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Impact of an intercalated BSc on medical student performance and careers: A BEME systematic review: BEME Guide No. 28

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Abstract

Introduction: Intercalated BScs (iBScs) are an optional part of undergraduate (UG) medicine courses in UK, Eire, Australia, New Zealand, the West Indies, Hong Kong, South Africa and Canada, consisting of advanced study into a particular field of medicine, often combined with research. They potentially improve students' skills and allow exploration of specific areas of interest. They are, however, expensive for institutions and students and delay workforce entry. There is conflicting evidence about their impact.

Methods: A mixed-method systematic review (meta-analysis and critical interpretive synthesis) of the biomedical and educational literature, focusing on the impact of iBScs on UG performance, skills, and career choice, and to explore students' and other stakeholders' opinions about iBScs.

Results: In the meta-analytic part of this review, we identified five studies which met our predetermined quality criteria. For UG performance, two studies using different methodologies report an improvement in UG performance; one study reported an Odds Ratio [OR] of 3.58 [95% CI 1.47–8.83] and the second reported a significant improvement in finals scores (1.27 points advantage 95% CI 0.52–2.02). One study reported a mixed result, while two studies showed no improvement. Regarding skills and attitudes, one paper suggested iBScs lead to the development of deeper learning styles. With regard to subsequent careers, two studies suggested that for those students undertaking an iBSc there is an increased chance following an academic career [ORs of 3.6 (2.3–5.8) to 5.94 (3.6–11.5)]. Seven of eight studies (with broader selection criteria) reported that iBSc students were less likely to pursue GP careers (ORs no effect to 0.17 [0.07–0.36]). Meta-analysis of the data was not possible. In the critical interpretative synthesis analysis, we identified 46 articles, from which three themes emerged; firstly, the decision to undertake an iBSc, with students receiving conflicting advice; secondly, the educational experience, with intellectual growth balanced against financial costs; finally, the ramifications of the iBSc, including some suggestion of improved employment prospects and the potential to nurture qualities that make "better" doctors.

Conclusion: Intercalated BScs may improve UG performance and increase the likelihood of pursuing academic careers, and are associated with a reduced likelihood of following a GP career. They help students to develop reflexivity and key skills, such as a better understanding of critical appraisal and research. The decision to undertake an iBSc is contentious; students feel ill-informed about the benefits. These findings could have implications for a variety of international enrichment programmes.

Background and need for the project

Medical schools aspire to produce fully rounded clinicians, with skills such as scientific literacy, self directedness in learning and motivation to explore specific areas of interest. There is, however, limited scope within crowded medical school curricula for medical students to develop these skills and interests as undergraduates. Self-directed courses (Murphy et al. 2008), summer research projects (Kemph et al. 1984; Griswold et al. 1991) and other initiatives have had varying degrees of success; however, an additional degree during *protected time* within the undergraduate medical curriculum has the potential to meet many of these objectives.

Intercalated, honours, honors or complementary BScs and BMedSci courses (collectively called iBScs from here on) are

Practice points

There is evidence that:

- intercalated BScs may improve subsequent undergraduate performance.
- iBScs are associated with increased chance of students pursuing academic medical careers.
- The educational experiences of these courses are often (but not universally) very rich, and students may develop skills in areas that traditional undergraduate courses struggle to provide.
- These courses are expensive for students, faculty and funding bodies and they delay workforce entry.

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Table 1. Examples of international intercalated iBScs.

Country	University	Web address
Australia	University of Sydney	(http://sydney.edu.au/science/fstudent/undergrad/course/com-scimed.shtml) (tinyurl.com/6k3k4aw)
New Zealand	Otago	(http://www.otago.ac.nz/courses/qualifications/bmedschons.html) (tinyurl.com/658m3tm)
Republic of Ireland	University College Cork	http://www.ucc.ie/medstud/YearInt/yearintercalate.html
Jamaica	University of the west Indies	http://sta.uwi.edu/resources/documents/facultybooklets/MedSciUndergrad.pdf
Hong Kong	The Chinese University of Hong Kong	http://www.med.cuhk.edu.hk/v7/Doc/BMedSc%20Information%20Sheet%202008.pdf
South Africa	UCT (Cape Town)	http://www.medicine.uct.ac.za/Clinical%20Scholar/Presentations/11H30%20AKatz.ppt
Canada	University of Manitoba	http://umanitoba.ca/faculties/medicine/education/undergraduate/bsc_med.html

usually periods of extended study during a medical undergraduate (UG) course, usually with a focus on a specific area of preclinical or clinical science. Intercalated BScs are undertaken in addition to basic undergraduate medical training and aim to give future clinicians important extra skills and experience). Traditionally, in the UK, iBScs have been offered only to the most academically able students, usually at the end of the preclinical course and in basic science subjects, such as physiology and anatomy. They were an expected *right of passage* for some students intending to pursue highly competitive careers (Jones et al. 2005; Park et al. 2010). More recently, some UK institutions, such as University College London (UCL) and Southampton University, have made these courses compulsory for non-graduate entrants. In other UK institutions (such as Nottingham University), these degrees are obtained as standard elements of attainment within an ordinary medical school degree, often as a B Med Sci.

As an educational intervention, iBScs often share the following properties: an extended course away from the traditional medical curriculum (Collins et al. 2010), encouraging in depth independent study (Yudkin et al. 2003), a project focusing on an area of interest (Gardner & Olojugba 2008), e.g. a laboratory-based project (Krishnan 2002b), or a formal dissertation (Jones et al. 2008). In some cases, they feature clinical work (Jones et al. 2001; Park et al. 2010).

Published iBScs course aims often suggest producing clinician scientists, rather than teaching enhanced skills for clinical practice. One UK iBSc course describes the degree as "research orientated" providing "good training in the techniques and methods of biomedical research" (p. 216) (Tait & Marshall 1995). One Australian course has multiple learning objectives, including "the process of research work, critical appraisal, development of skills about knowledge (evidence), how it should be assembled and evaluated and updated, encourage oral and written communication skills, and development of autonomy and independence in study" (p. e542) (Collins et al. 2010).

There are a range of iBSc courses available, including traditional preclinical sciences (physiology (Harris 1986), anatomy (Gogalniceanu et al. 2009), biochemistry, (Fraser et al. 1986) pathology (MacGowan et al. 1986; Wyllie & Currie 1986), as well as clinical subjects, such as microbiology, public health and primary care (Elwood et al. 1986; Williamson 1986; Jones et al. 2001). Various course descriptions have been published (Dudley 1970, 1989; Jones et al. 2001, 2005; Yudkin et al. 2003; Broome et al. 2007; Collins et al. 2010). A full list of the range of current UK intercalated BScs are available at www.intercalate.co.uk.

Intercalated BSc programmes are delivered in UK, Australia (Young & Sefton 1984; Eaton & Thong 1986; Ludbrook 1989; Collins et al. 2010), New Zealand (Al-Shaqsi 2010; Park et al. 2010) Hong Kong, the West Indies (Jamaica), South Africa (Baleta 2012) Eire, and occasionally Canada (Gerrard et al. 1988; Fingerote 1989; Table 1).

There are also various blogs discussing iBScs.

(http://blogs.bmj.com/bmj/2010/04/14/helen-jaques-to-bsc-or-not-to-bsc/) (tinyurl.com/bmsey8c), (http://www.thestudentroom.co.uk/wiki/A_Brief_Guide_to_Intercalated_Degrees) (tinyurl.com/6vz75o9)

Intercalated BScs have a long history, dating back to the 1890s in Australia (Young & Sefton 1984), and were introduced formally in UK in 1964 (Smith 1988). By 1985, 10% of UK medical graduates had a Bachelor of Arts or BSc (which may or may not have been intercalated), as did 39% of medical academics (Wakeford et al. 1985). The last published estimate suggests iBScs are undertaken by between 10% and 36% of UK medical students (Tamber 1986; McManus et al. 1999). Until 1986, they were explicitly funded in UK by the Medical Research Council (MRC) with the intention of seeding new clinical academics; a role they still fulfil in other countries (Baleta 2012). In UK, they are still widely offered, with 230 iBScs listed on the intercalate.co.uk website (accessed October 2012).

There is little published about why departments offer such courses. There may be an element of being a "shop window" to attract future medical academics,

> "departments often find that successful students return to the discipline after qualification" (p. 125) (Fraser et al. 1986),

and there may be altruistic reasons with faculty wanting to see future clinicians better equipped to undertake or understand research,

> "departments . . . welcome the opportunity of covering their subjects in depth and of training students in scientific methods" (p. 125) (Fraser et al. 1986),

funding advantages for departments, such as bringing in teaching income, and there may be a desire to increase departments' prestige and status by delivering these high profile courses.

In many countries, following a US model of medical education, primary medical courses are usually postgraduate, so there would be very limited student appeal for a faculty in offering an undergraduate intercalated BSc, but as discussed further on, intercalated higher degrees (PhD, MPH) are now being offered. Enrichment programmes that extend medical

school courses exist extensively in the US, although these programmes are designed primarily to enhance access to medical degree courses for minority groups (Barzansky et al. 2000). Programmes called complementary degrees also flourished in the 1970s, in the form of six-year BSc, MD courses; again, aimed at promoting access to medicine (Daubney et al. 1981).

Research programmes that extend medical courses with research methods programmes and projects or dissertations are common in the US, (Jacobs & Cross 1995) and these are often undertaken as summer courses (Kemph et al. 1984; Griswold et al. 1991). They also exist in Canada (Smith et al. 2001), Germany (Cursiefen et al. 1995), Croatia (Kolcic et al. 2005) and Finland (Remes et al. 2000). These research courses have some similarities with iBSc courses, and these courses are sometimes constructed for the completion of dual clinical/higher research degrees (MD/PhD, MD/MPH) (Andriole et al. 2008; Creavin et al. 2010; Table 3).

Student selected components (SSCs) in UK medical schools that offer some of the components of an iBSc, such as depth and breadth of study, a foray into areas of personal interest, and provide opportunities outside the standard medical arena, but often last only a few weeks (Whittle & Murdoch-Eaton 2002) (Murphy et al. 2008).

Where there is a choice, the decision whether to undertake an iBSc remains a substantial dilemma for many medical students (Nicholson et al. 2010). iBSc courses are expensive in terms of the opportunity cost of delayed graduation and entry to the medical workforce, as well as direct costs due to student fees, living expenses and faculty costs (teaching and supervision) (Fraser et al. 1986). Estimates of the total additional costs in UK are £40,000 per student (Gutenstein 2000; Sastry 2005). Collins quotes iBSc course fees of Aus $5000 (Collins et al. 2010). With such high costs, it cannot be assumed that 'optional' degrees will remain the norm in a current climate of austerity. The role of the iBSc in medical education has therefore become more pertinent, particularly in the UK, in light of recent reductions in government funding for UK higher education and higher course fees.

Previous reviews on this subject are available (Leung 2001; Collins et al. 2010) and discussed later. There is little data about the expected impact of iBSc courses. The following phrase from an editorial, "doing an intercalated BSc can make you a better doctor" (p. 760) (Greenhalgh & Wong 2003), which we have operationalised as: improved exam performance, skills acquired and the impact on students' subsequent careers. This structure has been used to frame the aims of our review, as follows.

Aim

To undertake a systematic review of the published literature on the impact for students undertaking a BSc, specifically focusing on the following:

- students' decisions about undertaking an iBSc;
- students' performance in undergraduate or final exams;
- impact on students' professional skills and values;
- students' experiences of doing an iBSc;
- effect on students' career choices;
- the ramifications (financial, personal) for students of doing an iBSc.

Methods

A systematic review with two components was undertaken to explore the impact of iBScs in medical education synthesising data from qualitative and quantitative methodologies (Adamson 2005). A traditional meta-analysis (reporting numerical data) and a critical interpretative synthesis (reporting qualitative data) were undertaken, each with its own prespecified criteria (see Table 3). The published literature was searched using the following databases: Medline/National Library of Medicine (NLM), PsychINFO, EMBASE, the student BMJ database and ERIC for papers that report student outcomes beyond the direct course outcome itself – such as degree class or result. In addition, we manually searched archived Student BMJs, as an established source of articles and UK student perspective on iBScs. Index papers were citation-tracked using ISI Web of Knowledge. We subsequently checked the search with a Google Scholar search using the search term "intercalated BSc".

Once the two analyses were complete we combined the resulting data (see Figure 1). We have not placed either process within a methodological hierarchy (i.e. quantitative data are stronger than the qualitative) but took the view that we would combine data in a complementary manner, using an "integrationist approach", (p. 232) (Adamson 2005) so that the data that illustrate a given concept or issue is used regardless of its source.

Scope of review

We have restricted our review to intercalating degrees at a Bachelor's level for medical students (and so we have excluded Veterinary or Dental science iBScs). Intercalating higher degree programmes such as intercalated Masters and MB/PhD programmes (Table 2) exist but are not included as they are relatively new, are not well evaluated currently

Table 2. Examples of intercalated medical and higher degrees.

Country	University	Course	Web address/reference
Scotland/UK	St Andrew's	MRes	http://medicine.st-andrews.ac.uk/documents/MRes_Leaflets_Feb11.pdf
UK	Keele	Masters	Creavin et al. (2010)
USA	Various	MD/PhD	Andriole et al. (2008)
UK	UCL	MB/PhD	http://www.ucl.ac.uk/mbphd/
NZ	Auckland	MB PhD others	Park et al. (2010)

Table 3. Data sources and criteria for both methodological sections of the review.

	Meta-analysis	Critical interpretative synthesis
Data source	Studies identified through searches of Medline/National Library of Medicine (NLM), PsychINFO, EMBASE, the student BMJ database, ERIC	
Search criteria	medical student AND (outcome OR progres$ OR exam OR succes$ OR fail$), BSc OR bachelor OR degree OR intercalated [Text Word] OR honours [TW] OR honors [TW] OR complementary	
Dates	No date range applied, searches undertaken in 2008 and updated in 2012.	Additionally we incorporated research papers, letters, opinion pieces and other articles relating to intercalated degrees within the medical undergraduate course. Date range 1.1.1984–1.6.2009 updated 1.11.12
Quality criteria	(i) observational or trial designs, (ii) controlled for previous academic performance, (iii) a focus on medical students, (iv) outcomes compared to the general under and graduate medical population and (v) availability of an English language abstract (vi) an adequate description of the course.	CIS methodology does not require assessment of quality of primary data sources, just the ability the data have to help generate concepts.

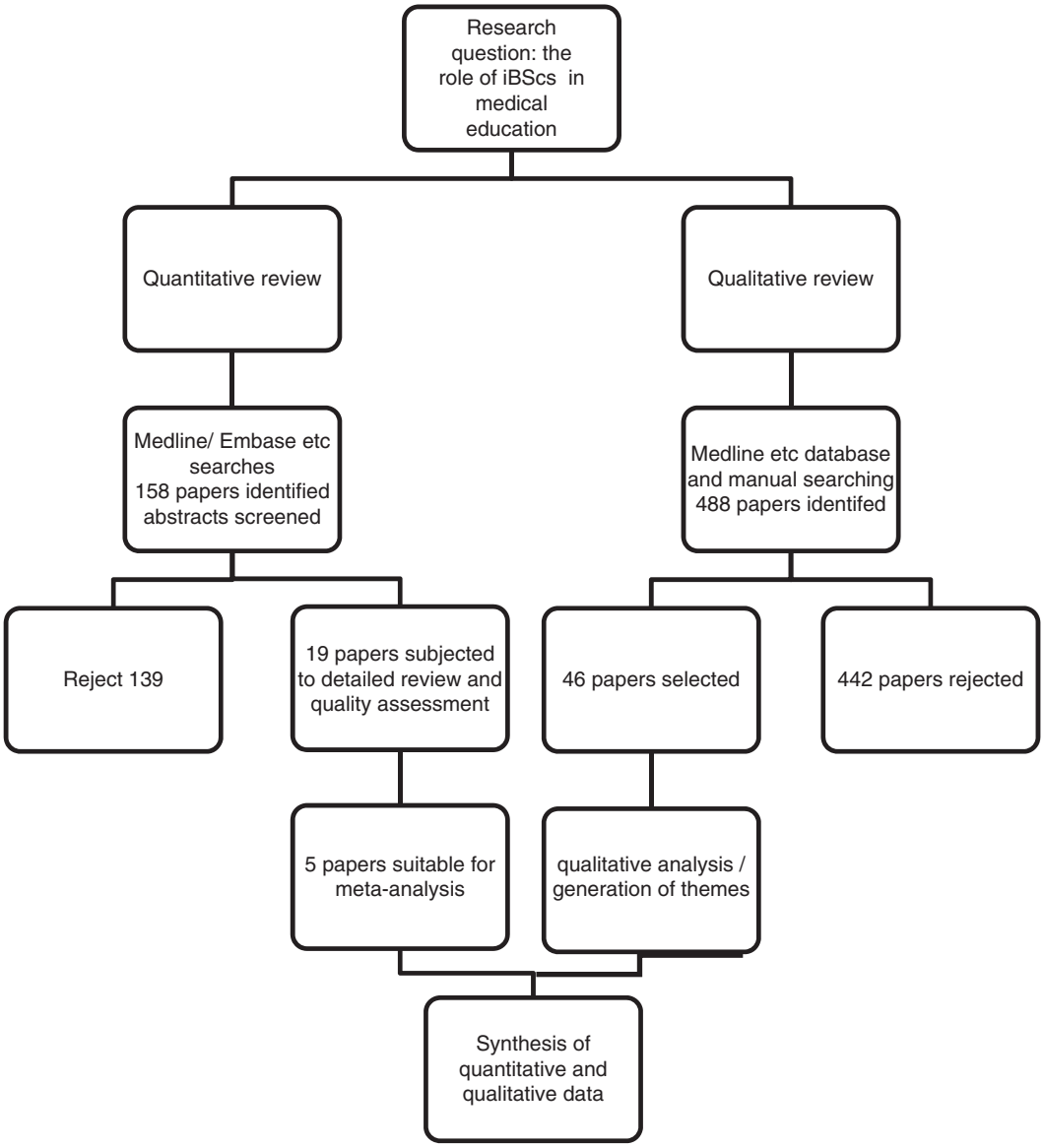

Figure 1. Flow chart of BEME iBSc review.

(so there is little published material on their impact to include in a systematic review), and are probably likely to be aimed at clinicians predominantly pursuing a research rather than primarily a clinical career. We have also excluded undergraduate research courses and special study modules (SSC/SSMs), as these are very heterogeneous in nature and vary in duration from a few days to several years. US enrichment and Medicine Access courses are excluded, as previously discussed.

Search terms

The following search strategy was used and adapted for each database. The following is an example of the NLM/Medline search.

(1) medical student AND (outcome OR progres$ OR exam OR succes$ OR fail$) = 2341
(2) bsc OR bachelor OR degree OR intercalated [Text Word] OR honours [TW] OR honors [TW] OR complementary [TW] = 430317
(3) Combined 1&2 = 158 citations

Criteria for entry

We set the following inclusion criteria for the meta-analysis/quantitative synthesis: (i) observational or trial designs, (ii) controlled for previous academic performance, (iii) a focus on undergraduate medical students, (iv) outcomes compared with the general undergraduate and graduate medical population, (v) availability of an English language abstract and (vi) an adequate description of the course to allow a judgment on the similarity with UK iBSc degrees.

For exploration of data on the impact of iBScs on pursuit of GP/hospital careers, we have dropped criterion (ii), as we felt adjusting for prior academic performance (i.e. producing a ranking of students) would be meaningless on this measure as it is impossible on the other side of the analysis to rank the merits or produce a hierarchy of different medical careers.

For the meta-analysis/quantitative synthesis, studies were reviewed by two researchers and data analysis was checked independently by a statistician. We anticipated conducting meta-analysis of the data if they were not heterogeneous. Forest plots (Clark & Djulbegovic 2001) were derived.

For the critical interpretative synthesis (CIS) (Dixon-Woods et al. 2006) component of this review we set the following criteria:

(1) Research papers, letters, opinion pieces and other articles (grey literature) relating to intercalated degrees within the medical undergraduate course.
(2) Date range 1.1.1984–1.11.2012 to link with more recent student experiences and to allow adequate capture of the surge of opinion pieces before and after the timing of the UK Medical Research Council's (MRC) withdrawal of funding to iBScs in 1986.
(3) Data identified from the meta-analysis/quantitative synthesis were included, when they contained reflective comments on their results.

CIS uses a wide variety of data sources such as letters and opinion pieces but is not a meta-synthesis of qualitative studies. The selection criteria do not therefore require any judgement about the "quality" of the source material; the aim is "to prioritise papers that appeared to be relevant, rather than particular study types or papers that met particular methodological standards" so that the data can act "to maximise the inclusion and contribution of a wide variety of papers at the level of *concepts*" (p. 4) (Dixon-Woods et al. 2006).

Analysis

(a) Meta-analysis/quantitative synthesis:

The data are reported as odds ratio (OR) of BSc students' performance ÷ non-BSc students. Where ORs are very wide, logs OR are used to visually represent the data. Where identified studies did not report their data in the form of ratios, the data are compared to other published work; e.g. career outcome (% iBSc/non-iBSc students going into general practice [GP]), or undergraduate performance.

(a) Critical interpretative synthesis:

With the critical interpretative synthesis of the qualitative data, this was analysed by two researchers (PH and SE) using a thematic framework approach (Ritchie & Spencer 1994).

The researchers independently familiarised themselves with the data, each constructing a preliminary framework of emergent themes, which were then modified and combined by consensus, and subsequently checked by a third researcher (MJ), who was familiar with the qualitative data. The data were then indexed according to the themes. In the form of excerpts, the data were then charted onto an Excel spreadsheet according to theme, seeking disconfirming evidence throughout, and modifying themes accordingly. All disagreements in interpretation were discussed until consensus was achieved.

Results

The data and themes of this review are presented in a chronological order that might follow a student's career and are not presented by the methodology from which they were obtained.

Data were organised under the following headings:

- The students' decision to undertake an iBSc
- Undergraduate performance
  - Acquisition of additional skills
- Student experience
- Impact on students' careers
  - Future ramifications of having taken an iBSc
  - Career progression
  - Impact on academic and GP careers

Data from the meta-analysis are embedded within the overall results as part of the following themes: impact on undergraduate performance, acquisition of skills, impact on

students' careers, academic careers and impact on choosing GP careers.

(a) Meta-analysis/quantitative synthesis:

For this element of the review we initially identified 19 papers (see Appendix 1) (Nade 1978; Young & Sefton 1984; Wakeford et al. 1985; Eaton & Thong 1986; Elwood 1986; Elwood et al. 1986; Harris 1986; MacGowan et al. 1986; Williamson 1986; Wyllie & Currie 1986; Gerrard et al. 1988; Tait & Marshall 1995; McManus et al. 1999; Lambert et al. 2001; Nguyen VanTam et al. 2001; Cleland et al. 2009; Collins et al. 2010; Howman & Jones 2011; Mahesan et al. 2011) reporting student impact (undergraduate performance, skills and attitudes and subsequent career progression), of which five met our full quality criteria for undergraduate performance (see Table 4 and Appendix 1) (Wyllie & Currie 1986; Tait & Marshall 1995; Cleland et al. 2009; Howman & Jones 2011; Mahesan et al. 2011). The papers are described in more detail in Appendix 1. The studies were methodologically heterogeneous, so we were not able to produce a pooled (or meta-analysed) result.

(a) Critical interpretative synthesis:

For this element of the review, we identified 46 papers, letters or articles which were deemed to be relevant to the subject of the review from an original search containing 488 items. The papers are described in detail in Appendix 2. From this data we generated three main themes: the decision to undertake an iBSc, the experience of doing an iBSc, and the future ramifications of having undertaken the degree.

The decision to undertake an iBSc

From our critical interpretative synthesis of the qualitative data, we found evidence that iBScs were pursued by students interested in research and academic medicine and in the expectation that these courses would help their career (Park et al. 2010). Within the literature there is, however, debate about whether, for some students, they should undertake an iBSc at all.

> The only exception was that if you are a student interested in going into research the article provided a fairly clear answer: "yes" . . . (otherwise with regard to iBScs and careers) The answer was elusive, it is now no clearer. (Student) (p. 478) (Aston 2001)

Our data suggest that iBScs are a sensible choice in terms of career enhancement for some careers, but uncertain for others (GP, psychiatry). From a strictly career enhancing perspective, there was some doubt about the impact of undertaking humanities iBScs. These themes are reflected by the following:

> In short, either decision, to do or not to do, can be the right one for you. (Student) (p. 479) (Burkitt Wright 2001)
>
> For those intending to pursue a clinical career in . . . psychiatry, general practice – you should consider whether your desire for intellectual stimulation outweighs the time and money constraints (doctor and medical journalist) (p. 419) (Leung 2001)

Structural factors also influenced the choice, such as the medical school's policy on compulsory courses, the nature of course offered or prior academic success.

> The proportion of students taking the intercalated degrees varies widely among medical schools. In some medical schools it is obligatory . . . In other schools, it is open only to students who performed well in the first two years. (Doctor and medical journalist) (p. 418) (Leung 2001)

Lack of advice and support to students from medical schools was also highlighted as an issue (Park et al. 2010).

Undergraduate performance

We identified five papers that report the impact of iBScs on medical school exam performance (Table 4 and Figure 2) (Wyllie & Currie 1986; Tait & Marshall 1995; Cleland et al. 2009; Howman & Jones 2011; Mahesan et al. 2011) with two reporting improvement in UG performance; Wyllie reports ORs of 3.58 (1.47–8.83). Mahesan et al.'s reports that "internally intercalating students had a year 5 mean result that was on average coefficient of 1.27 points (95% CI 0.52–2.02) greater than non-intercalating students", externally intercalating students showed a non-significant increase (the range of the data, however, was not published). It was not possible to calculate an OR from this data.

Table 4. Impact of the iBSc degree on undergraduate medical student performance.

Study	Measure	BSc students	Non-BSc students	Odds ratios	95% confidence intervals
Wyllie & Currie (1986)	Finals (getting high score in finals exam) >10/20	32/55 (58.2%)	14/50 (28%)	3.58	1.47–8.83
Cleland et al. (2009)	% achieving highest grade (1–2) in OSCE finals (861 students)	104/154 (67.5%)	421/707 (59.5%)	1.41	0.96–2.09
Howman & Jones (2011)	1st clinical year score – top half	53/136 (38.9%)	37/138 (26.8%)	1.81	1.09–3.01* (*note adjusted score is n/s)
Tait & Marshall (1995)	Data in unusable format – narrative summary				
Mahesan et al. (2011)	Finals score	Internal intercalating students scored 1.27 points (95% CI 0.52–2.02) greater than those who did not.			

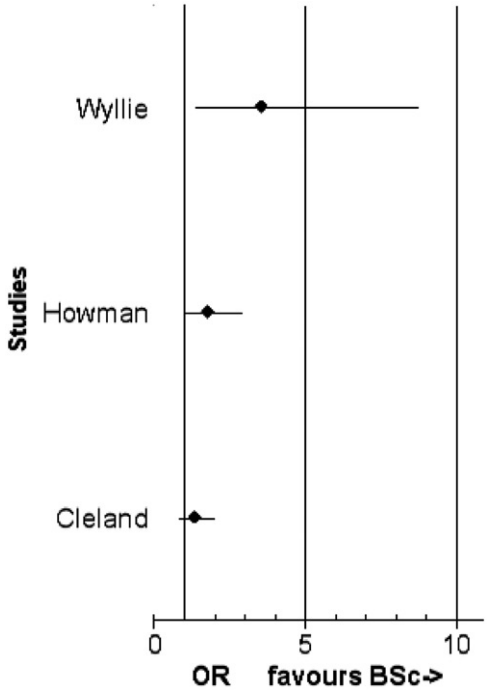

Figure 2. Impact of the iBSc degree on undergraduate medical student performance (diagram does not include data on two studies for which ORs were not calculable).

The study by Tait & Marshall (1995) reports that some factors in student performance improved, while others did not; but insufficient data were reported to derive an OR for this study. Cleland et al.'s (2009) study looked at multiple measures, but reported a non-significant improvement in finals OSCEs. Howman et al.'s paper in a medical school where iBScs are compulsory (minimising selection bias) suggests there is no effect on first clinical year performance with an adjusted mean score difference of 1.4 (−4.9 to +7.7 95% CI, $p = 0.66$) (overall mean score 238.0 "completed iBSc" students versus 236.5 "not completed" range 145–272 out of 300) (Howman & Jones 2011). In summary, two studies out of five reported an improvement in UG performance associated with undertaking an iBSc.

Acquisition of additional skills and changes in attitudes. Our analysis showed that one of the most frequently cited benefits of undertaking an iBSc was the acquisition of new skills (Asgari-Jirhandeh & Haywood 1997; Iqbal 2001; Krishnan 2002b; Agha & Howell 2005; Park et al. 2010), specifically including research or laboratory skills that are rarely learnt elsewhere in the curriculum (White 2006; Mabvuure 2012). Students and academics cited the improvement to critical appraisal skills from handling literature during the year (Attwell & Boyd 1996; Iqbal 2001; Weidmann 2002; Jones et al. 2005), and a variety of personal study skills, such as self-discipline and time management (Elwood et al. 1986; Price 1998). Empathy (Moscrop 2002) and improved communication skills were also mentioned with reference to iBScs with a clinical component. In Elwood's study, 34/98 [35%] of students mentioned improvements in interpersonal skills, such as "the ability to talk to patients" (p. 233) (Elwood et al. 1986). Additionally, the opportunity for independent intellectual thought and stimulation was highlighted (Williamson 1986; Elwood 1986).

We also investigated the impact that iBScs had on students' skills and attitudes within the quantitative framework and identified only three studies (two of high quality). McManus et al. (1999) report that students who had taken an intercalated degree had higher deep learning scores ($z = 3.73$, $p < 0.001$) and strategic score ($z = 4.56$; $p < 0.001$) (where the significance tests from multiple regression and multilevel modelling are reported as Z statistics). However, one study suggested a deterioration in the way students deal with ethical issues, following the iBSc (Goldie et al. 2004). Additionally, Elwood et al.'s study (student self-reports, with no comparator groups so not meeting our quality criteria) found that 90% (81/90) respondents believed that the course promoted their interpersonal skills as well as their research skills, and 58% (57/98) reported an increased awareness of the need for critical evaluation (Elwood 1986; Elwood et al. 1986).

Of interest to students and societal stakeholders is the question of whether undertaking an iBSc makes better doctors (Agha & Singh 2003; Greenhalgh & Wong 2003). Academic leaders felt that iBScs instilled skills that were highly valuable to future doctors (Greenhalgh & Wong 2003). However, with no agreed measure of a "good doctor," there is, unsurprisingly, no hard evidence to support or refute this as a potential outcome.

Student experience

Students often described the courses as being enjoyable and some felt it had had a profound effect on their lives, (Harris 1986; Holmes 1986; Smith 1986; Goldstein 2002) due to intellectual rewards or influence on career:

> That was the year that I learnt to think and to question and to find out things for myself. That is where the (iBSc) degrees may be so important they prepare students for a lifetime of learning (former editor of the BMJ) (p. 1620) (Smith 1986)

Also mentioned was the opportunity to have a break from the rigours of the medical course, although perceived workloads varied considerably (Krishnan 2002b; Moscrop 2002; White 2006). Some students discussed the chance to form new friendships, (Weidmann 2002; White 2006); however, others described the loss of social networks from the early years of medical school as a drawback (Thiagamoorthy 2001; Park et al. 2010).

The key negative aspect to undertaking an iBSc internationally were the additional financial costs (Fingerote 1989; Gray 1989; Gutenstein 2000; Gardner & Olojugba 2008; Park et al. 2010).

> With mounting student debt and moves by the UK government to almost triple tuition fees . . . accumulating yet another year's debt whilst also delaying repayment of your growing negative balance can be a serious turn-off. (Recently qualified doctor) (p. 1137) (Rushforth 2004)

Various practical problems were mentioned, such as students' concerns about not being able to pursue preferred subjects. There were faculty worries over the potential adverse impact on students' clinical skills, although in one study comparing those who intercalated and those who did not, intercalating students achieved higher clinical OSCEs scores than those who did not intercalate (Cleland et al. 2009).

Students voiced worries about their research not producing meaningful results, and some described a pressure to publish (Collier 2001). There were contrasting views on the quality of support from supervisors (Eaton & Thong 1986) with occasional voices expressing concerns about being exploited in laboratory settings (although in this specific case the published accusation (Krishnan 2002b) was contested (Kentish & Avkiran 2002) and subsequently retracted (Krishnan 2002a).

Impact on students' careers

Our analysis suggests there was a perceived benefit to general employment opportunities (Agha & Howell 2005; Park et al. 2010), particularly within the specific discipline of the iBSc subject (Child & Gupta 2009). However, the impact on employment of an iBSc was also contested by some commentators (Collier 2001; Leung 2001):

> No value put on the (intercalated) degree once you qualify (p. 30) (Park et al. 2010)

IBScs were perceived to confer advantages for candidates, in terms of useful personal contacts (Park et al. 2010), impact at interview (Iqbal 2001) and within their employment references (Leung 1999). Additionally, iBScs explicitly gain extra credit within the application system for the UK Foundation post system for junior doctors. Mahesan et al.'s study (2011) showed that iBSc students obtain higher scoring for their foundation school application, both from their improved exam performance, but also though improved scoring on "white space" (p. 2) question ("white space" online questions are free text reflective questions about team working and professionalism asked of all applicants for foundation training – however, this assessment format will disappear in 2013).

There was discussion about whether some careers really warranted an iBSc (Longmore 1986), linking back to the decision to undertake an iBSc in the first place. For those students undecided about their future career path, the suggestion was that iBScs were a sensible choice, particularly if aiming to branch away from medicine altogether as it gave students an exit degree without having to wait five to six years for a Medicine degree (Leung 2001).

Academic career progression (the pursuit of an academic career). We know that those who have already pursued UK and international academic careers are more likely to have iBScs (Wakeford et al. 1985; Evered et al. 1987; Seltzer 1987). A methodological difficulty was highlighted by authors in ascertaining a causal relationship between undertaking an iBSc and success in academic careers (Holgate et al. 1999; McManus 2011). The potential for students to attain publications from their research was mentioned as being a key benefit that enhanced career prospects (Agha & Howell 2005; Park et al. 2010). At Queensland (Australia) Medical school iBSc graduates were six times more likely to undertake higher research degrees (MSc, MD, PhD) [17.3% versus 3% ($p < 0.001$)] compared to non-intercalating students (Eaton & Thong 1986). The mechanism may be that an iBSc degree,

> "confers a significant advantage when applying for post graduate medical research scholarships to do a PhD, MD or MS" (p. 907) (Ludbrook 1989)

There is evidence that the intention to pursue an academic career is present at the undergraduate level – suggesting the iBSc merely acts as staging post for aspiring academics (McManus et al. 1999; McManus 2011).

There is some suggestion that departments run such courses to attract clinical academics back to their speciality and to build academic capacity (Fraser et al. 1986). There are also concerns that the threats to iBScs courses may have an adverse impact on academic capacity (Morrison 2004).

We identified three studies within the quantitative element of the review which indicate that students with an iBSc have improved prospects of academic progression (Table 5 and Figure 3) with ORs in the range 3.64 (95% CI 2.32–5.77) to 5.94 (95% CI 3.60–11.54) (Wyllie & Currie 1986; Gerrard et al. 1988). McManus reported a career preference to pursue "medical research" amongst final year students of 2.18 (SD 1.10) for iBSc students versus 1.71 (SD 0.88), $p < 0.001$ (on a range of 1–5 where 5 indicates a definite intention to pursue this career) (McManus et al. 1999). There was insufficient data to calculate an OR for this study. Additionally, the Nguyen study states that "55% reported that the (honours) year had increased their likelihood of choosing an academic career", however, 19% "felt it had reduced the chances." (p. 136) (Nguyen VanTam et al. 2001).

GP careers. There is an association of students with iBSc degrees and a lower likelihood of pursuing careers in GP/family practice (Table 6 and Figure 4), with many iBSc graduates instead pursuing hospital careers – OR for a GP career ranged from 0.99 (OR confidence intervals cross unity) to 0.17 (0.07–0.36).

Table 5. Impact of iBSc degrees on academic advancement – i.e. encouraging students to pursue academic careers.

Study	Measure	BSc students	Non-BSc students	Odds ratios	95% Confidence intervals
Gerrard et al. (1988)	Academic career	101/206 (49%)	43/206 (21%)	3.64	2.32–5.77
Wyllie & Currie (1986)	Academic careers	18/42 (43%)	321/2863** (Lambert & Goldacre 1998) (11.2%)	5.94	3.60–11.54

**Expected proportion of academics from Lambert (Lambert & Goldacre 1998).

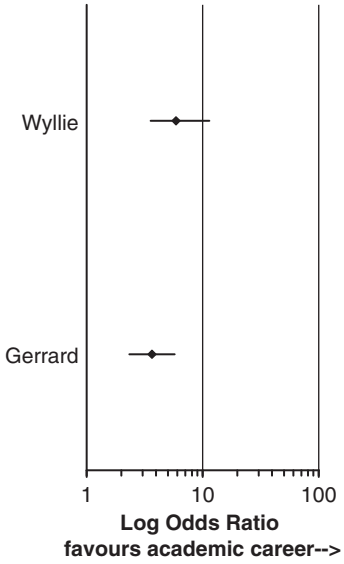

Figure 3. Impact of iBSc degrees on academic progression (the pursuit of an academic career).

Figure 4. Impact of iBSc degrees on subsequent careers in general practice.

Table 6. Impact of iBSc degrees on general practice as a career.

Study	Measure	BSc students	Non-BSc students	Odds ratios	95% Confidence intervals
Gerrard et al. (1988)	% family practice	17**/336 (5%)	215/1442 (13%)	0.36	0.20–0.60
Eaton & Thong (1986)	% general practice careers	11/90 (12.2%)	51/112 (45.5%)	0.17	0.07–0.36
MacGowan et al. (1986)	% general practice careers	9/46 (19.5%)	*528/1192 (44.3%)	0.31	0.13–0.65
Nguyen Van Tam et al. (2001)	% general practice careers	86/195 (44%)	*(44.3%)	0.99	0.72–1.36
Williamson (1986)	% general practice careers	3/19 (15.7%)	*(44.3%)	0.24	0.04–0.83
Wyllie & Currie (1986)	% general practice careers	7/42 (17%)	16/39 (41%)	0.29	0.09–0.89
Young & Sefton (1984)	% general practice careers	31/356 (8.7%)	51/112 (45.5%)	0.11	0.07–0.20
Lambert et al. (2001)	% general practice careers	319/2081 (15.3%)	776/2992 (25.9%)	0.52	0.45–0.60

*Expected proportion to follow a GP career (Lambert et al. 1996).
**Estimated from proportions in report, no raw data.

McManus et al. (1999) stated iBSc students "showed . . . less interest in general practice" (p. 542) with a career intention of 2.27 (SD 0.83) for iBSc students versus 2.46 (SD 0.88), $p < 0.001$ (on a range of 1–5 where 5 indicates a definite intention to pursue this career). These results may be explained by an historical lack of primary care-related BSc degrees – courses that now exist (Jones et al. 2001) – supported by the fact that the most community-orientated iBSc (public health and epidemiology) has no negative effect on GP recruitment (Nguyen VanTam et al. 2001).

Discussion

This study is the first attempt to systematically analyse the benefits of iBSc courses within UG medical education. This review showed conflicting evidence that undertaking an iBSc degree may have on undergraduate performance and acquisition of additional skills (this evidence is open to interpretation and is discussed further on). Though students may find the decision to undertake an iBSc difficult, there were suggestions that these courses were likely to benefit the future careers of some, in particular, those aspiring to an academic career. While students with iBScs are more likely to pursue careers in academia or hospital medicine, such choices do not necessarily indicate that these courses yield *better doctors*.

The primary studies that reported results from the CIS data add crucial context in this area, with suggestions of improved intellectual development, the time for students to reflect on their own skills, to develop life-long learning skills and "to get (their) head around research" (Greenhalgh & Wong 2003). These are not attributes that should be optional in medicine and are traditionally not well delivered by normal curricula (Tonks 2002; Watmough et al. 2009). Beyond the institutional and societal focus, however, the area of the results that may appeal to students (and consumers) of iBScs may relate to improved employment prospects, and more intangible components of spending a year *away* from the medical course, being another year older before qualifying as a doctor and working at a different pace. The uncertainty many students face about the choice to undertake an iBSc, where the course is optional, highlights the need for good careers advice

(Rushforth 2004; Nicholson et al. 2010; Park et al. 2010) so that students can make an informed choice relative to their own career plans.

Strengths and limitations

We have concluded on the basis of the data presented (supported by the CIS data), that overall, there is a positive effect on UG performance from iBScs. However, synthesising data across different study designs and methodologies is problematic (Adamson 2005). From within the quantitative analysis, two out of five studies suggest an improvement in UG performance but the data are not meta-analysable, so it is impossible to say what an overall result would be, were it possible to pool the data. Importantly, none of these studies suggest an adverse impact; it is a question of are these studies underpowered to detect a difference (effect not found) or there is no difference (no effect)? Balancing the overall effect of two positive studies with three *no difference* studies has, therefore, to be subjective and open to interpretation. Similarly, how we interpret and integrate the results from the CIS data, where qualitative data are traditionally within one epistemological school, seen as weaker in the hierarchy of evidence, can be viewed as contentious.

We do feel that using this combined methodology has a synergistic effect. This approach is used increasingly in health services research (Adamson 2005) and funding bodies like the MRC increasingly expect a mixed method approach. Mixing the methodologies, however, does produce difficulties in presenting the data. Examples include difficulties with the basic structures of manuscripts, such as listing study aims, which are to be expected in quantitative studies but run counter to the exploratory nature of qualitative work where the research process is expected to generate new concepts which may be unanticipated. The most obvious tension is the expectation that we will critically appraise or judge the quality of the qualitative literature that we include. This idea of prejudging the qualitative literature runs counter to what we are trying to achieve with these data sources, where we are hoping to elicit new concepts or themes, and the source of that idea may come from a student letter or a faculty authored comment in a high-quality observational study. Examples of this strength of synthesis are issues around student debt, which is a very strong theme from within the student sources, but is largely absent from faculty sources, but perhaps explains some of the reasoning behind students opting not to do iBScs, reasoning which is more complex than pure academic attainment.

Our work operationalised the concept of the *better* doctor to three measurable domains: we acknowledge that this concept may include many other attributes; there is, however, little agreement about these attributes in the literature or data about them to explore this area of analysis further.

Many of the studies within the statistical meta-analytic part of the review were of low quality; the wide ORs reflect the small study sample sizes, and there was also considerable heterogeneity in the results. Observational studies also have problems of confounding and selection-bias; in some institutions, the most academically proficient medical students are those likely to be offered the option to undertake iBScs. While we attempted to identify such effects, unrecognised bias may have occurred. Nicholson et al.'s work additionally suggests financial constraints; possibly an unrecognised confounder as it suggests a bias against students from lower income backgrounds, perhaps struggling with debt or part-time work or other issues that may impact on performance and this may be an issue among those who do not take up BScs (Nicholson et al. 2010).

Within those studies analysed in the CIS component of the study, we recognise the need to be cautious; just because opinion leaders say their courses improve aspects of students' intellectual development does not mean this is necessarily true. We also suspect an inherent bias in published material as there are strong motivations for students and organisers to write about successful outcomes to their courses. However, this data are remarkably consistent and informants who appear to have no obvious conflict of interest (Smith 1986) make similar claims of benefit from such courses.

We acknowledge that iBSc degrees are also a heterogeneous intervention (e.g. compare an iBSc physiology and one in international health). Expecting to see a consistent impact on any one measure, such as undergraduate finals, may, therefore, not be reasonable.

However, despite these concerns about some of the original data and limitations of our analyses, there are consistent patterns, validated across both methodologies, across countries, and over time, suggesting that iBScs can have a beneficial effect on students in UG medical education.

Links to other literature

Previous reviews on this subject are available (Leung 2001; Collins et al. 2010). Leung's review aimed at a student readership is comprehensive but is a non-systematic review of the literature and the source studies were not appraised. The review by Leung was published in 2001, so is now 11 years old, and misses some of the more recent methodologically higher quality studies, particularly those that cast some doubt on the beneficial impact of iBScs on UG performance. Collins et al. (2010), while more recent, is not primarily a review of the literature, but as part of the discussion pulls together much of this background material in a non-systematic manner and includes some UK and international policy documentation. This current review, therefore, brings previous reviews up to date (with searches updated to late 2012), adds critique of the primary studies and does so in a systematic manner across both the qualitative and quantitative research traditions.

Previous research also confirmed that there is a beneficial effect of an extra year of study and maturity on students' exam performance (Wilkinson et al. 2004). The effects we report on UG performance particularly may, therefore, not be arising from the iBSc but due to increasing student maturity from an extra year of study. Mahesan et al. report, however, that the extended MB BS course students do slightly worse than students undertaking the normal length course. Additionally, there seems to be no effect with year of intercalation suggesting a diminution of effect on exam performance with

time (Mahesan et al. 2011). These indirect pieces of evidence suggest additional student maturity may not be a key factor in our findings.

Conclusion

This review shows that iBScs may be a useful addition to the standard medical undergraduate curriculum in terms of impact on student performance, skills development and may positively impact on students' employability and subsequent careers. The more recent studies give conflicting answers about the impact of iBSc on student performance. The CIS data add new insights into the students' perspective on iBScs, enabling the appreciation of positive and negative student commentaries alike.

The increasing impact of course fees and other costs will have a heavy impact on students' decisions about such courses. In a time of austerity, the role of iBScs, as part of an already expensive medical course, is likely to come under close scrutiny. It is uncertain whether the potential benefits of iBScs could be squeezed into student selected components or into the ever expanding main medical career. Such interventions, while probably demonstrating improved student skills, may well harm the *intangible benefits* of iBSc courses that are not measureable, such as enhanced scientific curiosity and intellectual development.

There is some suggestion that the benefits of increased research training seen with iBScs might be being rebranded by institutions, and resources moved, to develop combined medicine/higher research degree programmes (such as MSs/MD/PhDs) (Creavin et al. 2010) to benefit from the greater marketability, status and international recognition attached to such degrees.

There is scope for future research regarding iBScs in medical education, as this review has demonstrated. Neither this review, nor any of the identified papers, addresses the question, what exactly is the function of an iBSc degree? Is it to seed new medical academics (the institutional focus) or is to help make *better* doctors (the societal focus)?

Cross-institutional or even international collaboration may help define the objectives, and delineate the potential benefits of these courses. Semi-structured interviews with or surveys of students and academic stakeholders, or discourse analysis of student internet blogs on the subject (http://www.thestudentroom.co.uk/wiki/A_Brief_Guide_to_Intercalated_Degrees) (tinyurl.com/6vz75o9), represent interesting possibilities for further work.

Educational practice and policy implications

Medical schools that offer optional iBScs need clear equitable selection policies that do not disadvantage able students from poorer backgrounds.

Course designers should have clear aims for these courses, and these aims need to consider clear societal benefits, i.e. *producing better doctors*.

There should be a diversity of courses offered by medical schools with a rebalancing towards more clinically related subjects

Medical schools that offer these courses should have clear generic objectives across all their iBScs which go beyond a narrow disciplinary focus.

National research funding bodies should (again) consider supporting these courses as they clearly impact on career choices of aspiring medical academics.

There should be more evaluations of such courses, particularly of those courses that are less successful (so that lessons can be learnt by other institutions).

Declaration of interest: MJ & SS are involved in UCL iBScs so may be perceived to have a professional interest in promoting these courses. The authors alone are responsible for the content and writing of the article.

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Glossary

Intercalated BSc: Intercalated, honours, honors or complementary BScs and BMedSci courses (collectively called iBScs) are usually periods of extended study during a medical undergraduate (UG) course, usually with a focus on a specific area of preclinical or clinical science. Intercalated BScs are undertaken in addition to basic undergraduate medical training and aim to give future clinicians important extra skills and experience.

Critical interpretative synthesis (CIS): CIS uses a wide variety of data sources such as letters and opinion pieces but is not a meta-synthesis of qualitative studies. The selection criteria do not therefore require any judgement about the "quality" of the source material; the aim is "to prioritise papers that appeared to be relevant, rather than particular study types or papers that met particular methodological standards" so that the data can act "to maximise the inclusion and contribution of a wide variety of papers at the level of concepts".
Reference: *Dixon-Woods et al. (2006)*

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Addendum

Subsequent to peer review a new article has been published reinforcing this study's messages about the impact on course fees and the educational experience (Stubbs et al. 2013).

Appendix 1. Meta-analysis – data sources.

Table A1. Meta-analysis – data sources.

	Author	Outcome measure	Methods/analysis	Commentary	Included	Reason
1	Mahesan et al. (2011)	Finals exam performance and early PG career	Linear regression analysis	School where >50% do iBSc	Yes	High quality study adjusting for prior performance and other baseline factors
2	Howman & Jones (2011)	Summative marks for year 3 (1st clinical year). iBSc taken before or after exam.	Multi-variate analysis of cross-sectional data	School where all non-graduates undertake iBSc reducing risk of selection bias (Author COI)	Yes	High quality study adjusting for prior performance and other baseline factors (NB author COI)
3	Cleland et al. (2009)	Summative MB BS degree assessments taken after intercalating.	Univariate and Multinomial logistic regression	School where 1/3 of student intercalate, selection largely on academic performance	Yes	High quality study adjusting for prior performance and other baseline factors
4	Gerrard et al. (1988)	Career outcome and publication record	Case control iBsc students compared with non-BSc students	Controlled for demographic profile and prior acadmic performance	Yes	High quality study controlling for a range of potential confounders
5	Wyllie & Currie (1986)	Finals performance and career	Case control matched on prior performance	60 Pathology iBSc students matched with non-iBSC	Yes	High quality study adjusting for prior performance and other baseline factors
Studies not included in meta-analysis						
6	McManus et al. (1999)	Study habits (surface, deep, and strategic learning style) and interest in different medical careers, including medical research.	Longitudinal questionnaire (prospective) multilevel modelling and multiple regression.	Large multicentre study	Yes	Very high quality study adjusting for prior performance and other baseline factors, but no data relating to review outcomes apart from careers.
7	Tait & Marshall (1995)	Marks in clinical exams subsequent to iBSc.	Case control study compares with gender/academically matched non-IBSc students	Very small numbers $n = 14$ in iBSc group multiple measures of student performance recorded	Yes	Moderate quality study
	Studies included for data on GP career impact (broader selection criteria)					
8	Eaton & Thong (1985, 1986) (2 versions)	Finals performance, careers and academic measures	Retrospective case control study	Australian study following students through to postgraduate training	Yes (for GP career analysis only)	Some matching but not controlled for prior performance
9	Lambert et al. (Med Ed 2001)	GP career by iBSc status	Retrospective survey of UK graduates looking at reported BSc participation	Study will not account for those who do not complete UG course	Yes (for GP career analysis only)	Large nationally representative survey no adjustment for prior academic performance
10	MacGowan et al. (1986)	Academic output (papers) and career destination	Descriptive no data on comparator groups (estimated from national data)	Case series of students completing B Med Biol degree	Yes (for GP career only)	Some source data for careers only
11	Williamson (1986)	Subsequent Career and academic activity	Descriptive series from 1 institution, no comparator group. Comparator data obtained form from national data source	Retrospective survey	Yes (for GP career data only)	Some source data for careers only
12	Nguyen VanTam et al. (2001)	Examine career choice of medical students who completed an honours year in public health & epidemiology	Descriptive analysis	Case series of public health/epidemiology intercalated honours degree	Yes (for GP career data only)	Some source data for careers only

13	Young & Sefton (1984)	Subsequent careers	Case series	No comparator group	Yes (GP career data only)	Some source data for careers only
	Studies not included					
14	Elwood et al. (1986) (JECH)	Case series (largely similar data set to BMJ letter & Nguyen data)	Descriptive Case series	No comparator group	No	No comparator group
15	Elwood (2) et al. (BMJ letter) (1986)	Case series (earlier data to1986 study and Nguyen data)	Descriptive	No comparator group	No	Data not usable
16	Wakeford et al. (1985)	UG performance of Profs and reader	Case control study	Not prospective data	No	Will not capture prospective effect of BSc
17	Collins et al. (2010)	Large Australian case series of iBSc students	Case series	No comparator group	No	No comparator group (and cannot reliably use UK comparator groups)
18	Harris (1986)	Series of iBSc students – some data on subsequent academic progression	Case series descriptive	No comparator group	No	Data not usable
19	Nade (1978)	Retrospective survey of higher degree holder	Descriptive no comparator groups	Retrospective	No	Data unusable in this review

Appendix 2. Data sources for the critical interpretive synthesis.

Table A2. Data sources for the critical interpretive synthesis.

	Author	Type of data source	Formal qualitative analysis	Commentary	Included	Reason
1	Agha & Howell (2005)	Study aimed at student attitudes to (dis)benefits of doing iBSc	No	Useful contextual information about student opinion on iBSc courses	Yes	Useful student informant data
2	Agha & Singh (2003)	Letter In journal of record	No	Student letter reflecting on personal development during an iBSc	Yes	Useful student informant data
3	Al-Shaqsi (2010)	Peer reviewed article (NZ) ''To intercalate or not to intercalate''	No	Contextual info by student about new iBSc course	Yes	Useful student informant data
4	Asgari-Jihandeh & Haywood (1997)	Short report in peer reviewed journal	No	Useful contextual information about skills acquisition from iBSc	Yes	Useful student informant data
5	Aston (2001)	Student BMJ (sBMJ) letter	No	Useful contextual information about student opinion on iBSc courses	Yes	Useful student informant data
6	Attwell & Boyd (1996)	Lancet letter	No	External stakeholder opinion on role of iBSc	Yes	Useful external stakeholder informant data
7	Burkitt Wright (2001)	Letter sBMJ	No	Data on career impact and finance	Yes	Useful student informant data
8	Broome et al. (2007)	Peer review paper on students' views	Yes	Useful contextual information about student opinion on iBSc courses	Yes	Useful student informant data
9	Collier (2001)	sBMJ letter on iBSc research	No	Source of data on student perspective about merits of undertaking research (negative opinion)	Yes	Useful student informant data (and a divergent voice)
10	Dudley (ANZJ Surg) (1989)	Descriptive piece of Australian course	No	Faculty opinion	Yes	Useful faculty informant data
11	Emmel/Goldstein (2002)	sBMJ article on BSc international health/student perspective	No	Some comment on benefits of IBSc	Yes	Useful student informant data
12	Evered et al. (1987)	BMJ peer review article	No	Evidence on provenance of medical researchers including iBSc	Yes	Useful professional (clinician/academic) informant data
13	Fingerote (& Gerrard author reply) (1989)	CMAJ letter	No	Qualified clinician perspective on financial barriers to iBSc	Yes	Useful professional (clinician) informant data
14	Gerrard et al. (1988)	Peer review article (Canada)	No	Some faculty insights in predominantly quantitative study	Yes	Useful faculty informant data
15	Gardner & Olojugba (2008)	sBMJ article on benefits of an iBSc	No	Student and clinician perspective on iBSc	Yes	Useful professional (clinician) and student informant data
16	Gray (1989)	Editorial	No	Faculty perspective on iBSc funding	Yes	Useful faculty informant data
17	Goldie et al. (2004)	Peer reviewed article (Med Ed)	No	Study data on students' handling ethical issues	Yes	Useful data about (adverse) impact on student skills
18	Greenhalgh & Wong (2003)	Editorial (commentary)	No	Faculty opinion on role of iBSc	Yes	Useful faculty informant data
19	Gutenstein (2000)	sBMJ giving data on medical education costs	No	Source of data on course costs	Yes	Costs data
20	Harris (1986)	BMJ letter	No	Course description/outcome	Yes	Mainly quantitative data
21	Holgate et al. (1999)	(BMJ) Rapid response to McManus	No	Useful contextual information about student opinion on iBSc courses	Yes	Useful student informant data
22	Holmes (1986)	BMJ letter	No	Qualified clinician perspective on benefits of iBSc	Yes	Useful professional (GP) informant data
23	Iqbal (2001)	Letter sBMJ	No	Useful contextual information about skills acquisition from iBSc	Yes	Useful student informant data
24	Jones et al. (2001)	Peer review article on an IBSc (author COI)	No	Faculty opinion on role of iBSc	Yes	Useful faculty informant data (Author COI)
25	Jones et al. (2005)	Peer review article on an IBSc (author COI)	Yes	Useful contextual information about student opinion on iBSc courses	Yes	Useful student informant data (Author COI)

26	Jones et al. (2008)	Peer review article on an IBSc (author COI)	Yes	Useful contextual information about student and faculty opinion on iBSc courses/skills acquisition	Yes	Useful student/faculty informant data (Author COI)
27	Kentish & Avkiran (2002)	Response to Krishnan and Krishnan partial retraction	No	Useful contextual information on student and faculty perception of project roles	Yes	Useful student/faculty informant data (and a negative voice/divergent data)
28	Krishnan (2002b)	Letter sBMJ	No	Useful contextual information about skills acquisition from iBSc (rare adverse student comment – subsequently retracted)	Yes	Useful student informant data (and a negative voice/divergent data)
29	Leung (2001)	Article to student about merits doing an iBSc	No	Opinion on merits of IBSc for jobs	Yes	Useful external informant data
30	Leung (1999)	Article aimed at students about strengthening CV	No	Opinion on merits of IBSc for jobs	Yes	Useful external informant data
31	Longmore	BMJ letter	No	Clinician stakeholder opinion(divergent) about role, of iBSc	Yes	Useful clinician stakeholder informant (divergent) data
32	Ludbrook (1989)	Editorial	No	Faculty opinion on role of iBSc	Yes	Useful faculty informant data
33	Morrison (2004)	Editorial Journal of record	No	Faculty opinion on long term impact of iBSc	Yes	Useful faculty informant data
34	Moscrop (2002)	sBMJ letter	No	Useful contextual information about student opinion on iBSc courses	Yes	Useful student informant data
35	Nicholson et al. (2010)	Peer review article	No	Useful contextual information about student opinion on non-participation in iBSc courses	Yes	Useful (divergent) student informant data
36	Patel (2001)	sBMJ letter	No	Useful contextual information about student opinion on iBSc courses and impact on employment	Yes	Useful student informant data
37	Price (1998)	sBMJ letter	No	Intercalating helps personal development and medical skills	Yes	Useful student informant data
38	Rushforth (2004)	Med ed editorial Academic medicine and inter-calated degrees – the myth of student choice''	No	Useful contextual information about student/ recent graduate opinion on iBSc courses	Yes	Useful student/stakeholder informant data
39	Smith (1986)	BMJ editorial	No	Clinician/science publisher perspective on iBSc	Yes	Useful professional (BMJ editor) informant data
40	Thiagamoorthy (2001)	sBMJ letter	No	Useful contextual information about student opinion on iBSc courses	Yes	Useful student informant data
41	White (2006)	sBMJ article Tips on surviving a iBSc	No	Useful contextual information about student opinion on iBSc courses	Yes	Useful student informant data
42	Williamson (1986)	BMJ letter	No	Useful contextual information about student/ faculty opinion on iBSc courses	Yes	Useful student/faculty informant data
43	Wyllie & Currie (1986)	Peer review article	No	Some faculty insights in predominantly quanti-tative study	Yes	Useful faculty informant data
44	Yudkin et al. (2003)	Lancet description of new course	No	Contextual info by faculty and student about new iBSc course	Yes	Useful student and faculty informant data
45	Weidmann (2002)	sBMJ	No	Useful contextual information about student opinion on iBSc courses	Yes	Useful student and faculty informant data
46	Park	JNZMA	No	Useful information – survey of intercalated graduates (but some intercalated higher degrees)	yes	Useful student informant data
	Studies not included					
	Andriole et al. (2008)	US MD PhD students	No	Characteristics and Career Intentions of the Emerging MD/PhD Workforce	No	Outside scope of review
	Barzansky (2000)	US programme	No	Educational Programs in US Medical Schools	No	Outside scope of review
	Child & Gupta (2009)	sBMJ on pathology	No	Student and faculty view on merits of iBSc in pathology	No	Limited contextual information
	Cursiefen et al. (1995)	Peer reviewed study	No	Research course but not intercalated degree	No	Outside scope of review
	Creavin (2010)	Description of new course	No	Intercalated course but at Masters level	No	Outside scope of review
	Dudley (Br J Med Ed) (1970)	Descriptive piece of Australian course	No	Faculty opinion	No	Little usable data

(continued)

Table 8. Continued.

Author	Type of data source	Formal qualitative analysis	Commentary	Included	Reason
Gogalniceanu et al. (2009)	UG anatomy teaching	No	Brief description of iBSc anatomy teaching	No	Limited data
Griswold et al. (1991)	Peer reviewed paper	No	Summer research school	No	Outside scope of review
Jacobs & Cross (1995)	Peer reviewed paper	No	Course description – research course	No	Outside scope of review
Johnstone & Cartwright (2008)	Comparison of med/non-med students doing a BSc	No	Not comparing 2 groups of Medical students	No	Comparison of B.Med Sci (non-medical students) with med students
Jones et al. (1999)	BMJ (Rapid response to McManus)	No	Faculty opinion (author COI)	No	Limited data
Kemph et al. (1984)	Peer review paper	No	Summer research school	No	Outside scope of review
Kolcic et al. (2005)	Peer review journal	No	Research training programme	No	Outside scope of review
MacGowan et al. (1986)	BMJ letter	No	Course description/outcome	No	Mainly quantitative data
Peile & Johnson (2008)	sBMJ article on academic medicine	No	Some comment on benefits of IBSc	No	Insufficient contextual information
Seltzer (1987)	BMJ letter (response to Evered)	No	Comment on results	No	No useable data
Smith et al. (2001)	Peer review paper	No	Research training programme	No	Outside scope of review
Smith (1988)	Review on medical research training	No	Some review of data on IBsc	No	Data used in meta-analysis
Tamber (1986)	News article on MRC withdrawal of funding for BSc	No	Limited data on funders stakeholder opinion	No	Limited data
Villanueva (2007)	sBMJ article	No	Some contextual information about student opinion on iBSc courses	No	Too brief to be useful
Wakeford et al. (1985)	Lancet peer reviewed article	No	Evidence on provenance of medical researchers including iBSc	No	Too focused question for this review
Wakeford (1995)	Med Ed letter (Response to Tait paper)	No	No new data	No	Highlights prev article