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| Study (identified by first author and date of publication) | General characteristics of the study | | | Training course(s) | Findings of the study | |
| **Design** | **Period and location** | **Involved participants** | **Measurement method(s)** | **Main reported results** |
| Bellamy et al, 2000 | Interventional study | Canada | Family practitioners | Review of the literature and summary of the recommendations followed by demonstration of the injection skills by a local preceptor, then supervised injection on a voluntary patient that had been recruited by the trainee | Assessments of the WOMAC 3.0 index of the voluntary subject suffering from osteoarthritis of the knee before the joint injection and six weeks after it | Statistically and clinically significant improved pain score and physical functions, as demonstrated by a decrease in the WOMAC 3.0 index |
| Vogelgesang et al, 2002 | Randomised controlled trial | During the 1997-1998 academic year; Iowa (United States of America) | Residents and fourth-year medical students | Deterministic allocation in three groups on the basis of educational scheduling considerations: classic university-based rotation through hospital departments without additional training, didactic lecture, combination of a this lecture with a hands-on workshop on a commercially available manikin | Both written and practical tests at the end of the one-month university-based rotation through rheumatology, baseline knowledge assessed by the same evaluation method on a random sample of ten participants before receiving any instruction | Better theoretical performance in the lecture and combined training groups, statistically significant improvements in practical competencies of the participants having received the combined training in comparison with the other groups |
| Gormley et al, 2003 | Randomised controlled trial | Belfast, Northern Ireland | Principal general practitioners in the Northern Ireland Eastern Health and Social Services Board | Common training including a lecture and work in small groups using rubber manikins on shoulder anatomy assessment and injections techniques, then random selection of half of the participants for receiving an additional training by providing supervised injections to patients in clinics | Surveys administered before and six months after the training course about the participants’ level of confidence, the number of shoulder injections performed and the number of patients referred regarding this topic during the past semester | Subsequent increased level of confidence in providing a shoulder injection and number of such procedures performed with a significant correlation between this values, better results after the additional training on patients |
| Cuccurullo et al, 2004 | Interventional study | New Jersey (United States of America) | Second-year to fourth-year post-graduate physical medicine and rehabilitation residents | Workshop composed by a lecture session and a laboratory demonstration with supervised practice on synthetic models, followed by two weeks of training using the same manikins | Multiple-choice written examination and evaluation of the competencies in providing injections to the synthetic models, performed before the training course and after the two weeks of practice sessions | Substantially increased knowledge and skills regarding the musculoskeletal injections |
| Stitik et al, 2005 | Randomised controlled trial | New Jersey (United States of America) | Second-year to fourth-year post-graduate physical medicine and rehabilitation residents | Random allocation in two parallel groups: lecture of the standard injection texts, videotaped self-paced instruction followed by hands-on training using a synthetic model with visual feedback | Written tests and injection performance examinations on an actual patient, based on a standardized checklist, before the training course and at the end of this one | Significantly better performances in both the first injection and in the mean score of repeated procedures for trainees having attended the video-based and hands-on training course |
| Leopold et al, 2005 | Randomised controlled trial | Seattle, Washington (United States of America) | Medical doctors, osteopathic physicians, advanced registered nurse-practitioners and physicians’ assistants | Random assignment in three parallel groups: lecture using a printed guide / video instructions using a CD-ROM / hands-on training on a commercialised anatomic knee model | Pre- and post-training graduation of the performance in providing a joint injection on the synthetic model by preceptors based on a predefined objective checklist and self-assessment of the competencies through a 10-point Likert scale | Improved confidence and competencies in performing a joint injection after any training course, no statistically significant difference among the three groups |
| Wilcox et al, 2006 | Interventional study | From October 2003 to May 2004; Chicago, Illinois (United States of America) | Internal medicine second-year and third-year residents at the University of Chicago | Workshops including lecture and hands-on practice with the use of commercially available manikins of the knee and shoulder joints, followed by a training on patients in a dedicated injection clinic during four hours a week for a month | Written test, self-assessment of the level of confidence and observed practical examination graded using a checklist based on the proper techniques, performed before and after the educational intervention | Improved self-confidence and measured competencies in performing a joint injection, better efficiency of the training course regarding the knee injections than the shoulder ones |
| Jolly et al, 2007 | Interventional study | From October 2004 to September 2005; Oak Lawn, Illinois (United States of America) | First-year to third-year internal medicine and family practice residents and internal medicine faculty members | Lecture of a printed handout, theoretical topic provided by an instructor, demonstration and hands-on training using commercialised synthetic models with an audible feedback | Survey asking the self-assessed comfort scores about theoretical and practical aspects of performing the injections, completed before and after the training course | Higher levels of confidence regarding both the theoretical and the practical considerations about performing the injections after the training course, with a correlation of the efficiency of the educational intervention with the faculty status highlighted by better results among the first-year residents |
| Watson et al, 2008 | Randomised controlled trial | United Kingdom | General practitioners across five centres of the United Kingdom | Random assignment in two groups: no additional training than the participants’ actual experience or smalls groups training course comprising a 60-minutes lecture and a hands-on workshop allowing the practice of injections on a synthetic model | Baseline then repeated evaluations (at 1 month, 3 months and 6 to 12 months after the training course) of patient-assessed outcomes through validated instruments (SF-36, EQ-5D, BSDQ) and visual analogue scales | Improved and clinically significant early patient-related outcomes in the trainees group, persistence of lasting better results but no statistically significant difference at 12 months |
| Barilla-LaBarca et al, 2009 | Interventional study | Long Island, New York (United States of America) | First-year to third-year internal medicine residents and students rotating through the division of rheumatology, second-year to fourth-year rehabilitation residents | Half-day educational intervention including a 1-hour lecture followed by a hands-on workshop using commercialised manikins | Self-assessment questionnaires and medical knowledge tests administered before and after the training course | Significantly increased self-confidence in performing joint injections and improved knowledge about this topic, declared usefulness of the training course and impact on the everyday practice of the participants |
| Watson et al, 2010 | Cohort study | United Kingdom | Final-year medical students at the University of Cambridge and postgraduate trainees in the Eastern region of England | Training using a modified version of a commercially available manikin, alongside other practical clinical skills | Objective structured clinical examination in a simulated clinical skills laboratory setting and questionnaire about confidence and impact on clinical practice | Improved confidence in providing a knee injection and increase in the number of such skills performed in clinical practice |
| Gray Sterrett et al, 2011 | Interventional study | From January 2008 to January 2010; South Florida (United States of America) | Fourth-year medical students, internal medicine residents and advanced subspecialty rheumatology residents | 1-hour workshop including a formal didactic lecture followed by a practical training portion with the use of commercialised synthetic models | Self-assessment questionnaire administered before and after the training course, then follow-up surveys at 3 and 6 months after the workshop | Significantly increased comfort level in performing joint injections with a maintained over time effect of the training course, assumed usefulness of the workshop for their current practice by all the respondents |
| Berman et al, 2012 | Randomised controlled trial | New York City, New York (United States of America) | First-year rheumatology fellows and second-year internal medicine residents from two teaching institutions | Allocation in two groups : common theoretical part consisting in a lecture and a demonstration of the anatomic landmarks on a human volunteer, followed by a hands-on workshop using either cadavers or synthetic models | Surveys regarding the self-reported comfort level and the number of performed injections in various joints, assessed before any training then immediately after the teaching intervention and at the end of month-long rheumatology rotation or the six weeks of fellowship | Significantly increased comfort in performing joint injections after the training courses with a continuing improvement through the following practice, better observed efficiency of the workshop involving the use of cadavers |
| Preisner et al, 2012 | Randomised controlled trial | From October 2006 to October 2009; Pittsburgh, Pennsylvania (United States of America) | First-year post-graduate internal medicine residents at the University of Pittsburgh | Common training including a web-based review of theoretical considerations and a hands-on workshop using a synthetic model, then random selection of half of the participants for being given access to the original web-based instructional material | Evaluation of the procedural skills in performing shoulder and knee injections and self-assessment of the participant’s level of confidence, realised at the conclusion of the training courses and between 6 and 30 months later | Decreased performance over time but improved long-term retention of the acquired skills for the trainees having observed a review of the educational material after the original workshop, higher maintained level of confidence reported by the residents having reported doing the concerned procedures |
| Fox et al, 2013 | Randomised controlled trial | United Kingdom | Students enrolled in the third year of veterinary course | Random allocation in three groups : lecture of a textbook, hands-on practice using either a cadaver or a designed and manufactured manikin with immediate feedback | Self-rating of the confidence on a Likert scale after the respective teaching sessions and assessment of the ability in performing joint injections using the model one week after the training courses, with a check of the correct location by radiographs | Increased confidence and improved competencies in providing joint injections in the trainees having followed a hands-on workshop using either the designed model or cadavers in comparison with those having been assigned to the lecture group, better assumed usefulness of this training methods |
| Chiowchanwisawakit et al, 2015 | Interventional study | From April 2013 to February 2014; Bangkok (Thailand) | Sixth-year medical students rotating through the department of internal medicine at the Siriraj Hospital | 90-minutes workshop including a formal didactic lecture, a demonstration by a rheumatologist and practice using of a commercialised manikin with an immediate visual feedback by the aspiration of an inserted fluid | Self-evaluation questionnaires and competencies evaluation by an objective structured clinical examination, performed before and after the workshop | Significantly improved knowledge about the concerned topic, confidence level and practical skills in performing a knee arthrocentesis |
| Battistone et al, 2016 | Interventional study | From July 2012 to 2015; Salt Lake City, Utah (United States of America) | Internal medicine, physical medicine and rehabilitation, orthopaedic surgery residents, physicians’ assistants and advance practice nursing students | Hands-on workshop using commercially available knee and shoulder manikins in the context of an educational week regarding musculoskeletal concerns | Self-assessments of the proficiency using Likert scales and objective structured clinical examinations, performed before the training course and on the final day of the educational week | Increased confidence and improved competencies in providing knee or shoulder injections |
| Kay et al, 2016 | Interventional study | From July 2015 to January 2016; Arizona (United States of America) | Third-year medical students with no joint arthrocentesis experience | Hands-on cadaver procedure lab about knee, elbow and wrist arthrocentesis | Evaluation of the practical skills in performing a joint arthrocentesis on a cadaver through an observation using a checklist that had been reviewed by experts in the field of orthopaedic surgery and questionnaire regarding theoretic considerations, repeated before the training course and after 5 weeks | Statistically significantly improved comfort level, theoretical competencies with a better knowledge related to the procedure and increase in the number of correctly performed steps in performing a joint arthrocentesis |