Title: The effectiveness of inpatient Consultation-Liaison Psychiatry service models: A systematic review of randomized trials.

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ABSTRACT

Objective

To systematically review randomized trials of the effectiveness of inpatient Consultation-Liaison (C-L) Psychiatry service models in improving patient outcomes, reducing length of hospital stay and decreasing healthcare costs.

Method

We searched databases including Ovid Medline, Ovid Embase, Ovid PsycINFO and EBSCO CINAHL for relevant trials. Two independent reviewers assessed articles and extracted data. The review is registered with PROSPERO, number CRD42019120827.

Results

Eight trials were eligible for inclusion. All had methodological limitations and all were published more than ten years ago. None reported clear evidence that the C-L Psychiatry service model evaluated was more effective than usual medical care alone. All the service models tested focused on providing a consultation for patients identified by screening. Clinical heterogeneity precluded meta-analysis.

Conclusion

Whilst we found no evidence that any of the inpatient C-L Psychiatry service models evaluated is effective, the sparseness of the literature and its methodological limitations preclude strong conclusions. The trials do, however, suggest that purely consultation-based service models may not be effective. A new generation of robust clinical trials of a wider range of C-L Psychiatry service models is now required to inform future service developments.

KEYWORDS:

C-L psychiatry

Randomized trials

Systematic review

Consultation

Liaison

1. Introduction

Psychiatric disorders, such as delirium, dementia, depression and alcohol misuse, are known to be common in general hospital inpatients [1-3]. This psychiatric morbidity is important because it complicates the delivery of medical care and is associated with poorer patient outcomes, longer hospital stays and higher healthcare costs [4-7].

Psychiatric services that aim to address this psychiatric morbidity have been long established and continue to be developed. These are usually referred to as 'Consultation-Liaison' (C-L) Psychiatry, Liaison Psychiatry or Psychological Medicine. There are a variety of different inpatient C-L Psychiatry service models in use: some emphasize the provision of individual patient consultations, others emphasize various forms of liaison with medical teams and most embrace elements of both [8]. There are also newer service models such as proactive and integrated C-L Psychiatry [9, 10].

There is evidence that inpatient C-L Psychiatry adds value to medical care in a number of ways [11]. However, we require randomized trials, summarized in a systematic review, to properly address the question of its effectiveness in improving specific outcomes [12, 13]. Several relevant systematic reviews have been published in recent years, but none of these have adequately addressed the question of effectiveness. This is because they have either included only a subset of the relevant trials [14-17], or they have combined evidence from randomized and non-randomized studies [11, 15, 16, 18].

We therefore aimed to determine, in a systematic review of all the relevant randomized trials, how effective inpatient C-L Psychiatry service models are in improving patient outcomes, reducing length of hospital stay and decreasing healthcare costs.

2. Method

2.1 Design

We did a systematic review of all relevant trials. We registered the study protocol with PROSPERO (number CRD42019120827) and report our work according to PRISMA guidelines [19].

2.2 Search strategy and selection criteria

We identified relevant trials by searching a wide range of databases. We searched Ovid Medline, Ovid Embase, Ovid PsycINFO, EBSCO CINAHL, the Cochrane Database of Systematic Reviews, the Cochrane Central Register of Controlled Trials, the Database of Abstracts of Reviews of Effects and NHS Economic Evaluation Database, and the World Health Organization International Clinical Trials Registry Platform up to 28th April 2020. Searches were run for the combination of 'randomized controlled trial', 'psychiatric service', and 'general hospital inpatient' using standardized subject and free text terms, including synonyms and alternative spellings. Full search strategies are available in the Online Appendix. We manually searched the reference lists of all the relevant review articles we found. We also did a forward-citation search on all the included articles.

We judged articles to be relevant if they met all the following criteria: (1) The article described a randomized controlled trial. (2) Trial participants were adult (aged 16 years or over) general hospital inpatients. (3) The trial evaluated the effectiveness of an inpatient C-L Psychiatry service model; defined as a service model that was delivered by psychiatrists, psychologists, psychiatric nurses or other psychiatric professionals and aimed to improve patient care predominantly during the inpatient stay (rather than predominantly or solely

after discharge). We did not include trials that evaluated a specific psychological or pharmacological treatment rather than a service model. We sought to include all trials that compared an inpatient C-L Psychiatry service model with any appropriate comparator and which measured effectiveness using patient outcomes, length of hospital stay or healthcare costs. We only included studies for which we could obtain the full paper to allow data extraction. We applied no language restrictions.

2.3 Data collection and analysis

Two researchers (MT and LH) independently screened the titles and abstracts of all articles identified by the searches in order to determine whether each might meet our selection criteria. If an article was considered to be potentially relevant, two researchers (MT and FC) then reviewed the full text, with the help of a translator when necessary. Any disagreements about whether to include an article in the review were resolved by discussion with a third researcher (JW). The following data were then independently extracted (by MT, FC and JW) from the included articles: trial aims, participants, interventions (inpatient C-L Psychiatry service model and comparator), outcomes and results (benefits and harms). We assessed each trial's risk of bias using the Cochrane Collaboration's Risk of Bias Tool [20].

We described the characteristics and results of the trials in both narrative and table format. We also considered whether a statistical synthesis of the findings by meta-analysis was appropriate.

3. Results

3.1 Literature overview

Our initial screening of 15,832 titles and associated abstracts yielded 493 articles for full paper review (see Figure 1). Eight of these articles met our selection criteria. The trials they describe are summarized in Table 1 [21-28]. The trials were mostly small in size (sample sizes ranged from 47 to 509; median 114). All had been conducted some time ago (the articles were all published between 1990 and 2007). Four trials were done in the UK, two in the USA, one in Canada and one in the Netherlands.

[Figure 1 and Table 1 about here]

3.2 Patients included in the trials

All eight trials recruited patients who had been identified by some sort of screening process and then randomly allocated these patients to either the inpatient C-L Psychiatry service model or to the comparator (the specific trial designs are described in Table 1). Seven of the trials recruited patients who had screened positive for one or more psychiatric problems (depression, confusion or anxiety) using a cut-off on a rating scale [21-27]; the eighth recruited patients deemed to require one-to-one nursing observation (a 'sitter') because of their suicidal or unpredictable behavior [28]. None of the trials recruited patients from referrals.

Four trials explicitly excluded patients who had severe cognitive impairment or were unable to provide consent [23, 25-27], six trials excluded patients with severe physical illness [21-26], and three trials excluded patients who had expressed suicidal thoughts [21, 23, 24].

Four trials included only older inpatients (aged 65 years and older) [21-23, 27], whilst the others included adult inpatients of any age [24-26, 28].

3.3 Inpatient C-L Psychiatry service models evaluated in the trials

A brief description of the inpatient C-L Psychiatry service model tested in each trial is included in Table 1. None of the trial reports provided service manuals or detailed descriptions of the service models they were evaluating. Nor did they describe robust quality assurance methods designed to ensure that the service model was delivered as intended. As a result, we were unable to extract full descriptions of what each service model actually comprised.

Two of the inpatient C-L Psychiatry service models were specifically designed for patients with depression [23, 27]. The other six models were designed for patients with a range of psychiatric problems [21, 22, 24-26, 28]. Five of the service models were intended to be delivered by psychiatrists [22, 24-27], and three by psychiatric nurses [21, 23, 28].

All the inpatient C-L Psychiatry service models evaluated in the trials were similar in the way that they delivered care. Their main service activity was providing a consultation. This typically comprised: (a) an interview of the patient, review of their medical records, and sometimes a discussion with their physicians, nurses and family; (b) communication of the findings of this assessment to the ward team together with recommendations for changes to the patient's care. It was then largely up to the ward team to implement the recommendations. Active follow-up of patients by the C-L Psychiatry clinicians was typically infrequent or provided on an 'as needed' basis. Only two of the service models appear to

have included some direct ongoing intervention in patient care, both of which were delivered by nurses [21, 28].

3.4 Comparators used in the trials

In all the trials, the inpatient C-L Psychiatry service model was added to usual medical care and compared with usual medical care alone. For ethical reasons, patients allocated to usual medical care alone could be referred to psychiatry if this was deemed necessary. The percentage of patients referred was reported for six trials [22-27], and ranged from 5% to 23% (see Table 1). These patients were excluded from the statistical analysis in three trials [22, 26, 28].

3.5 Trial outcomes

The trials evaluated a wide range of outcomes. Patient outcomes were measured in seven trials [21-27] and included: psychiatric symptoms (depression, anxiety, cognitive function), health and social functioning, quality of life, psychiatric 'caseness' (whether the patient met criteria for a psychiatric diagnosis), satisfaction with care, and independent functioning. Length of hospital stay was measured in six trials [21, 22, 25-28], and healthcare costs in two trials [24, 25]. These outcomes were measured at a variety of times after randomization, ranging from two weeks to one year. There was a clearly pre-specified primary outcome identifiable in four of the trial reports [21, 23, 25, 27].

3.6 Risk of bias in the trials

We rated the risk of various forms of potential bias in the trials; full details are given in the Appendix. We often rated the risk of selection bias (due to poor allocation concealment),

detection bias (through unblinded data collection) and reporting bias (due to unspecified primary outcomes) as 'unclear' due to the limited information in the trial reports. This lack of information probably reflects the fact that all the trial reports were published prior to the widespread adoption of recommended reporting standards such as CONSORT [29]. We rated the risk of performance bias (due to usual medical care differing between the trial arms) as 'high' in all eight trials due to the lack of blinding of patients and clinicians, a common issue in trials of complex interventions [20].

3.7 Trial findings

The trial results are listed in Table 1. None of the trials reported clear evidence that the inpatient C-L Psychiatry service model being evaluated as a supplement to medical care was more effective than usual medical care alone in improving patient outcomes, reducing length of hospital stay or decreasing healthcare costs. None of the trials which had a pre-specified primary outcome found a statistically significant difference in this. Two trials reported a statistically significant beneficial effect of the inpatient C-L Psychiatry service model in a single secondary outcome (one found slightly lower depression scores and the other greater patient satisfaction with care) [21, 23].

3.8 Meta-analysis

The substantial heterogeneity in participant characteristics and trial outcomes made meaningful meta-analysis inappropriate.

4. Discussion

4.1 Main findings

We aimed to determine, in a systematic review of all the relevant randomized controlled trials, how effective inpatient C-L Psychiatry service models are in improving patient outcomes, reducing length of hospital stay and decreasing healthcare costs. We found only eight relevant trials, all with methodological shortcomings and all published more than ten years ago. These trials evaluated a narrow range of the inpatient C-L Psychiatry service models currently in use. Furthermore, they did this only in patient samples obtained by screening. None of the trials found convincing evidence that the service model they evaluated was more effective than usual medical care alone.

4.2 Strengths and limitations of this review

We undertook a broad search of the literature with no restriction on language, we used clearly defined criteria in order to minimize selection bias and we used a clear definition of an inpatient C-L Psychiatry service model. We also used rigorous methods to extract data from the included papers. We did not however search for grey literature by contacting relevant experts for unpublished manuscripts, although we think it unlikely that this would have yielded additional trials. We were also unable to combine the data from the trials in a meta-analysis because of the substantial clinical and methodological heterogeneity between them.

4.3 Discussion of the findings

We found that the relevant literature is surprisingly sparse, probably reflecting the significant practical and ethical challenges of doing randomized trials of inpatient C-L

Psychiatry service models. It is notable that there are no published trials of inpatient C-L Psychiatry service models that focus on liaison with staff to provide education and advice, or of models that deliver more proactive and integrated approaches [9, 10]. There are also no published trials done in samples of more severely medically and psychiatrically ill patients, such as might be obtained by referral.

Why, despite the large amount of non-randomized evidence supporting the provision of inpatient C-L Psychiatry, did we find no evidence of effectiveness in randomized trials? One possible explanation is that effectiveness was obscured by shortcomings in the trial methods. Relevant shortcomings we found included: (a) Recruitment of patients who may have been unlikely to benefit from C-L Psychiatry. The trials mostly recruited patients who screened positive for, often relatively minor, psychiatric problems and excluded patients with more severe problems such as cognitive impairment, severe physical illness or suicidal thoughts. Whilst this approach to recruitment may have made it easier to do a trial, it may have reduced the likelihood that an inpatient C-L Psychiatry service model could influence the patients' outcomes. (b) Uncertain quality of delivery of the inpatient C-L Psychiatry service model. The trial reports contained little information on the design and implementation of the service models they evaluated, with an absence of service manuals and quality assurance procedures. (c) Possible contamination and performance bias in the comparator arm. Whilst the comparator was described as usual medical care in all the trials, in practice patients allocated to this trial arm could be referred to psychiatry by the ward team. Consequently, contamination is likely to have occurred in trials in which the same team delivered the inpatient C-L Psychiatry service model and also responded to referrals of patients receiving usual medical care. As noted in the risk of bias assessment, performance

bias may also have changed 'usual medical care'; the ward team knew which patients had not been allocated to the inpatient C-L Psychiatry service model and may, as a result, have made a referral to psychiatry. Although the percentage of patients referred to psychiatry from those allocated to usual medical care was generally small, these referrals may have reduced the observed treatment effect. Some trials excluded these referred patients from their analyses, but this does not adequately address the problem and means that the analyses were not 'intention to treat' [30]. (d) Trial samples that were probably too small to detect a difference. Most of the trials were too small to detect even a minimally clinically important difference between trial arms [31].

Another possible explanation is that, notwithstanding the methodological limitations noted above, the trials were correct in finding that the inpatient C-L Psychiatry service models evaluated were no more effective than usual medical care. If the service models were ineffective, why might this be? Review of the descriptions of the inpatient C-L Psychiatry service models evaluated indicates that they all emphasized the provision of a consultation. That is, they appeared to assume that simply making a psychiatric diagnosis or creating a problem list and then recommending changes in the patient's care would improve outcomes. We now know, both from the reports of the trials themselves and also from other studies, that medical teams frequently do not act on recommendations from C-L Psychiatry [22, 24, 25, 27, 28, 32]. Furthermore, if the recommendations are for treatments that take time to act, for example antidepressant drugs, short-term outcomes are unlikely to be improved. In addition, the inpatient C-L Psychiatry service models that did make efforts to ensure implementation of their recommendations do not appear to have done this sufficiently intensively. It may be, therefore, that these trials tell us that inpatient C-L

Psychiatry service models that focus solely on consultation actually have little effect on outcomes.

4.4 Other literature

No previous systematic review has adequately addressed the question of the effectiveness of inpatient C-L Psychiatry service models using evidence from randomized trials. We did, however, identify six relevant systematic reviews: Two reviews summarized a variety of research studies, randomized and non-randomized, and noted that the methodological limitations of the studies identified did not allow clear conclusions to be drawn [11, 18]. One review focused on trials that assessed cost-effectiveness and was also unable to draw clear conclusions [14]. One review focused on the effects of C-L Psychiatry on depression and anxiety in general hospital patients and, whilst finding evidence of effectiveness, did not clearly distinguish between inpatient and outpatient service models [17]. The remaining two reviews were of studies of the newer C- L Psychiatry service models: One focused on proactive C-L Psychiatry, which aims to identify all those inpatients who might benefit from timely psychiatric care and actively deliver it to them. It found encouraging evidence that this might reduce length of hospital stay, but only from non-randomized studies [16]. The other focused on integrated C-L Psychiatry, in which psychiatrists are embedded into ward teams. It found evidence that this type of service model might improve patient outcomes but, again, only from non-randomized studies [15].

4.5 Implications for future research

Whilst there are many ways to determine the value that inpatient C-L Psychiatry service models can add to general hospitals, randomized trials remain the gold standard for

determining their effectiveness in directly improving patient care. The limitations of the existing literature highlight the pressing need for a new generation of clinical trials. Which service models should these trials evaluate and how should the trials be done?

We should, ideally, evaluate all of the inpatient C-L Psychiatry service models in use, as well as new models as they are developed. These will include service models that focus on delivering: (a) rapid consultations for patients with urgent and/or complex problems; (b) education and clinical supervision for ward teams; (c) clinical advice to ward teams about specific patients; (d) proactive identification of patients who might benefit from psychiatric care; (e) integrated psychiatric care by embedding C-L psychiatrists in ward teams. It will be important to match each service model with a problem it could feasibly address before beginning a trial. For example, a proactive integrated service model could feasibly reduce the time that older patients spend in hospital; we are conducting a trial to find out whether this is the case [33].

The new generation of trials will need to be well designed and executed in order to produce robust findings. In particular, each new trial will need to: (a) recruit patients from the population that the service model being evaluated seeks to serve; (b) clearly specify the service model and what it aims to achieve, describe its procedures in a manual and ensure it is delivered as intended using quality assurance; (c) ensure that the comparator, typically usual medical care with access to an existing C-L Psychiatry service, is both well-described and not overly contaminated by the new service model (for example, by having different psychiatrists working in the established and experimental service models); (d) use a primary outcome that is relevant both to the population's need and to the service model's purpose;

(e) be big enough to detect a minimal clinically important difference (for example, a trial that evaluates the effect of a service model on length of hospital stay will need to be much larger than any so far conducted to have adequate power to address this highly variable outcome) [34]; (f) use an appropriate trial design, for example a cluster randomized trial may be required if the C-L psychiatry service model aims to change the ward milieu [35]; (g) be done with appropriate expertise in the design and conduct of trials of complex interventions [36]; (h) be clearly reported to allow both readers and systematic reviewers to fully assess the methods used and the risk of bias in them.

4.6 Implications for current clinical practice

Given the scale of psychiatric need in general hospital inpatients, the case for providing inpatient C-L Psychiatry is not in doubt. C-L Psychiatry adds value to the general hospital in many ways: it provides education and support to medical and nursing staff, informs and shapes hospital policies and practices, and helps ward teams to provide care for individual patients. The question we have addressed in this review is whether it improves patient outcomes, shortens length of hospital stay and reduces healthcare costs. Whilst the existing randomized trial literature does not really answer this question, it does offer clues about which inpatient C-L Psychiatry service models might be more effective than others. The trials all evaluated consultation-based service models, many of which were designed to serve patients with a wide range of psychiatric problems. It may be that service models which include more direct intervention in patient care and those that are designed to address a narrower range of psychiatric problems could be more effective in changing outcomes. Furthermore, we only reviewed trials of service models that delivered care predominantly during the inpatient stay. Service models that include active treatment post-

discharge may be more likely to yield benefit, especially for disorders which require pharmacological and psychological treatments that take time to be effective [37].

4.7 Conclusion

Trials of inpatient C-L Psychiatry, done by pioneers in the field, found no clear evidence that any of the C-L Psychiatry service models tested were more effective than usual medical care alone in improving outcomes. Whilst all these trials had methodological limitations, the service models they evaluated were probably based on overoptimistic assumptions about what consultation could achieve. The time is now ripe for a new generation of robust randomized trials of well-defined C-L Psychiatry service models that will tell us where this increasingly important clinical specialty should go from here.

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Disclosures

None.

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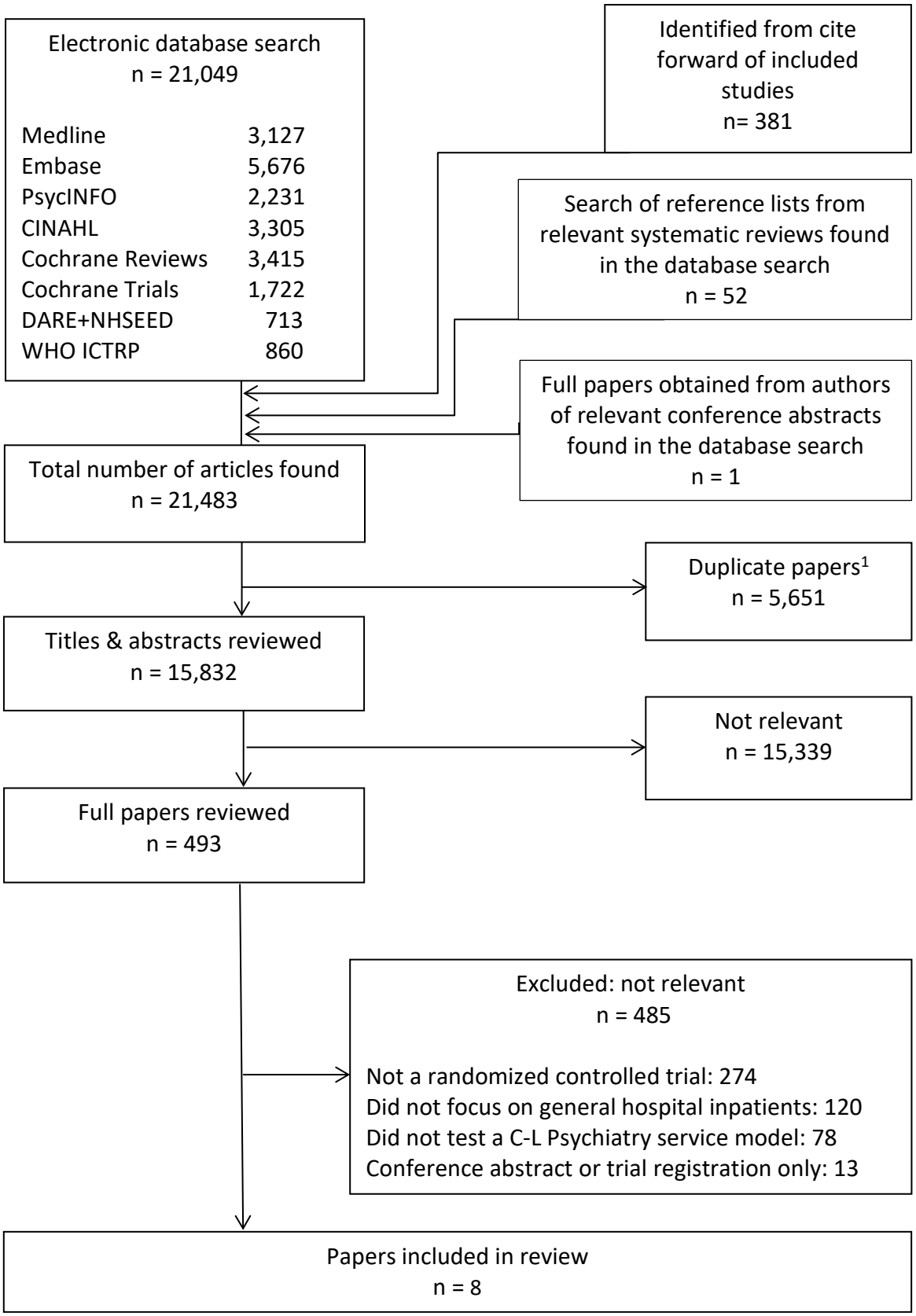
Figure 1: The effectiveness of inpatient Consultation-Liaison Psychiatry service models: systematic review flowchart



C-L = Consultation-Liaison, DARE+NHSEED = The Database of Abstracts of Reviews of Effects and NHS Economic Evaluation Database, WHO ICTRP = World Health Organization International Clinical Trials Registry Platform

[1] Duplicates of the same paper due to searching multiple databases, cite forward, reviews and reference lists.

Table 1: The effectiveness of inpatient C-L Psychiatry service models: characteristics of the trials included in the review

Study	Design	Patient characteristics	Total sample size, age and sex	Inpatient C-L Psychiatry service model arm	Comparator arm(s)	Outcomes	Results
Baldwin (2004)[21] UK	Single center 2 arm parallel group RCT	Medical inpatients aged ≥ 65 years. Screened positive for depression (GDS-4 ≥ 2) and/or confusion (OMC > 10) at day 3-5 post-admission. Excluded if acute risk of self-harm, unable to complete research schedules due to medical instability or profound sensory loss.	N = 153 Mean (SD) age 80·3 (7·3) years. 64% female.	N = 77 (66 seen, 59 analyzed) Assessment, direct interventions (e.g. problem-solving), liaison support (e.g. staff education about mental disorder and signposting to services). Given over maximum of 6 weeks (number of visits not reported). Delivered by psychiatric nurse.	N = 76 (61 analyzed) Usual medical care including referral to local old age psychiatry if required (number referred not available).	Primary: HoNOS65+ at 6-8 weeks. Others: GDS-30 score and MMSE score at 6-8 weeks. Length of hospital stay. Proportion prescribed psychotropic medication on discharge. Readmissions and deaths within 3 months.	Primary outcome: Adjusted mean difference -0·04 (95% CI -1·4 to 1·3), p = 0·958. Other outcomes: Mean GDS-30 score lower in patients allocated to C-L Psychiatry service model than those allocated to usual medical care. Adjusted mean difference -2·0 (95% CI -4·0 to -0·1), p = 0·043. No other significant differences.
Cole (1991)[22] Canada	Single center 2 arm parallel group RCT	General hospital inpatients aged ≥ 65 years referred to hospital's Multidisciplinary Geriatric Team. Screened positive for confusion (SPMSQ ≥ 3), depression (GDS ≥ 52) or anxiety (ASI ≥ 50). Excluded if seen by psychiatry in the last month, admitted to intensive care unit, unable to speak English or French.	N = 80 Mean age 83 years. 72% female.	N = 41 (38 seen, 35 analyzed) Assessment (interviews with patient, family and staff) leading to psychiatric diagnoses and treatment recommendations (summarized in notes and often discussed with Multidisciplinary Geriatric Team). Reassessment at least once per week for at least 8 weeks where appropriate (mean follow-up visits 2·6). Delivered by psychiatrist (member of the Multidisciplinary Geriatric Team).	N = 39 (28 analyzed) Usual medical care including referral to psychiatry if required (9 patients, 23%, received a consultation)*.	Primary: Not specified. Others: SPMSQ, ASI, GDS and CGBRS at 2, 4 and 8 weeks. Length of hospital stay.	All outcomes: No significant differences.

Cullum (2007)[23] UK	Single center 2 arm parallel group RCT	Medical inpatients aged ≥ 65 years. Screened positive for depression (GDS-15 ≥ 8) at day 3-6 post-admission. Excluded if severe dysphasia or deafness, too physically unwell or confused, alcohol dependent, expressing suicidal ideas.	N = 121 C-L Psychiatry service model arm: Mean (SD) age 79·7 (7·94) years, 53% female. Usual medical care arm: Mean (SD) age 80·1 (8·07) years, 64% female.	N = 62 (46 seen, 41 analyzed) Assessment (psychological and social needs and need for antidepressant medication), support for carers, liaison with other services to arrange depression care. Follow-up every 2-3 weeks for maximum of 12 weeks (42 followed up). Delivered by psychiatric nurse.	N = 59 (45 analyzed) Usual medical care including referral to psychiatry if required (3 patients, 5%, referred).	Primary: Presence of ICD-10 defined depressive disorder and change in GDS-15 from baseline to 16 weeks. Others: QALW and patient satisfaction with care at 16 weeks.	Primary outcomes: Depressive disorder 46% (C-L Psychiatry service model) vs 60% (usual medical care), Adjusted Odds Ratio 0·4 (95% CI 0·2 to 1·2), p = 0·10. Change in GDS-15 Adjusted mean difference 0·4 (95% CI -1·1 to 1·9), p = 0·59. Other outcomes: 93% of patients allocated to the C-L Psychiatry service model were 'very satisfied' or 'highly satisfied' with the service they received compared with 67% of those allocated to usual medical care. Adjusted Odds Ratio = 7·7 (95% CI 1·9 to 31·4), p < 0·01. No other significant differences.
Gater (1998)[24] UK	Single center 3 arm parallel group RCT	Medical inpatients. Screened positive for probable psychiatric illness (GHQ-28 ≥ 10). Excluded if already receiving psychiatric care, admitted following self-	N = 209 C-L Psychiatry service model arm: Mean (SD) age 55 (17) years, 57% female.	N = 68 (68 seen, cost outcomes 58 analyzed, other outcomes 47 analyzed) Assessment, detailed recommendations in medical notes and discussions with medical, nursing or social work	N = 70 (cost outcomes 61 analyzed, other outcomes 50 analyzed) 'Physician informed': GHQ-28 form pinned in notes for medical staff to act on as they wished, including	Primary: Not specified. Others: Healthcare costs, psychiatric 'caseness', subjective health status, QALY and health service costs at 6 months.	All outcomes: No significant differences.

		harm, severe physical illness, language difficulties.	'Physician informed' arm: Mean (SD) age 50 (19) years, 64% female. Usual medical care arm: Mean (SD) age 49 (19) years, 62% female.	staff. Follow-up as required ('small number'). Delivered by psychiatrist.	referral to psychiatry if appropriate (approx. 16% referred). N = 71 (cost outcomes 63 analyzed; other outcomes 56 analyzed) Usual medical care including referral to psychiatry if required (approx. 16% referred).		
Levenson (1992)[25] USA	Single center cluster RCT	Medical inpatients. Screened positive for anxiety, depression, confusion or pain (high MIST scores). Excluded if too physically unwell for interview, unable to give consent, unable to speak English.	N = 509 patients, 5 clusters (ward teams) C-L Psychiatry service model arm: Mean (SD) age 47·8 (16·9) years, 46% female. Usual medical care arm: Mean (SD) age 47·7 (17·5) years, 53% female.	N = 256 (158 seen, cost outcomes 256 analyzed) Assessment (chart review, patient interview, contact with clinical team and family as appropriate, average 1·3 hours), consultation note, including DSM-III diagnosis. Follow-up as required (18 followed up, average 1·5 visits, 0·7 hours). Delivered by six psychiatrists.	N = 253 (cost outcomes 253 analyzed) Usual medical care including referral to psychiatry if required (20 patients, 8%, referred).	Primary: Length of hospital stay and healthcare costs. Others: Physical functioning, depression and anxiety at 3 months.	Primary outcomes: No significant differences between C-L Psychiatry service model and usual medical care on any inpatient utilization outcome variables after adjustment for illness severity. Other outcomes: No significant differences.
Meesters (1991)[26] The Netherlands	Single center 2 arm parallel group RCT	Medical and orthopedic inpatients, in hospital for ≥ 17 days. Screened positive for psychiatric symptoms (GHQ-28 ≥ 9).	N = 70 Mean age not reported, % female not reported.	N = 36 (29 seen, 20 analyzed) Assessment (diagnostic interview and assessment of need for psychiatric intervention) and follow-up as required (number not reported).	N = 34 (8 analyzed) Usual medical care including referral to psychiatry if required (3 patients, 9%, referred)*.	Primary: Not specified. Others: GHQ-28 at discharge, number of medical procedures during hospital stay, length of hospital stay,	All outcomes: No significant differences.

		Excluded if severe illness, language barrier, cognitively impaired, already seen by psychiatric consultation service.		Delivered by psychiatrist.		prescription of psychotropic or analgesic during hospital stay.	
Shah (2001)[27] UK	Single center 2 arm parallel group RCT	Geriatric medicine inpatients. Screened positive for depression (GDS >11 and BAS-DEP ≥ 7). Excluded if severe cognitive or sensory impairment.	N = 47 Median age (range) 85 (67-97) years. C-L Psychiatry service model arm: 74% female. Usual medical care arm: 46% female.	N = 19 (19 seen, 14 analyzed) Diagnostic assessment and management advice. Delivered by psychiatrist.	N = 28 (17 analyzed) Usual medical care including referral to psychiatry if required (2 patients, 7%, referred).	Primary: Change in BAS-DEP and MADRS at 10 weeks. Others: Change in GDS, BAS-OBS, Barthel Index and CGIPI score at 10 weeks and 1 year. Change in BAS-DEP and MADRS at 1 year. Length of hospital stay.	Primary outcomes: Change in BAS-DEP scores median -5 (C-L Psychiatry service model) vs -5 (usual medical care), not significant. Change in MADRS scores median -12 (C-L psychiatry service model) vs -12 (usual medical care), not significant. Other outcomes: No significant differences.
Talley (1990)[28] USA	Single center 2 arm parallel group RCT	Medical, surgical, obstetric or gynecological inpatients. Assigned a sitter (due to suicidal behavior, falls, confusion-related or unpredictable behavior) for at least 1 shift on 2 consecutive days.	N = 107 analyzed Mean age not reported. 40% female.	N = 47 analyzed Assessment (reason for sitter request, chart review, liaison with nursing team and patient interview), nursing team education, direct behavioral interventions. Follow-up as required (number not reported). Delivered by psychiatric nurse.	N = 60 analyzed Usual medical care including referral to psychiatry if required (number referred unknown)*.	Primary: Not specified. Others: Length of hospital stay, number of sitter shifts, number of nursing observations documented and number of incident reports.	All outcomes: No significant differences.

* Patients referred to psychiatry were excluded from the analysis. ASI = Anxiety Status Inventory, BAS-DEP = Brief Assessment Schedule depression scale, BAS-OBS = Brief Assessment Schedule organic brain syndrome scale, CGBRS = Crichton Geriatric Behavioural Rating Scale, CGIPI = Clinical Global Impression of Physical Illness, CI = Confidence Interval, DSM = Diagnostic and Statistical Manual of Mental Disorders, GDS = Geriatric Depression Scale, GHQ = General Health Questionnaire, HoNOS65+ = Health of the Nation Outcome Scale, ICD = International Classification of Diseases, MADRS = Montgomery-Asberg Depression Rating Scale, MIST = Medical Inpatient Screening Test, MMSE = Mini-Mental State Examination, OMC = Orientation-

Memory-Concentration test, QALW = Quality Adjusted Life Week, QALY = Quality Adjusted Life Year, RCT = Randomized Controlled Trial, SD = Standard Deviation, SPMSQ = Short Portable Mental Status Questionnaire.

Supplementary Appendix

Supplement to: The effectiveness of inpatient Consultation-Liaison Psychiatry service models: A systematic review of randomized trials.

This appendix has been provided by the authors to give readers additional information about their work.

Search strategies

We ran searches in August 2018. We updated them in April 2020.

Ovid Medline (1946 to 2020)

1 Hospitals, District/
2 Hospitals, General/
3 Tertiary Care Centers/
4 exp Hospitals, Teaching/
5 "district hospital*".ti,ab.
6 "general hospital*".ti,ab.
7 "tertiary hospital*".ti,ab.
8 "teaching hospital*".ti,ab.
9 "medical centre*".ti,ab.
10 "medical center*".ti,ab.
11 "general medical".ti,ab.
12 (ward* adj4 patient*).ti,ab.
13 (hospital* adj4 patient*).ti,ab.
14 Inpatients/
15 in$patient*.ti,ab.
16 Hospitalization/
17 Hospital Units/
18 Patient Admission/
19 OR/ 1-18
20 "psych* consult*".ti,ab.
21 (liaison adj2 psych*).ti,ab.
22 "psychosomatic medicine".ti,ab.
23 "psych* medicine".ti,ab.
24 "consultation-liaison*".ti,ab.
25 Psychiatric Department, Hospital/
26 "behav* medicine*".ti,ab.
27 "mental health liaison*".ti,ab.
28 "hospital psych*".ti,ab.
29 "mental health service".ti,ab.
30 "mental health unit".ti,ab.
31 "general hospital psych*".ti,ab.
32 "mental health".ti,ab.
33 OR/ 20-32
34 randomized controlled trial.pt.
35 controlled clinical trial.pt.
36 (placebo or trial or groups).ab.
37 random*.ti,ab.
38 OR/ 34-37
39 19 and 33 and 38

Ovid Embase (1974 to 2020)

1 public hospital/
2 general hospital/
3 tertiary care center/
4 exp teaching hospital/
5 "district hospital*".ti,ab.
6 "general hospital*".ti,ab.
7 "tertiary hospital*".ti,ab.
8 "teaching hospital*".ti,ab.
9 "medical centre*".ti,ab.
10 "medical center*".ti,ab.
11 "general medical".ti,ab.
12 (ward* adj4 patient*).ti,ab.
13 (hospital* adj4 patient*).ti,ab.
14 hospital patient/
15 in$patient*.ti,ab.
16 hospitalization/
17 "hospital subdivisions and components"/
18 hospital admission/
19 OR/ 1-18
20 "psych* consult*".ti,ab.
21 (liaison adj2 psych*).ti,ab.
22 "psychosomatic medicine".ti,ab.
23 "psych* medicine".ti,ab.
24 "consultation-liaison*".ti,ab.
25 psychiatric department/
26 "behav* medicine*".ti,ab.
27 "mental health liaison*".ti,ab.
28 "hospital psych*".ti,ab.
29 "mental health service".ti,ab.
30 "mental health unit".ti,ab.
31 "general hospital psych*".ti,ab
32 "mental health".ti,ab.
33 OR/ 20-32
34 exp "controlled clinical trial (topic)"/
35 (placebo or trial or groups).ab.
36 random*.ti,ab.
37 OR/ 34-36
38 19 and 33 and 37

Ovid PsycINFO (1806 to 2020)

1 "district hospital*".ti,ab.
2 "general hospital*".ti,ab.
3 "tertiary hospital*".ti,ab.
4 "teaching hospital*".ti,ab.
5 "medical centre*".ti,ab.
6 "medical center*".ti,ab.
7 "general medical".ti,ab.
8 (ward* adj4 patient*).ti,ab.
9 (hospital* adj4 patient*).ti,ab.
10 exp Hospitalized Patients/
11 in$patient*.ti,ab.
12 Hospitalization/
13 hospital admission/
14 OR/ 1-13
15 mental health services/
16 "psych* consult*".ti,ab.
17 (liaison adj2 psych*).ti,ab.
18 "psychosomatic medicine".ti,ab.
19 "psych* medicine".ti,ab.
20 "consultation-liaison*".ti,ab.
21 "behav* medicine*".ti,ab.
22 "mental health liaison*".ti,ab.
23 "hospital psych*".ti,ab.
24 "mental health service".ti,ab.
25 "mental health unit".ti,ab.
26 "general hospital psych*".ti,ab.
27 "mental health".ti,ab.
28 OR/ 15 - 27
29 clinical trials/
30 (placebo or trial or groups).ab.
31 random*.ti,ab.
32 OR/ 29-31
33 14 and 28 and 32

EBSCO CINAHL (1937 to 2020)

S35 S18 AND S29 AND S34
S34 S30 OR S31 OR S32 OR S33
S33 TI random* OR AB random*
S32 AB placebo or trial or groups
S31 (MH "Clinical Trials+")
S30 (MH "Randomized Controlled Trials")
S29 S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28
S28 (MH "Sexual Counseling")
S27 (MH "Motivational Interviewing")
S26 (MH "Emergency Services, Psychiatric")
S25 TI "mental health" OR AB "mental health"
S24 TI "hospital psych*" OR AB "hospital psych*"
S23 TI "behav* medicine*" OR AB "behav* medicine*"
S22 TI "consultation-liaison*" OR AB "consultation-liaison*"
S21 TI "psych* medicine" OR AB "psych* medicine"
S20 TI liaison n2 psych* OR AB liaison n2 psych*
S19 TI "psych* consult*" OR AB "psych* consult*"
S18 S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17
S17 (MH "Patient Admission")
S16 (MH "Hospital Units") OR (MH "Burn Units") OR (MH "Delivery Rooms+") OR (MH "Intensive Care Units+") OR (MH "Nurseries, Hospital") OR (MH "Nursing Units") OR (MH "Observation Units") OR (MH "Oncology Care Units") OR (MH "Operating Rooms") OR (MH "Rehabilitation Centers+")
S15 (MH "Hospitalization+")
S14 TI inpatient* OR AB inpatient*
S13 (MH "Inpatients")
S12 TI hospital* n4 patient* OR AB hospital* n4 patient*
S11 TI ward* n4 patient* OR AB ward* n4 patient*
S10 TI "general medical" OR AB "general medical"
S9 TI "medical center*" OR AB "medical center*"
S8 TI "medical centre*" OR AB "medical centre*"
S7 TI "teaching hospital*" OR AB "teaching hospital*"
S6 TI "tertiary hospital*" OR AB "tertiary hospital*"
S5 TI "general hospital*" OR AB "general hospital*"
S4 TI "district hospital*" OR AB "district hospital*"
S3 (MH "Tertiary Health Care")
S2 (MH "Hospitals, Community") OR (MH "Hospitals, Rural") OR (MH "Hospitals, Urban") OR (MH "Magnet Hospitals") OR (MH "Cancer Care Facilities") OR (MH "Hospices") OR (MH "Hospital Ships") OR (MH "Hospitals, Public+")
S1 (MH "Hospitals, Public+")

Cochrane Database of Systematic Reviews (1992 to 2020)

#1 MeSH descriptor: [Hospitals] explode all trees
#2 MeSH descriptor: [Hospitals, Animal] explode all trees
#3 MeSH descriptor: [Hospitals, Psychiatric] explode all trees
#4 MeSH descriptor: [Hospitals, Pediatric] explode all trees
#5 #2 or #3 or #4
#6 #1 NOT #5
#7 "district hospital*".ti,ab.
#8 "general hospital*".ti,ab.
#9 "tertiary hospital*".ti,ab.
#10 "teaching hospital*".ti,ab.
#11 "medical centre*".ti,ab.
#12 "medical center*".ti,ab.
#13 "general medical".ti,ab.
#14 (ward* near/4 patient*).ti,ab.
#15 (hospital* near/4 patient*).ti,ab.
#16 MeSH descriptor: [Inpatients] explode all trees
#17 MeSH descriptor: [Hospital Units] explode all trees
#18 MeSH descriptor: [Hospitalization] explode all trees
#19 inpatient*.ti,ab.
#20 #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 83367
#21 MeSH descriptor: [Psychiatric Department, Hospital] explode all trees
#22 "psych* consult*".ti,ab.
#23 (liaison near/2 psych*).ti,ab.
#24 "psych* medicine".ti,ab.
#25 "consultation-liaison*".ti,ab.
#26 "behav* medicine*".ti,ab.
#27 "hospital psych*".ti,ab.
#28 "mental health".ti,ab.
#29 #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28
#30 #20 and #29

Cochrane Central Register of Controlled Trials (1992 to 2020)

#1 MeSH descriptor: [Hospitals] explode all trees
#2 MeSH descriptor: [Hospitals, Animal] explode all trees
#3 MeSH descriptor: [Hospitals, Psychiatric] explode all trees
#4 MeSH descriptor: [Hospitals, Pediatric] explode all trees
#5 #2 or #3 or #4
#6 #1 NOT #5
#7 "district hospital*".ti,ab.
#8 "general hospital*".ti,ab.
#9 "tertiary hospital*".ti,ab.
#10 "teaching hospital*".ti,ab.
#11 "medical centre*".ti,ab.
#12 "medical center*".ti,ab.
#13 "general medical".ti,ab.
#14 (ward* near/4 patient*).ti,ab.
#15 (hospital* near/4 patient*).ti,ab.
#16 MeSH descriptor: [Inpatients] explode all trees
#17 MeSH descriptor: [Hospital Units] explode all trees
#18 MeSH descriptor: [Hospitalization] explode all trees
#19 inpatient*.ti,ab.
#20 #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 83367
#21 MeSH descriptor: [Psychiatric Department, Hospital] explode all trees
#22 "psych* consult*".ti,ab.
#23 (liaison near/2 psych*).ti,ab.
#24 "psych* medicine".ti,ab.
#25 "consultation-liaison*".ti,ab.
#26 "behav* medicine*".ti,ab.
#27 "hospital psych*".ti,ab.
#28 "mental health".ti,ab.
#29 #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28
#30 #20 and #29

Database of Abstracts of Reviews of Effects and NHS Economic Evaluation Database (1994 to 2015, when the database closed)

Title: Psych*	AND	*(Any field:)*
		Hospital*
		"medical centre*"
		"medical center*"
		Inpatient*
		"patient admission*"
		"ward patient*"

Title: "mental health"	AND	*(Any field:)*
		Hospital*
		"medical centre*"
		"medical center*"
		Inpatient*
		"patient admission*"
		"ward patient*"

Title: liaison	AND	*(Any field:)*
		Hospital*
		"medical centre*"
		"medical center*"
		Inpatient*
		"patient admission*"
		"ward patient*"

Title: "behav* medicine"	AND	*(Any field:)*
		Hospital*
		"medical centre*"
		"medical center*"
		Inpatient*
		"patient admission*"
		"ward patient*"

World Health Organization International Clinical Trials Registry Platform

(The platform aggregates data from a number of databases. We searched the platform in August 2018. We were unable to re-run the search in April 2020 because the platform was offline due to Covid-19. We therefore re-ran the search in Clinicaltrials.gov which is the largest contributing database in the platform.)

Searching the Intervention Field in the Advanced Search (Recruitment Status is ALL) for these phrases (without quotation marks):
Psychiatric consultation
Psychiatry consultation
Liaison psychiatry
Liaison psychiatrist
Psychosomatic medicine
Psychiatric medicine
Consultation-liaison
Consultation liaison
Behavioural medicine
Behavioral medicine
Mental health liaison
Hospital psychiatry
Hospital psychiatrist
Hospital psychiatrists

		Intervention:
Title: hospital	AND	Mental health
Title: medical centre	AND	Mental health
Title: medical center	AND	Mental health
Title: inpatient	AND	Mental health
Title: admission	AND	Mental health
Title: ward	AND	Mental health

Searching the Other Terms Field in the Advanced Search (Recruitment Status is ALL) for these phrases:

Psychiatric consultation
Psychiatry consultation
Liaison psychiatry
Liaison psychiatrist
Psychosomatic medicine
"Psychiatric medicine"
Consultation-liaison
Consultation liaison
"Behavioural medicine"
"Behavioral medicine"
Mental health liaison
"Hospital psychiatry"
"Hospital psychiatrist"
"Hospital psychiatrists"

Condition or disease fields:
Hospital “mental health”
“medical centre” “mental health”
“medical center” “mental health”
Inpatient “mental health”
Admission “mental health”
Ward “mental health”

Assessment of risk of bias

We assessed risk of bias using the Cochrane Collaboration's Risk of Bias Tool. This tool requires reviewers to evaluate each trial for risk of five types of bias and to judge each of these as either 'low', 'high' or (when there is insufficient information) 'unclear'.

The types of bias are: selection (high risk means that the allocation of participants to treatments is not random or that treatment allocations could have been foreseen in advance by study staff or potential participants); performance (high risk means that there are likely to be systematic differences between the groups in the care provided or in exposure to factors other than the interventions being tested); detection (high risk means that there are likely to be systematic differences between the groups in the way that outcomes are determined, usually because outcome assessors are not blind to treatment allocations); attrition (high risk means that there are systematic differences between groups in study withdrawals or substantial missing outcome data); and reporting (high risk means that the outcomes reported are not adequately pre-specified).

Study	**Selection Bias**		**Performance Bias**	**Detection Bias**	**Attrition Bias**	**Reporting Bias**
	Random sequence generation	**Allocation concealment**	**Blinding of participants and clinicians**	**Blinding of outcome assessors**	**Incomplete outcome data**	**Selective reporting**
Baldwin 2004	low	low	high	low	low	low
Cole 1991	low	unclear	high	low	high	unclear
Cullum 2007	low	low	high	low	low	low
Gater 1998	unclear	unclear	high	unclear	low	unclear
Levenson 1992	unclear	unclear	high	unclear	low	low
Meesters 1991	unclear	unclear	high	unclear	high	unclear
Shah 2001	unclear	unclear	high	low	low	low
Talley 1990	unclear	unclear	high	unclear	unclear	unclear