articles for discussion
• Choose relevant case-based or clinical articles for discussion. These papers should be of interest to all participants. Articles should be chosen in line with the overarching purpose of the journal club.
• Identify one journal club member (either the designated leader or a member) who has the responsibility for identifying the literature to be discussed for each meeting. This person should also lead the discussion on the article at the journal club.

Circulating articles for discussion
• Provide all participants for each journal club (in addition to the leader) with pre-reading at a suitable time period prior to the journal club (may be up to a week prior). Participants should agree to the time frame for pre-reading. In some curriculum-based situations, assessment of whether pre-reading has occurred may be appropriate.
• Use the internet as a means of distributing articles prior to the meeting, maintaining journal club resources and optimizing use of time and resources.

Efficiently running the journal club
• Use established critical appraisal approaches and structured worksheets during the journal club session, which leads to healthy and productive discussion.
• Formally conclude each journal club by putting the article in context of clinical practice.

Journal club effectiveness
• Depending on the journal club purpose, it may be appropriate to evaluate knowledge uptake formally or informally.
• Evaluation should specifically relate to the article(s) for discussion, critical appraisal, understanding of biostatistics reported in the paper and translating evidence into practice.

References
Appendix 1: Excluded references

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Appendix 2

**Detailed information on outcome measures used in the included studies**

**Linzer & Hupart (1987)** [13]
Self-assessment questionnaire to assess critical reading, reading habits, educational value of journal club; and knowledge of epidemiology and biostatistics. Questionnaire consisted of 15 questions drawn from the ‘question bank’ used for examinations in clinical epidemiology and biostatistics for the first year medical students in the Department of Community Medicine of the Mount Sinai School of Medicine of the City University of New York. These questions were selected based upon the work of [21] who sorted the statistical methods used in 760 research articles in the New England Journal of Medicine and described the statistical and epidemiologic techniques with which physicians should be conversant in order to have ‘statistical access’ to the articles; Reading behaviour was assessed by asking about quantity (number of journals subscribed to and number of articles read per month) and quality (thoroughness) of reading. The questionnaire was validated by an expert in questionnaire design and two clinical epidemiologists.

**Linzer et al. (1988)** [10]
A test instrument improved by the Delphi method was administered before and after the journal club intervention. The instrument was validated by an expert in questionnaire design and two clinical epidemiologists. Intra- and inter-rater observability was reported in the paper. The evaluation consisted of four parts – research background and other teaching received in critical appraisal, epidemiology and biostatistics; interns’ reading habits; knowledge of the epidemiology and biostatistics – 15 questions drawn from the ‘question bank’ used for examinations in clinical epidemiology and biostatistics for the first year medical students in the department of community medicine of the Mount Sinai School of Medicine of the City University of New York; to measure the interns’ critical appraisal skills.

**Seeleg (1991)** [14]
Prior to the journal club intervention, a questionnaire was administered addressing the basic principles of critical appraisal stressed in the educational session. Four months after the pre-test, post test was administered. Contents of the pre- and post test were identical. Also, the participants were asked to report on the average number of hours per week spent reading medical journals and to list in rank order the five journals they most frequently read. A course evaluation (lectures, classroom exercises, written assignments, handouts, references) using a Likert scale, was completed at the end of 4-month period.

**Langkamp et al. (1992)** [15]
Intervention and control residents completed a pre-and post test on clinical epidemiology and biostatistics. Pre-test included 23 questions about clinical epidemiology and biostatistics selected from questions used in medical school courses at the University of North Carolina and the Medical college of Wisconsin. Pre- and post test questions were identical except that they asked the intervention residents about attendance at journal club meetings and their perceptions of club’s usefulness.

**Burstein et al. (1996)** [16]
Evaluation survey consisting of five items assessing overall satisfaction with the journal club. Residents were not told that a change in the journal club format (SRI, structured review instrument) was being evaluated. Attendance was noted before and 6 months after the introduction of the SRI. The SRI was used to guide residents in critical reading and review of journal club articles.

**Spillane & Crowe (1998)** [17]
A questionnaire was used to assess how well journal club achieved its aims, overall value, educational effect, satisfaction with the format, attendance record of members and enthusiasm for the concept.

**Bazarian et al. (1999)** [18]
A 1-hour pre- and post test was administered by evaluating a fictitious article using an essay format. Residents were asked to answer one question ‘After critically appraising this article, would you use intravenous propranolol for the treatment of migraine headache? Give at least five reasons to support this decision.’ The article was originally used to test the editorial skills of reviewers of the Annals of Emergency medicine and was purposely created with 17 methodologic flaws. The errors in the fictitious article were first revealed by the study’s author during a lecture given at the 1995 ACEP Scientific assembly, and subsequently published in a manuscript. [22] Inter-tester reliability was assessed between three test graders and reported within the study.

**Khan et al. (1999)** [12]
Knowledge was assessed by a questionnaire with 20 items covering different aspects of evidence-based medicine such as study
design, evaluation of bias, evaluating statistical tests/principles, assessment of the general value and clinical application of the article; educational performance of the trainees was assessed using self-administered structured questionnaire designed to evaluate knowledge. There were five control items that were not covered in the educational programme and were used to determine the stability and content validity of the questionnaire. The validity of the instrument was reported ($P = 0.11$), and test–retest reliability was reported ($r = 0.9$) within the study for repeated use of the knowledge questionnaire;

A questionnaire was distributed at the conclusion of the journal club session to the residents and the staff. A pre-test or post test was given in keeping with the authors’ intent to avoid a course-like atmosphere

Several of the investigators in this study developed a 2-hour test of critical appraisal skills (Cronbach $\alpha = 0.77$). This has been described elsewhere [23]. Two general surgeons with expertise in clinical epidemiology developed an answer key for the examination. The examinations were all marked by a single clinical epidemiologist; participants were also asked to complete an evaluation form after each month’s journal club package. Inter-rater reliability of two physicians marking the examination was 0.93.

**Struck et al. (2005)** [19]
The impact of clerkship on students was assessed in three areas:

- **Knowledge** (33-question pre- and post test). Questions were randomly pulled from a question pool of 100 previously developed questions ref. Faculty developed the questions based on United States Medical Licensing Examination guidelines and underwent peer review to check item face-value relevance. Question content included geriatric assessment, preventive care, cognitive examination, hospice care, iatrogenic complications in hospitalization and other common geriatric syndromes.

- **Skills** (faculty observation and evaluation during patient encounters as well as self-assessment on Likert-scales regarding improvement of physical examination skills and patient assessment skills)

- **Attitude** (using answers on Likert-scale survey as well open-ended questions allowing students’ written feedback) using a pre-and post knowledge test, student satisfaction survey and written comments.

**Mukherjee et al. (2006)** [20]
A list of questions used in quantitative appraisal was summarized from various sources and provided to the facilitators. For the qualitative papers a series of questions based upon the framework suggested by [24] were developed. Two short questionnaires composed of a mixture of open answer boxes as well as some five-point Likert scales were developed. The first questionnaire was used to obtain baseline options. The second distributed after four sessions over a 6-month period was used to assess any change in confidence when appraising qualitative papers and participants’ enjoyment and the perceived usefulness of the new format.