

# Systematic Review of Pain Medicine Content, Teaching, and Assessment in Medical School Curricula Internationally

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Received: June 26, 2018 / Published online: July 30, 2018  
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## ABSTRACT

**Introduction:** Pain management is a major health care challenge in terms of the significant prevalence of pain and the negative consequences of poor management. Consequently, there have been international calls to improve pain medicine education for medical students. This systematic review examines the literature on pain medicine education at medical schools internationally, with a particular interest in studies that make reference to: a defined pain medicine curriculum, specific pain medicine learning objectives, dedicated pain education modules, core pain topics, medical specialties

**Enhanced digital features** To view enhanced digital features for this article go to <https://doi.org/10.6084/m9.figshare.6845405>.

**Electronic supplementary material** The online version of this article (<https://doi.org/10.1007/s40122-018-0103-z>) contains supplementary material, which is available to authorized users.

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that teach pain medicine, elective study opportunities, hours allocated to teaching pain medicine during the curriculum, the status of pain medicine in the curriculum (compulsory or optional), as well as teaching, learning, and assessment methods.

**Methods:** A systematic review was undertaken of relevant studies on pain medicine education for medical students published between January 1987 and May 2018 using PubMed, Medline, Excerpta Medica database (EMBASE), Education Resources Information Center (ERIC), and Google Scholar, and Best Evidence Medical Education (BEME) data bases.

**Results:** Fourteen studies met the inclusion criteria. Evaluation of pain medicine curricula has been undertaken at 383 medical schools in Australia, New Zealand, the United States of America (USA), Canada, the United Kingdom (UK), and Europe. Pain medicine was mostly incorporated into medical courses such as anaesthesia or pharmacology, rather than presented as a dedicated pain medicine module. Ninety-six percent of medical schools in the UK and USA, and nearly 80% of medical schools in Europe had no compulsory dedicated teaching in pain medicine. On average, the median number of hours of pain content in the entire curriculum was 20 in Canada (2009), 20 in Australia and New Zealand (2018), 13 in the UK (2011), 12 in Europe (2012/2013), and 11 in the USA (2009). Neurophysiology and pharmacology pain topics were given priority by medical

schools in all countries. Lectures, seminars, and case-based instruction were the teaching methods most commonly employed. When it was undertaken, medical schools mostly assessed student competency in pain medicine using written examinations rather than clinical assessments.

**Conclusions:** This systematic review has revealed that pain medicine education at medical schools internationally does not adequately respond to societal needs in terms of the prevalence and public health impact of inadequately managed pain.

**Keywords:** Curricula; Education; Health science; Medical student; Pain medicine; Systematic review

## INTRODUCTION

Medical schools need to ensure that graduates perform as effectively as expected in order to serve society, which implies being responsive to increased scientific knowledge and perceptive to the priorities of health issues [1]. Pain management is a public health challenge for a number of important reasons related to the prevalence of pain, negative consequences of poor management of pain, disparities in terms of who has access to care, vulnerability of certain populations, and the importance of pain prevention at both the population and individual level [2]. Acute pain is one of the most common reasons for patients to seek treatment at an emergency department [2, 3]. Over a third of adult appointments with a general practitioner involve a patient with chronic pain and many of those will have experienced pain for longer than 6 months [4, 5]. However, most people presenting with pain will be treated by a medical practitioner who has not trained as a specialist in pain management [6]. At least 40% of the patients with chronic pain treated in routine practice settings receive inadequate pain management [6, 7]. Newly qualified doctors have expressed a lack of preparedness to deliver prompt and effective management of acute and chronic pain [8]. Primary care providers have indicated a lack of training regarding pain management and limited confidence in their ability to provide effective pain

treatment [4, 9–15]. The lack of education and training in the discipline of pain medicine among health professionals has been highlighted as one of the barriers to best-practice pain management [16–18].

There have been significant advances in the understanding and management of pain, and excellent evidence-based interventions for acute and chronic pain are available [19–22]. However, despite these advances, acute and chronic pain management remains a challenge for the clinician [23, 24]. There appears to be a disconnect between the advances in therapies for managing pain and the actual application of these modalities in routine clinical practice [24]. Acute, chronic, and cancer pain remain ineffectively managed, partly as a result of a lack of expertise of medical practitioners [6, 7, 16, 25, 26]. Those who have not been adequately trained in pain medicine may not therefore be able to recognize, properly diagnose, or treat pain conditions [16].

There have been calls internationally for improved pain medicine education for medical students [2, 27, 28]. The need for the early introduction of pain medicine concepts in medical training has been identified by many professional pain organizations, including the International Association for the Study of Pain (IASP), the British Pain Society, the European Federation of IASP chapters, and the Faculty of Pain Medicine of the Australian and New Zealand College of Anaesthetists [28–31].

Advances are being made in terms of the development of pain-focused curricula; the most utilized of these is the core curriculum developed by the IASP, which has been applied internationally by universities to educate medical students about pain management [30, 32–38]. These curricula have attempted to connect global scientific knowledge with experience and practice [37]. Clear objectives are stated with regard to the attainment of knowledge, clinical skills, as well as essential attitudinal and behavioural learning objectives [31]. Core competencies in pain assessment and management have been developed by an Expert Interprofessional Pain Competencies Consensus Group to provide guidance related to pre-licensure pain medicine education for all major

health care professionals [39]. However, the degree to which these recommended competencies have been integrated into individual medical school curricula, and the adequacy of current pain medicine education in preparing medical graduates to manage patients with pain, is yet unknown. This systematic review examines the literature on the state of pain medicine education at medical schools internationally with particular reference to the documentation of a defined pain curriculum, specified pain medicine learning objectives, dedicated pain education modules, core pain topics, medical specialties that teach pain medicine, elective study opportunities in pain medicine, hours allocated to the teaching of pain medicine during the entire medical curriculum, whether pain medicine education is compulsory or not; and teaching and assessment methods.

## METHODS

A systematic review was undertaken of studies describing the delivery of pain medicine education for medical students published between January 1987 and May 2018. Inclusion criteria required that the research publication examined the pain-related content of the entire entry-level medical education curriculum. The literature was limited to peer-reviewed studies published in English. PubMed, Medline, Excerpta Medica database (EMBASE), Education Resources Information Center (ERIC), Google Scholar, and Best Evidence Medical Education (BEME) databases were searched for relevant studies related to pain curricula for students undergoing medical training. Key search terms were “pain, education, medical student, undergraduate, health science, pain management, medical school and curriculum”. The term “pain” was included in all of the searches.

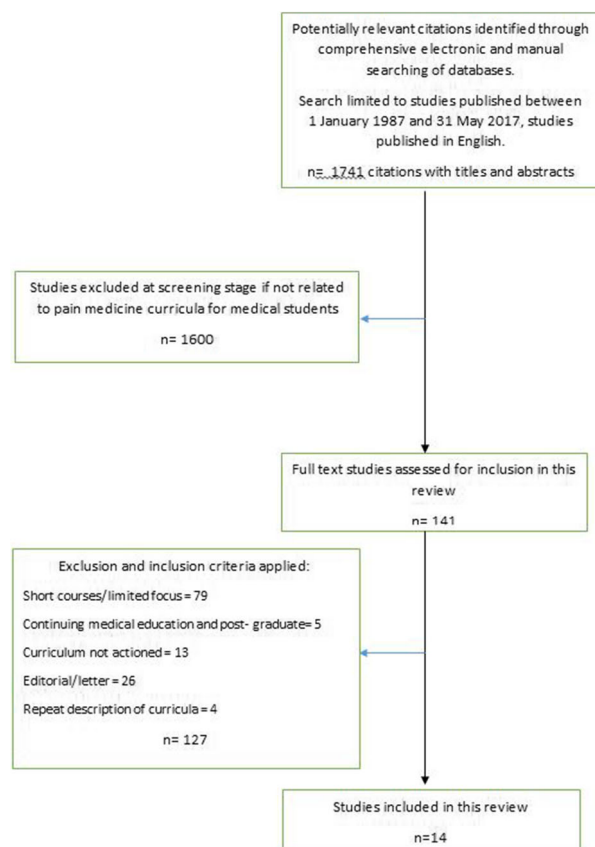
Citations were retrieved from the initial database searches and duplicates were removed. The initial scoping exercise involved reviewing the title, and if necessary, the abstract of the search item. The citations were screened for relevance to the research question in relation to type of student (only those which pertained to medical students were included) with a focus on pain medicine

education. Short courses or modules focused on only one aspect of pain medicine such as palliative care, cancer, paediatric, or low back pain were excluded. Curricula that were described but not actioned were not included. Continuing medical education and post-graduate medical courses were excluded. Editorials, letters to the editor, and review studies were excluded. The remaining studies were examined more closely by retrieving the abstract and/or the full study. Fourteen studies were included in the final review. Meta-analysis was not pursued due to the heterogeneous and descriptive nature of the studies. Two reviewers (EES and EAS) independently screened all studies, first reviewing titles and abstracts and then full texts according to the predetermined inclusion/exclusion criteria (as discussed earlier). Where the decision regarding eligibility was unclear, consensus was sought between the reviewers. In instances where the single curriculum was described in more than one study, the study that provided the most complete description was identified and the others were excluded.

All studies were subjected to thematic analysis according to date of publication, country, training facilities, educational modality, research tools and response rate, documentation of a defined pain medicine curriculum (whether the curriculum was delivered using a specific pain medicine course or within modules not specifically dedicated to pain medicine; whether defined learning objectives were specified; whether the curriculum was a compulsory component of the medical degree; whether the pain teaching was offered to all students; whether the training facility offered an elective in pain medicine); total time spent in formal pain medicine education; core topics covered within the curricula; method of instruction and method of student assessment. This article is based on previously conducted studies and does not contain any studies with human participants or animals performed by the author.

## RESULTS

A total of 1741 citations were identified through the database searches using the keywords outlined above, of which 141 were relevant to the



**Fig. 1** Flow diagram of search and selection process

research topic (see Fig. 1). Review of the title, abstract, and full text against inclusion/exclusion criteria left a total of 14 studies for inclusion in this review. Descriptive and interventional studies into pain medicine curricula were performed from 1988 [40] to 2018 [41], with the majority published from 2009 onwards [30, 32–37, 41–45]. Characteristics of these curricula are summarized (Table 1).

Evaluation of pain medicine curricula was undertaken in Australia and New Zealand [41], the United States of America (USA) [32–35, 43, 45], Canada [37, 42, 43], United Kingdom (UK) [30, 40], and Europe [36, 44, 46]. Six studies reported on the curriculum within a single teaching institution [32–35, 37, 45]. Eight studies reviewed medical curricula across multiple teaching institutions. Information about pain medicine curricula was obtained from 83% ( $n = 19$ ) of medical schools in Australia and New Zealand (2018) [41], 81% ( $n = 104$ ) of

schools in USA (2009/2010) [43], 77% ( $n = 13$ ) of Canadian schools (2009/2010) [43], 96% ( $n = 27$ ) of schools in the UK (1988) [40], 100% ( $n = 5$ ) of schools in Finland (1995) [46], and 97% ( $n = 242$ ) of medical schools in 15 European countries [44]. The latter was the largest study and was undertaken in 2012–2013, capturing information from all medical schools in Belgium, Bulgaria, Denmark, France, Germany, Ireland, Italy, the Netherlands, Poland, Portugal, Romania, Spain, Sweden, Switzerland, and the UK [44]. There was no literature published on pain medicine education in Asia, South America, or Africa.

### Research Instruments Used for Information Collection

The majority of studies obtained information from university deans or university faculty responsible for medical curricula or pain medicine education [30, 33–35, 37, 40–42, 46]. Three studies sourced information from websites (medical school, government or central repository of curriculum information), independent university catalogs, and course-management systems [43–45]. Publicly available curriculum information on recognized medical school websites, government websites, student forums, newspaper websites, and independent university course literature was used in the largest study of 242 medical schools in Europe [44]. The most common research instrument used in the studies was paper-based or e-mailed questionnaires/survey tools. The majority of studies were designed using the IASP pain medicine curriculum for medical students as a Reference. [30, 32, 36, 37, 41–43, 46].

### Provision of Pain Medicine Teaching

One hundred percent of medical schools in Finland, 95% of medical schools in Australia and New Zealand, 80% of medical school in the USA, 70% of medical schools in Europe, and 68% of medical schools in the UK taught pain medicine within modules not specifically dedicated to pain, such as anesthesiology, pharmacology, anatomy, physiology, oncology, and

**Table 1** Characteristics of pain medicine curricula

Date and author of publication and country	Number of medical schools included in study/total number of schools in the country	Pain medicine course structure, compulsory status, learning objectives, elective opportunities	Time in hours spent in formal pain medicine education (range)	Main department/s delivering the pain medicine education	Pain medicine course topics	Teaching method	Tools for assessment of pain medicine knowledge, attitudes, and skills
1988 Marcer et al., United Kingdom [40]	27/28	85% of medical schools provided formal teaching in pain/pain control. Specific details of a defined curriculum such as learning objectives, and mandatory teaching, and elective opportunities were not described	Mean 3.5 h (range 0.5–10)	Anaesthesia, pharmacology and medicine	Not specified	22% of schools offered all their students experience in a pain relief clinic or hospice	37% included questions on pain control in formal examinations
1999 Poyhia et al., Finland [46]	5/5	All medical schools provided pain medicine education. No university had developed its own defined curriculum on pain for undergraduate medical teaching. Pain was taught in an inconsistent way, with an overlap of the same topics. No details of defined learning objectives, mandatory teaching, or elective opportunities in pain medicine were described	Mean 32.7 h and median 30 h (range, 28.5–45.5) in 1994/5	Not specified	Most hours were devoted to pharmacology of pain, anatomy, physiology, and anaesthesiology, and physiotherapy. There was a serious lack of teaching in psychology of pain	Not specified	Not specified

Table 1 continued

Date and author of publication and country	Number of medical schools included in study/total number of schools in the country	Pain medicine course structure, compulsory status, learning objectives, elective opportunities	Time in hours spent in formal pain medicine education (range)	Main department/s delivering the pain medicine education	Pain medicine course topics	Teaching method	Tools for assessment of pain medicine knowledge, attitudes, and skills
2004 Watt et al., Canada [37]	1/17	Specific mandatory integrated pain curriculum for all 2nd- or 3rd-year pre-licensure students from six health science faculties/ departments. Learning objectives were clearly defined in terms of knowledge and clinical skills. No details of elective opportunities in pain medicine were described	20 h	Not specified	Epidemiology, principles of assessment and management, relevant neuropathology as a basis for pain and related management, impact of pain on patient, family, and society, pharmacotherapy basics and clinical issues; complementary and alternative strategies; common acute pain challenges; pain in children/adolescents with arthritis; pain guidelines; treatment of arthritic and neuropathic pain; addiction prevalence, screening and universal precautions; pain, genetics and sex; pain and work; inter-professional approaches/roles; cancer pain; pain mechanisms, assessment, and management; inter-professional team acute and persistent pain assessment and management; development of team comprehensive pain management plans	Didactic teaching, self-learning, case-based education and inter-professional small group sessions	Questionnaire and a comprehensive pain management plan

**Table 1** continued

Date and author of publication and country	Number of medical schools included in study/total number of schools in the country	Pain medicine course structure, compulsory status, learning objectives, elective opportunities	Time in hours spent in formal pain medicine education (range)	Main department/s delivering the pain medicine education	Pain medicine course topics	Teaching method	Tools for assessment of pain medicine knowledge, attitudes, and skills
2005 Poyhia et al., Finland [36]	5/5	27% of students received specific pain medicine education in addition to pain medicine teaching within other modules; 34% of students were offered advanced studies on pain management and 15% had been offered research projects in pain medicine. Specific learning objectives were not identified	This was not measured	Anesthesiology	Anatomy, biochemistry, physiology, and pharmacology of pain were well covered. The definitions of pain, pain research, sociological issues, pediatric, and geriatric and intellectually disabled patients' pain were poorly taught. The lack of teaching about the multidisciplinary pain clinic was recognized by almost all students	Didactic lectures, small group teaching, case-based education, and self-learning	Not specified
2009 Stevens et al., USA [34]	1/128	Pain medicine education was mandatory for all 2nd-year medical students. Specific goals and learning objectives were identified. No details of elective opportunities in pain medicine were described	8 h	Not specified	Pain pathophysiology; assessment; pharmacotherapy, behavioral therapy, alternative treatment; attitudes to pain; acute, chronic and cancer pain; and assessment of pain, development of a therapeutic relationship, emotion handling and negotiation of a treatment plan	Lectures, small group, case-based seminars	Formative OSCE

Table 1 continued

Date and author of publication and country	Number of medical schools included in study/total number of schools in the country	Pain medicine course structure, compulsory status, learning objectives, elective opportunities	Time in hours spent in formal pain medicine education (range)	Main department/s delivering the pain medicine education	Pain medicine course topics	Teaching method	Tools for assessment of pain medicine knowledge, attitudes, and skills
2009 Yanni et al., USA [33]	1/128	Pain medicine education was mandatory for all 3rd-year medical students. The curriculum was organized into six modules that covered 20 specific competency-based objectives. No details of elective opportunities in pain medicine were described	Time to complete the course was not stated	Not specified	The following topics were included: assessing chronic pain, treating chronic pain with a multidisciplinary approach; reviewing the management of specific pain syndromes; confronting challenges including prescription drug misuse; and reviewing laws and regulations that govern controlled substance prescribing	E-learning self-directed study	Online electronic pre- and post-intervention questionnaires
2009 Watson et al., Canada [42]	9/17	32.5% of health science programs identified specific mandatory pain course content. Electives were offered at some institutions but no details were described. Specific details of a defined curriculum such as learning objectives were not described	Mean 16 h (range, 0–38)	Not specified	Neurophysiology and pharmacological management were the subjects covered most thoroughly. The least number of hours were allocated to pain misbeliefs, assessment, and follow-up. Respondents indicated that pain was mentioned in many different courses, but only as a diagnostic indicator of etiology related to the presentation of illnesses and the need for investigation	Most respondents indicated that they did not combine their content with other professions but specific details were not described	Not stated



**Table 1** continued

Date and author of publication and country	Number of medical schools included in study/total number of schools in the country	Pain medicine course structure, compulsory status, learning objectives, elective opportunities	Time in hours spent in formal pain medicine education (range)	Main department/s delivering the pain medicine education	Pain medicine course topics	Teaching method	Tools for assessment of pain medicine knowledge, attitudes, and skills
2011 Briggs et al., UK [30]	9/32	There was a lack of a formal pain curriculum in the majority of programs. Pain medicine content was mostly integrated throughout several modules. Separate pain modules tended to be optional courses. The educational content was largely fragmented throughout the curricula. Specific details of a defined curriculum such as learning objectives and elective opportunities were not described	Median 13 h (range 6–50)	Not specified	Neurophysiology and pharmacological management were most frequently taught topics. 5% of the pain teaching content was devoted to pain assessment and 5% to non-pharmacological methods of pain management	Lectures (88%), case-studies (78%), student-led enquiry or problem-based learning (42%), Inter-professional education around pain was rare and only 19% shared content with another health disciplines, and this was typically lectures suggesting a multi-professional approach of learning alongside one another rather than IPE	70% of programs included examination or case-based assessment
2011 Mezei et al., USA and Canada [43]	117/145	Only 4% of US medical schools reported having a mandatory specific pain medicine course. Pain was mostly taught in the context of a more generalized course; 20% of US and 8% of Canadian medical schools do not require any pain sessions within the curriculum; 16% of medical schools offered a designated pain elective. Specific details of a defined curriculum such as learning objectives were not described	USA: Mean 11 h and median 9 h (range 1–31) Canada: Mean 28 h and median 19.5 h (range, 3–76)	Not specified	Pain neurobiology, visceral pain, clinical assessment, and pharmacological management were commonly included in the medical school curricula. Cancer pain, pediatric pain, geriatric pain, and the medico-legal aspects of pain care were virtually unaddressed	Not addressed	Not addressed

Table 1 continued

Date and author of publication and country	Number of medical schools included in study/total number of schools in the country	Pain medicine course structure, compulsory status, learning objectives, elective opportunities	Time in hours spent in formal pain medicine education (range)	Main department/s delivering the pain medicine education	Pain medicine course topics	Teaching method	Tools for assessment of pain medicine knowledge, attitudes, and skills
2011 Murinson et al. USA [32]	1/128	A mandatory pain medicine course was delivered to all 1st-year medical students. Learning objectives were specified. The core content was delivered in a specific 4-day pain course and also in other parts of the 4-year medical school curriculum. No details of elective opportunities in pain medicine were described	35 h	Not specified	Topics covered in the course included pain neurobiology, the human and social cost of pain; clinical assessment of pain; non-pharmacological pain management; pharmacological pain management; interventional approaches to pain management; acute and chronic pain; pediatric pain, geriatric pain; cancer pain; impact of culture and ethnicity of pain and medicolegal aspects of pain care	Didactic (less than 60% of the course), small-group, laboratory, and team-based learning sessions; and design-built elements to strengthen emotional skills including a brief pain narrative, self-reflection, use of fine-art images	Multiple-choice exam, a brief assessment portfolio, and a paired-work assignment
2013 Tauben, Loeser. USA [35]	1/128	An integrated structured pain medicine course was mandatory for all 3 <sup>rd</sup> and 4 <sup>th</sup> year students. Elective pain education opportunities for selected students. Specific details of learning objectives were not described	25 h. 320 h in a pain elective	Not specified	Course focuses on pain interviewing skills, patient narrative, co-occurring biopsychosocial conditions and risks, common office-based primary care chronic pain conditions, and opioid, non-opioid, and non-drug treatments, with less attention to pain pathways, research design, and surgical and neuromodulatory interventions	Case-based teaching, didactic lectures, interactive workshop, clinical exposure, e-learning opportunity, with an emphasis on inter-professional education	OSCE evaluation

**Table 1** continued

Date and author of publication and country	Number of medical schools included in study/total number of schools in the country	Pain medicine course structure, compulsory status, learning objectives, elective opportunities	Time in hours spent in formal pain medicine education (range)	Main department/s delivering the pain medicine education	Pain medicine course topics	Teaching method	Tools for assessment of pain medicine knowledge, attitudes, and skills
2015 Briggs et al., European countries [44]	242/249	In 55% of schools, pain was taught only within compulsory non-pain-specific modules. The curricula of 7% of schools showed no evidence of any pain teaching. Where pain modules were provided, they were compulsory in only 18% of all schools; 88% of all schools documented some form of compulsory pain medicine teaching (range from 40% in Bulgaria to 100% in Denmark, Poland, Sweden and Romania). Five schools with available information enrolled a mean of 22 students (range, 15–50) in elective dedicated pain modules, representing 4–11% of the schools' students in that year group. Specific details of a defined curriculum such as learning objectives were not described	Median 12 h (range, 4–56) for compulsory dedicated modules and median 9 h [range 1–60] for other compulsory non-pain-specific modules	Pharmacology, anesthesiology, physiology/pathology, emergency medicine, and palliative care modules	Not specified	95% of the schools used classroom teaching, 48% used placements, and 26% used case-based learning	Examinations (93%), assignments (24%), Placements, practical assessments, attendance presentations, group work, clinical methods or problem-based learning was each used for assessment by < 10% of schools

Table 1 continued

Date and author of publication and country	Number of medical schools included in study/total number of schools in the country	Pain medicine course structure, compulsory status, learning objectives, elective opportunities	Time in hours spent in formal pain medicine education (range)	Main department/s delivering the pain medicine education	Pain medicine course topics	Teaching method	Tools for assessment of pain medicine knowledge, attitudes, and skills
2017 Bradshaw et al., USA [45]	1/128	Fragmented teaching was mandatory for all students. 660 total instances of the term "pain" and selected pain-related terms in the 2 years. Specific details of a defined curriculum such as learning objectives were not described. No details of elective opportunities in pain medicine were described	Not addressed	Not specified	Early emphasis on nociceptive transduction and signaling mechanisms followed by minimal attention to the social and multidimensional nature of pain. Overall, pain was presented as a symptom of other conditions rather than a disease entity per se. By subject, clinical anatomy, microbiology and infectious disease and reproductive health contained the highest number of terms	Not addressed	Not addressed
2018 Shipton et al., Australia and New Zealand [41]	19/23	95% of schools taught pain medicine only as a topic integrated into other compulsory subject areas over the entire curriculum. Learning objectives were identified by 58% of medical school but, in general, these were not comprehensive. 53% of schools offered electives in pain medicine	Mean of 19.6 h and median of 20 h (range, 5–43 h)	Anesthesia (74%), physiology/neurophysiology (58%) and pharmacology (47%)	Neurophysiology of pain, clinical assessment, analgesia use and the multidimensional model of pain medicine, palliative/cancer pain and the concept of peripheral/central sensitization. Fewer than half the schools covered the topic of psychological methods for managing pain, medical interventions, and ethics. The multidisciplinary pain clinic, medico-legal aspects of pain medicine, geriatric pain and pediatric pain were topics covered by the least number of schools	Didactic teaching methods (100%), clinical exposure (84%), tutorial teaching methods (47%) and case-based learning (42%), problem-based learning (26%), e-learning (21%). Self-directed learning and simulation-based learning were used very infrequently. 79% of medical schools indicated that medical students were not exposed to IPL in the context of pain medicine education	Multiple choice questions (MCQs) were used by 63% of schools and the objective structured clinical examination (OSCE) was used by 32% of schools. 16% of schools unsure of whether any assessment took place

emergency medicine [30, 36, 40–46]. The teaching of pain medicine in the curriculum was described as fragmented in four studies [30, 43, 45, 46]. In the UK, the number of medical schools including pain medicine content in their curriculum decreased from 24/28 (85%) in 1988 to 19/28 (68%) in 2012/2013 [40, 44].

Ninety-six percent of medical schools in the UK and USA, and 82% of medical schools in Europe had no compulsory dedicated teaching in pain medicine [43, 44, 46]. France had the highest percentage of medical schools offering dedicated compulsory pain modules in the medical curriculum (84%) [44]. There was no evidence of compulsory pain teaching in the curricula (dedicated or as part of another module) in 17/104 (16%) of medical schools in the USA [43], 1/13 (8%) of schools in Canada, and 17/242 (7%) of schools in Europe [42–44].

Pain medicine learning objectives were specified in six studies [32–35, 37, 41]. Five of these studies described the development of individual dedicated comprehensive pain courses which incorporated innovative teaching methods. Limited pain medicine learning objectives were identifiable at 58% of medical schools in Australia and New Zealand, [41].

Details of elective studies in pain medicine were documented in six studies [35, 36, 41–44]. Fifty-three percent of medical schools in Australia and New Zealand offered a student elective in pain management ranging from 2 to 6 weeks [41]. In Finland, 34% of students were offered advanced tuition in pain management and 15% had been offered research projects in pain medicine [36]. In the USA, 16% of medical schools offered a pain medicine elective [43]. These electives ranged from 1 to 4 weeks, and it was reported that the majority were administered by anesthesiology departments. Elective pain education opportunities of up to a total of 320 h were offered to selected students of each year group at the University of Washington [35]. In Europe, five schools with available information enrolled a mean of 22 students (range, 15–50) in elective dedicated pain modules, representing 4–11% of the schools' students in that year group [44]. One study

indicated that electives were only offered to a few students [36].

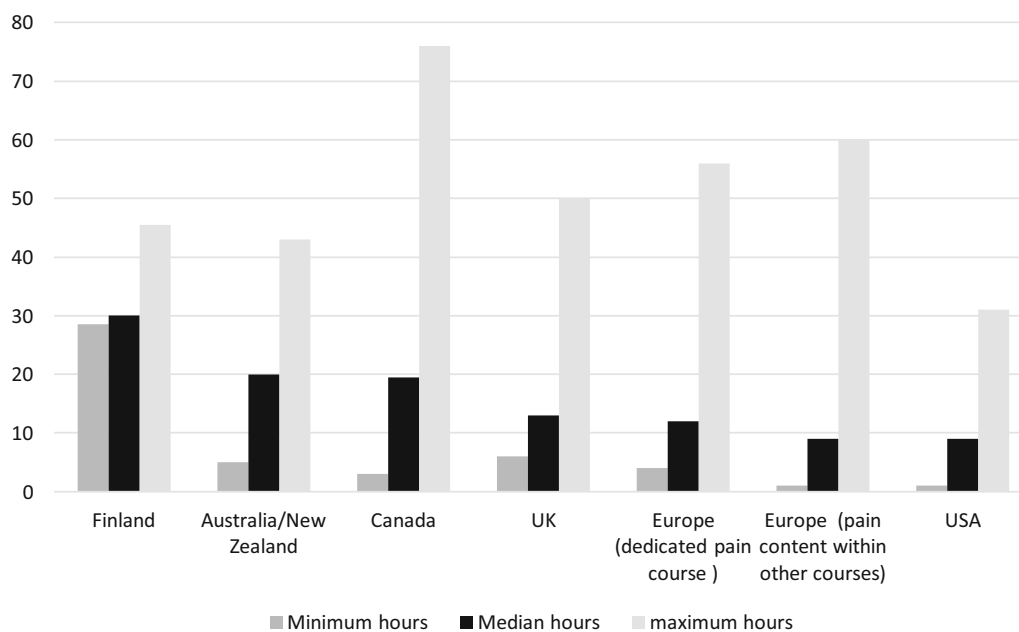
### Hours Allocated to Teaching Pain Medicine Content in the Curriculum

Time allocated to pain medicine content across the entire medical course was highest in Poland and Finland, with a median of 39 and 30 h, respectively, and least in Romania and Italy with a median of 4 h in each country [44, 46]. Medical schools in Canada, Australia, and New Zealand both had a median of 20 h allocated to pain medicine teaching within general subject modules [41, 43], as shown in Fig. 2. In Europe in general, a median of 12 h was allocated for compulsory pain medicine courses and 9 h for other compulsory pain medicine content within other courses [43, 44]. The median number of hours spent teaching pain in the UK was 13, and 9 h in the USA [30, 40, 43]. Time allocated for pain medicine teaching in Australia and New Zealand during the entire medical curriculum ranged from 5 to 43 h, with a median of 20 h [41]. In 2009/2010, 20% of medical schools in the USA reported less than 5 h of teaching on the topic [43].

### Pain Medicine Topics Addressed in the Curriculum

Pain medicine topics related to neurophysiology, neuroanatomy, and pharmacology of pain were included in the curricula of medical schools in all countries [30, 36, 41–46]. Less consistently taught topics varied between studies but included clinical assessment [30, 42], non-pharmacological management of pain [30, 36, 42], multidisciplinary pain management [36, 41, 46], paediatric pain [36, 41, 43], geriatric pain [36, 41, 43], and medico-legal and ethical aspects of pain medicine [43].

A longitudinal perspective on pain medicine content teaching within the medical school curricula in Finland was provided by Poyhia over a period from 1991 to 2001 [36, 46]. There were no significant changes in the curriculum during this period. Ninety-five percent of students considered that the amount of



**Fig. 2** Total number of hours allocated to pain medicine education

multidisciplinary pain clinic teaching had been insufficient [36].

The specifically designed pain medicine modules in the USA and Canada focused on pain assessments, the multi-disciplinary team, medical plus non-medical management of pain, the importance of a therapeutic relationship, and development of a comprehensive treatment plan [32–35, 37].

Tauben documented the revision of a pain medicine curriculum at one medical school in the USA over the period 2009 to 2011 [35]. The curriculum was restructured to focus on pain interviewing skills, emerging concepts in pain theory (such as central sensitization), and improved understanding of persistent pain as a chronic complex condition, rather than neurophysiological pain pathways, and surgical and neuromodulatory interventions.

### Teaching Methods

Teaching methods were discussed in 11 out of the 14 studies (79%). Lectures and seminars in the classroom were the most common teaching methods employed by medical schools, with 100% of schools in Australia and New Zealand,

95% of schools in Europe, and 88% of schools in the UK using these methods [30, 32–36, 40–42, 44]. The next most frequently used teaching method was case-based instruction, and, although most studies did not specify exact percentages, it was noted that 78% of schools in the UK, 42% of schools in Australia and New Zealand, and 26% of schools in Europe employed this method [30, 34–37, 41, 44]. Four studies mentioned small group teaching [32, 34, 36, 37] and two studies cited problem-based learning, which took place in 26% of schools in Australia and New Zealand and 15% of schools in Europe [30, 41]. Eighty-four percent of medical schools in Australia and New Zealand, 26% of medical schools in Europe, and one individual course in the USA indicated that clinical placements were a part of the pain medicine teaching [35, 44]. Twenty-two percent of medical schools in the UK offered clinical placement in a pain clinic in 1988, and by 2013 this percentage had risen to 48% [40, 44]. There was little emphasis on computer-based or online teaching methodologies with e-learning only mentioned in three studies [33, 35, 41].

The Interfaculty Pain Curriculum described by Watt-Watson at the University of Toronto,

Canada detailed the variety of teaching methods used to deliver the pain course [37]. This course included both multi-professional and interprofessional learning (IPL). The students were given a manual prior to the course for self-study and pre-readings. Multi-professional, large group sessions incorporated didactic teaching by speakers with an international reputation as pain experts focussing on neurophysiology, common clinical challenges, disability associated with pain, ethical, legal, and political issues and patient advocacy. An interactive session followed with a panel of adult patients with pain related to a variety of pain conditions. Interprofessional small-group sessions focused on developing assessment skills and management plans for patients using standardized patients. These small groups were facilitated by clinicians who were skilled in pain management and group teaching.

The course described by Murinson at the John Hopkins University, USA, identified a diverse range of teaching methods such as didactic teaching, small group sessions, laboratory work, and team-based learning sessions. Innovative teaching methods were included such as the use of fine-art images, assessing personal responses to the experience of pain during a common psychophysical test, and writing a brief pain narrative in order to comprehensively address both the knowledge and the emotional development needs of the students [32]. Didactic teaching amounted to less than 60% of the course.

The pain medicine education course described by Tauben at the University of Washington, USA, included case-based teaching, didactic lectures, an interactive workshop, clinical exposure, and e-learning opportunities with an emphasis on interprofessional learning [35].

Respondents and students in the UK, Canada, and Finland recommended less didactic teaching, with more focus on problem-based, case-based, interprofessional, small group teaching, and self-learning (including Web-based resources) [30, 36, 42, 46]. Some educators indicated a need for generic pain curricula and further resources to inform them

on current pain research and pain management practices [30, 42].

IPL was not addressed in most studies. Two studies describing pain medicine education at multiple schools in Canada and the UK noted that IPL around pain was rare [42, 43]. In one study, 19% of schools in the UK shared content with another health discipline, but this was typically lectures suggesting a multi-professional approach of learning alongside one another rather than IPL. Seventy-nine percent of medical schools in Australia and New Zealand indicated that medical students were not exposed to IPL in the context of pain medicine education [41]. Two individually designed pain courses in USA and Canada specifically incorporated IPL methods in order to provide high-quality pain management education [35, 42].

### Assessment Methods

Eight studies reported assessment methods for pain medicine, with written examinations being the most common method [30, 32–34, 37, 40, 41, 44]. In the UK, 10/27 (38%) of schools regularly included questions on pain medicine in formal assessments in 1988, increasing to 20/24 (83%) in 2012–2013 [40, 44]. In Europe, information on assessment methods was available from 193 of the 242 (80%) medical schools [44]. These schools mostly assessed pain medicine learning using written examinations (93%), while almost a quarter used assignments (24%) [44]. Practical or clinical assessments, presentations, group work, or problem-based learning were each used as a method of assessment by less than 10% of schools in Europe [44]. The use of Objective Structured Clinical Examination (OSCE) was used by 32% of schools in Australia and New Zealand [41] and was reported in one study from a single university in the USA [34].

## DISCUSSION

There are approximately 2600 medical schools worldwide [47]. This systematic review examined pain medicine curricular information of 383 medical schools over a period from 1987 to

2018. Published studies regarding the inclusion of pain medicine content in medical curricula have increased in the last 15 years in North America and Europe [30, 36, 42, 43, 46]. A careful look at what is being taught in medical schools is important in order to establish a baseline for future improvements.

Universities design curricula that reflect a vision of the future, either implicitly or explicitly [48]. Explicit value can be judged by the amount of time and resources allocated to the teaching of a topic, and the weighting it receives in the assessment process. In the countries examined in this review, the reality exists that in general, there is a lack of dedicated course structure, minimal learning time, limited breadth of course content as recommended by IASP curricula, and low emphasis on assessment of pain knowledge and clinical competence [30, 40–44, 46]. Comprehensive pain medicine content does not appear to be mandatory in the medical curriculum [30, 36, 40, 42–44, 46]. Some schools are unable to identify any compulsory pain medicine content in their medical curricula [42–44]. In most countries, pain medicine is taught in a fragmented way within modules in other areas of medicine (such as anaesthesia), rather than in dedicated pain modules. It is encouraging to note that some countries in Europe are making good progress nationally in terms of incorporating pain medicine education into medical school curricula. Pain education has been prioritized nationally in France resulting in 84% of the medical schools providing compulsory, dedicated pain medicine modules [44]. In Germany, education on chronic pain became compulsory in 2012 within federally defined medical school curricula so an increase in the number of mandatory pain modules may be expected [44].

There is wide variation in learning time allocated to pain content in the curriculum, and, in general, the majority of students received less than 15 h of pain medicine education in the entire medical curriculum. In Europe, compulsory dedicated pain medicine modules and pain medicine teaching delivered within other modules represented approximately 0.2% of the minimum total teaching hours provided throughout an undergraduate

medical course [44]. Similarly, total hours allocated to pain medicine teaching at medical schools in Australia and New Zealand amounted to approximately 0.4% of the minimum total teaching hours of a medical degree [41]. This lack of emphasis illustrates the low priority given to pain medicine education at medical schools internationally, considering the clinical and societal burden of pain.

Advances in pedagogy call for the medical curriculum to be structured in terms of defined learning outcomes that can be measured to determine mastery of specified competencies upon graduation [49]. These learning outcomes influence the core elements of the curriculum such as content, learning experiences, teaching strategies, and assessment [48, 50]. Universities increasingly require academics to specify learning outcomes for courses [51]. What is intended that students should learn and achieve should ideally be clearly defined before the teaching takes place [52]. Teaching methods should be selected in order to optimize engagement of the students in the learning activities so as to increase the achievement of the outcomes [52]. Assessment methods can then be designed to assess the standard at which the learning outcomes have been achieved [52]. This review has exposed the limited number of references in the literature to specific pain medicine learning objectives or outcomes for medical schools internationally. One study recently highlighted the lack of comprehensive pain focused learning objectives in medical school curricula in Australia and New Zealand [41].

There were significant gaps in the breadth of core topics between internationally recommended pain medicine curricula and documented educational content [30, 41–43, 46]. There was a strong emphasis on pain-related neurophysiology and pharmacology in medical schools. Neuroscience courses often fail to discuss the plasticity that occurs in the nervous system and tend to ignore the roles that anxiety, fear, and the social environment play in modulating the experience of pain [53]. Essential topics reflecting the biopsychosocial framework and multidisciplinary treatment of pain appear to be underrepresented [54]. Subjects intrinsic to the recommended curricula



such as paediatric pain, geriatric pain, and medico-legal aspects of pain are only addressed by a minority of medical schools [41, 43]. Few students are offered electives in pain management [36, 42–44]. The risk of not giving pain medicine the attention it deserves in medical undergraduate course is likely to result in continuing under treatment of pain [55, 56].

The current teaching of pain medicine using didactic methods is likely to result in ineffective learning. Exposure to clinical activities such as high- and low-fidelity simulations, and interdisciplinary treatment planning are likely to encourage the acquisition of higher conceptual thinking skills [32, 57–60]. The ideal pain medicine curriculum needs to develop the medical students' reserves of emotional intelligence and resilience in conjunction with clinical knowledge [61]. To be effective in pain management, students need to learn to demonstrate empathy and empower their patients and include patients in the treatment plan [62]. However, this review has shown that there was limited use of creative educational methods for medical students' growth in these areas. There was also little evidence of students being exposed to a variety of clinical experiences that are more reflective of the modern clinical practice, such as multidisciplinary out-patient pain clinics, rehabilitation centers, general practice clinics, workplace and home visits.

Optimal management for chronic pain patients involves an interprofessional approach [63–65]. This review highlighted the significant lack of interprofessional education for medical students in the field of pain medicine internationally. Attempts are being made at developing more web-based resources to increase pain medicine education, such as the pain interprofessional resource for pre-licensure health science students in universities across Canada and the pain management resource developed at the Virginia Commonwealth University in the USA [33, 66]. However, there does not appear to be widespread use of e-learning resources at most of the medical schools.

Formative and summative assessment of both knowledge and practice-orientated aspects of the curriculum is essential in order to address

the need for health professionals that are responsive to the changing needs of the increasingly complex health system yet adaptable to local contexts [67]. This systematic review revealed that a significant number of medical students are not specifically required to display adequate knowledge and skills in pain medicine. Assessments of the pain medicine learning were mostly performed using written examinations, if undertaken at all. OSCEs, placements, and practical assessments were used by very few medical schools [30, 40, 41, 44]. Assessment of knowledge, skills, and attitudes cannot be performed using a single test format [68, 69]. Incorporating formal assessment of knowledge, attitudes, and clinical skills related to pain medicine would enhance the seriousness and importance of pain medicine education [43]. Academic accrediting bodies and professional regulatory bodies significantly shape curricula through the regulations they impose to ensure that graduates are competent and safe to practice [70]. However, competencies that specifically identify pain medicine-related skills, knowledge, or attitudes are minimal or mostly absent in regulatory requirements for medical graduates in Canada and the UK. A recent review of the United States Medical Licensing Examination found that 15% of questions reviewed (40% of total examination questions) were identified as being fully or partially related to pain [71]. However, these questions were predominantly focused on assessment of pain rather than knowledge of the nature and context of pain, or implications for safe and effective treatment [71].

Another challenge facing medical educators is the identification of unique values of the medical school that underpin their curriculum. Chronic pain has a low priority within medical education systems, possibly because traditional models refer to pain only as a symptom rather than recognizing the current concept of pain as a disease in its own right, and because historically, teaching of pain medicine at medical schools has been lacking [54, 55, 72]. Political factors interplay as entrenched university administrators perpetuate long-standing biases towards basic sciences as well as the value of one medical disease over another [35]. Curricular

change is often difficult, as finding time in an already loaded medical curriculum that is tightly timetabled into a calendar year, often requires that some other content must be excluded. Transformation of the value system in the curriculum is unlikely to succeed unless there is the support from senior leadership for implementing these changes [73]. However, those who have not been adequately trained in pain medicine may not recognize the need for curriculum reform. Many medical schools disperse students over a number of training centers which require a curriculum that is flexible and portable. Internationally, medical schools are embracing new content that values social accountability, patient-centered care, teamwork of professionals, chronic disease management, and community care [73, 74]. Positive advances have been made in terms of inclusion of previously lacking topics such as palliative care into the modern curriculum over the last two decades [75]. A similar positive trend is not reflected in pain medicine education.

There have been repeated calls for innovative, interprofessional, and integrated pain medicine-related curricula, education, and resources [30, 36, 40, 42–44, 46]. Six studies described the process of developing a specific pain curriculum in Canada and USA, and provided details of the teaching and learning associated with the course [32–35, 37, 45]. Five courses stood out as models advancing pain medicine curricula: the 20-h interprofessional pain curriculum at the University of Toronto, Canada, which has been well described in the literature; the course in pain medicine at the Johns Hopkins University, USA, which focused on establishing foundation-level knowledge while comprehensively addressing the emotional development of the student; the integrated pain curriculum offered at the University of Washington, USA; and the Pain Assessment and Management curriculum developed by the University of New York [32, 34, 35] [42]. The comprehensive e-learning resource in pain management from the Virginia Commonwealth University used innovative technology to make the learning resource available to a range of health professionals [33]. Evaluation of these courses indicated a positive outcome in terms of

students' pain knowledge, beliefs, and competencies as well as generating a high degree of student satisfaction with both the content and process of teaching [32, 34, 37]. Detailed description of curricular development process and course delivery could potentially be a useful source of information for other curriculum designers. There is little evidence that the emergence of these courses has profoundly influenced the other medical schools in these two countries.

There are a few limitations to this study. Firstly, not all the medical schools in each country provided a complete set of information. Secondly, some of the studies were of lower-quality evidence only, and different systems were used to categorize curricula delivery, content, as well as teaching and assessment methods. Quality data that evaluate and compare pain medicine curricula, as well as teaching and assessment methods is lacking. The difficulty associated with retrieving information on the pain medicine content of curriculum was highlighted, often related to poor documentation of pain medicine topics within the curriculum and a lack of a defined comprehensive pain medicine curriculum [42, 44]. Questionnaire-based surveys were limited as the respondent completing the survey might possibly not have been the most appropriate person to complete the questionnaire. Web-based research tools to evaluate curriculum are relatively new and have been shown to be useful for improved sourcing of information on specific aspects of medical education such as pain medicine. Web-based curriculum maps enable students and educators to find out what learning is expected, where in the course such learning occurs, and how such learning links to other components of the course [76]. They can also provide information on measures used to determine whether or not the student has achieved the expected learning outcomes [76]. The innovative approach to quantifying content using a computer-based detailed inventory and content analysis to describe medical school curriculum was useful for highlighting the presentation of pain as a symptom of other conditions rather than a disease entity per se [45]. It enabled identification of particular emphases in

the pain curriculum (such as nociceptive transduction), and lack of attention to certain topics known to be integral to pain medicine. It was also possible to expose a bias in terms of presentation of pain, such as chronic pain being associated with drug abuse and addiction. However, this was a very time-intensive method of data collection and it was not possible to estimate contact hours as other pain educators have done. This method appears to be most suitable for assessing teaching in the preclinical years.

Considering the prevalence and public health burden of pain, major changes are needed to the provision of medical education in order to prepare medical students to face the challenge of meeting the pain management needs of the communities they will serve in the future. Pain medicine teaching should be made a compulsory element of the medical curriculum. A coherent pain medicine curriculum needs to portray the concept of pain as a disease entity per se, rather than a symptom of other diseases [45]. Pain medicine education needs to embrace the biopsychosocial model of pain and the comprehensive multidisciplinary management of pain. Core competencies in pain management for health professionals have been developed and could serve as a foundation for defining and revising curricula [39]. Training and professional certification standards need to be established in order for pain-specific competencies to be included as a component for entry-to practice requirements by regulatory systems [55, 72]. Contemporary medical curricula require inclusion of appropriate pain medicine learning outcomes; formative and summative assessments to enhance the importance of pain education; and opportunities for students to learn about pain medicine with their interprofessional peers and teachers in order to deepen understanding of both the affective and cognitive dimensions of pain [52, 77, 78]. The innovation of online pain medicine education resources that could be used across medical schools internationally may alleviate some of the financial burden of individual medical schools involved in developing and restructuring the medical curriculum. The commitment of the IASP to pain education is

acknowledged by the designation of 2018 as the Global Year for Excellence in Pain Education [79]. This presents an opportunity for educators to “strengthen the identity, goals, and professional culture of pain education” [80].

## CONCLUSIONS

This systematic review has revealed that, in general, pain medicine education at medical schools internationally does not adequately respond to societal needs in terms of the prevalence and public health impact of inadequately managed pain. There have been initiatives at various medical schools to develop comprehensive pain medicine curricula, but these have not been widely implemented. A theoretical framework is needed to assist medical schools implement defined pain medicine curricula with specified learning objectives that focus on connecting scientific content and activity with professional practice using transformative teaching and assessment methods.

## ACKNOWLEDGEMENTS

The authors are sincerely grateful to Dr. Raoul Oehmen, Dr. Helen Slater, and Prof. David Paul, who provided expertise and insights that greatly assisted the research.

**Funding.** No funding or sponsorship was received for this study or for the publication of this article.

**Authorship.** All named authors meet the International Committee of Medical Journal Editors (ICMJE) criteria for authorship for this article, take responsibility for the integrity of the work as a whole, and have given their approval for this version to be published.

**Disclosures.** Elspeth E. Shipton, Frank Bate, Raymond Garrick, Carole Steketee, Edward A. Shipton, and Eric J. Visser have nothing to disclose regarding the publication of this paper.

**Compliance with Ethics Guidelines.** This article is based on previously conducted studies and does not contain any studies with human participants or animals performed by the author.

**Data Availability.** Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

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