Interprofessional Learning in Multidisciplinary Healthcare Teams Is Associated With Reduced Patient Mortality: A Quantitative Systematic Review and Meta-analysis

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Objective: The aim of the study is to identify quantitative evidence for the efficacy of interprofessional learning (IPL) to improve patient outcomes.

Methods: We conducted a systematic review and meta-analysis of quantitative patient outcomes after IPL in multidisciplinary healthcare teams reported in the Medline, Scopus, PsycInfo, Embase, and CINAHL databases.

Results: In 2022, we screened 15,248 reports to include 20 and extracted rates of mortality and primary outcomes in conventional care groups and intervention groups (involving initiatives to promote IPL in multidisciplinary teams). The meta-analysis of the 13 studies reporting mortality outcomes demonstrated that the 7166 patients in the intervention group had a significant 28% (95% confidence interval [CI], 40%–14%; $P < 0.0003$) reduced risk of dying compared with the 6809 patients in the conventional care group. The meta-analysis of the 14 studies reporting other treatment-related adverse outcomes demonstrated that the 4789 patients in the intervention group had a significant 23% (95% CI, 33%–12%; $P < 0.0001$) reduced risk of experiencing an adverse outcome during care compared with the 4129 patients in the conventional care group. Sensitivity analysis, involving the exclusion of the 20% of individual studies with the widest 95% CIs, confirmed the precision and reliability of our findings.

Conclusions: We believe that our results are the first to demonstrate significant quantitative evidence for the efficacy of IPL to translate into changes in clinical practice and improved patient outcomes. Our results reinforce earlier qualitative work of the value of IPL, but further prospective quantitative and mixed-methods research is needed to better define such benefits.

Key Words: interprofessional learning, quantitative evidence, patient harm, quality and safety, healthcare curricula

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Modern healthcare is complex and multidisciplinary by nature. However, the formation of a competent multidisciplinary healthcare team involves more than simply bringing together a group of individually competent clinicians. If individually competent clinicians do not know how to work effectively with other professions in their team, the team as a whole may fail to deliver competent care to the patient, contributing to preventable treatment-related harm and death.[1–4] In this context, Interprofessional Learning (IPL) that allows individuals from different professions within a multidisciplinary healthcare team to learn with, from, and about each other is a potentially powerful method to improve collaboration and the quality of care.[4–7] Such IPL is often thought of as being achieved through formal Interprofessional Education (IPE) such as workshops or simulation courses. However, the scope for informal IPL in the clinical workplace is considerably greater, one estimate suggesting that 90% of learning between professions in the workplace occurs informally through unplanned or deliberate workplace interactions, review meetings, or team-based multidisciplinary problem solving.[8–10] Many benefits of IPL have been purported, including improved communication between professional groups, more effective teamwork, and gaining a better understanding of other professions' skills, roles, and knowledge.[5] In addition, more recently, IPL has been seen as a means to address workforce shortages, particularly in rural and remote locations.[11,12] Such perceived benefits have led to IPL being promoted widely throughout the world in curricular strategic plans, policy documents from healthcare colleges, and by the World Health Organization.[11–15] Establishing the clinical evidence for the efficacy of IPL is therefore important for achieving better outcomes for patients.[14,16]

A recent review study goes further, suggesting that IPL should be repositioned from the margins to the center of healthcare education and training, before and after qualification.[17] However, many in core healthcare disciplines, such as medicine and surgery, remain skeptical of the evidence for the efficacy of IPL. While many of the benefits of IPL have good face validity, the great majority of the current evidence supporting their value and effectiveness remains qualitative, typically based on self-report from participants.[7,10,18–20] Many published studies emphasize the need for further evidence demonstrating that IPL can translate into changes in clinical practice and improvements in patient outcomes, but such evidence has proved difficult to obtain.[21–24] For example, 2 Cochrane review studies, considering interventions promoting interprofessional collaboration and the improvement of healthcare outcomes, report inconclusive findings—that the quality of evidence for the efficacy of IPL to improve patient outcomes is poor, that no evidence suggests reduced rates of patient mortality, and that more definitive studies are needed.[25,26]

It should be noted that Cochrane reviews typically admit into their analyses only randomized, or randomized and controlled trials (RCTs), and given the paucity of such study designs in IPE research this severely limits the ability to conduct a meta-analysis of such data. Despite the persistent popularity of RCTs as a universal study design in medicine, RCTs were in fact devised as a reliable method for the much narrower domain of laboratory experiments and clinical drug trials. It is therefore questionable whether it is appropriate to assess educational interventions or quality and safety

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initiatives with RCTs.[27–29] However, before we can resolve the degree to which IPL should be incorporated into healthcare curricula, the central question remains: what quantitative evidence is there that IPL improves patient outcomes? Between the domains of qualitative research, often preferred by those working in IPE, and the RCTs preferred by the Cochrane Review Group, there exists a middle ground of quantitative evidence, comprising cohort and quasi-experimental studies, that has largely been ignored. In the following, we aim to conduct a systematic review and meta-analysis of the quantitative evidence, which includes this middle ground, for the efficacy of IPL to improve patient outcomes.

METHODS

We conducted a systematic review of the refereed literature to find original reports of interventions intended to improve the performance of multidisciplinary healthcare teams and which contained IPL occurring in the clinical setting and which reported quantitative patient-related outcomes. We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA, prisma-statement.org) to guide our review and the Checklist for Quasi-Experimental Studies (JBI Systematic Reviews, jbi.global) to confirm the quality of included reports. To synthesize studies from around the world into a form suitable for meta-analysis, we chose a random effects model and extracted rates of events associated with primary outcomes and mortality occurring in a known number of patients in the intervention and nonintervention groups. This allowed us to conduct a meta-analysis using risk ratios, without a sole reliance on RCTs.

Search and Screening Process

On August 16, 2022, we conducted an electronic search using the databases Medline, Scopus, PsycInfo, Embase, and CINAHL using the three sets of search terms in Table 1. These databases were chosen to be both comprehensive and the most likely to contain reports of important healthcare outcomes for patients, including adverse events and mortality. For each database, we used the Boolean operator OR to combine search terms within a set and the Boolean operator AND to combine search terms between sets. In all searches, we used the search-engine delimiters of studies with human participants only, written in English, and where the full text was available. We deliberately selected our key words and cast the net wide to capture studies, which contained formal and informal IPL. References were imported into an electronic library using Endnote 20 (Clarivate, Pa) and duplicates were automatically removed. We then screened reports using the inclusion and exclusion criteria in Table 1, first at the level of title and abstract, then during reading of the full text. We wished to include original clinical quantitative and mixed-methods studies in our analysis; hence, other report types were excluded (Table 1C). Screening was conducted collaboratively within the author team, with authors S.L. and K.A. conducting screening at the title and abstract levels, with any uncertainties being resolved through discussion at regular meetings with C.S.W. and T.J. C.S.W., T.J., and T.C. conducted the final full-text screening, resulting in 20 reports being included in the meta-analysis[30–49] (see Fig. 1 for the PRISMA flow diagram and Supplementary File 1 for completed PRISMA checklist, http://links.lww.com/JPS/A577). Four studies were excluded because they reported results only in a form unsuitable for inclusion in risk ratio calculations (e.g., as odds ratios only or as continuous scores without numerators of outcome events).[50–53]

Data Analysis

We extracted all primary outcomes and mortality outcomes from included studies. We were guided by Donabedian highly influential Structure-Process-Outcome model in electing to separate mortality outcomes from other treatment-related outcomes.[54] We aligned the direction of all outcome measures for the purposes of the meta-analysis by reverse coding outcomes reported positively (e.g., survival was reverse coded as the number of deaths in each group—Table 2). Hence, a benefit for patients in the intervention group would manifest as the occurrence of significantly fewer deaths or other adverse outcomes in that group compared with the conventional care group. We then performed 2 meta-analyses using a standard random-effects model and risk ratios for both mortality outcomes and other treatment-related outcomes using Review Manager 5.4 (Cochrane Collaboration, London, United Kingdom).

RESULTS

The characteristics of the 20 included studies are shown in Table 2, demonstrating that studies came from 12 countries, not all of which were high-income countries. The most common study designs, as described in each study, were before-after and retrospective cohort designs. Given our comprehensive inclusion and exclusion criteria (Table 1) all included studies were of good methodological quality (while admitting the inclusion of designs other than RCTs)—and this was confirmed by the fact that all included studies scored an 8 or 9 (out of 9) on the Checklist for Quasi-Experimental Studies. Eleven studies passed all criteria except for the presence of a control group (hence, scoring an 8 out of 9; see Supplementary File 2 for completed quality Checklist, http://links.lww.com/JPS/A578). However, 9 studies did use a control group and 4 of these also used randomization. Despite diverse clinical contexts, participating clinical personnel and patient conditions, most interventions were described similarly as initiatives to foster effective multidisciplinary care, indicating informal problem-based IPL (Table 2). However, 5 of the 20 included studies also described additional formal education or training as part of their IPL intervention, one of which involved case-based simulation (studies 3, 6, 7, 9, and 18 in Table 2). In addition, 2 studies reported weekly multidisciplinary meetings to review team performance (studies 4 and 15), and a further 3 studies reported strategies to standardize or synchronize workflows, decision making, and communication within the multidisciplinary team (studies 9, 16, and 18). In terms of reported outcomes, 3 studies were related to diabetes treatment and had similar outcomes measures; however, the remaining 17 studies involved a variety of primary outcome measures reflecting the patient conditions featured in included studies. For the purposes of meta-analysis, treatment-related adverse outcomes included failure to achieve the desired therapeutic outcome, but also included process measures, such as medication error and hospital readmission (Table 2). Thirteen studies reported mortality outcomes and 14 studies reported other treatment-related outcomes (with 7 studies reporting an outcome of both types).

Figure 2 shows the results of our 2 meta-analyses—values under the "Events" heading identifies the numerators of events associated with the outcome measures in each group, while the "Total" heading indicates the denominators of the number of patients in each group. The meta-analysis of the 13 studies reporting mortality outcomes demonstrates that in the 7166 patients in the intervention group, patients had a highly significant 28% (95% confidence interval [CI], 40%–14%) lower risk of dying compared with the 6809 patients in the conventional care group—risk ratio 0.72 (95% CI, 0.60–0.86), $P < 0.0003$, Figure 2A. A similar benefit was seen in the 14 studies reporting other treatment-related outcomes. Demonstrating that in the 4789 patients in the intervention group, patients had a highly significant 23% (95% CI, 33%–12%) lower risk of experiencing an adverse

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TABLE 1. Search Terms and Study Inclusion and Exclusion Criteria

A. Search terms in 3 sets

Set 1—terms related to scope of intervention

Interprofessional, interdisciplinary, multidisciplinary

Set 2—terms related to intervention

Education, training, learning

Set 3—terms related to professional groups involved

Healthcare, nursing, pharmacy, medicine, allied

B. Inclusion criteria

Sample frame

- Reports must involve clinicians or allied health professionals from 2 or more disciplinary groups
- Reports must contain IPL (either formal or informal) between clinicians
- Reports must be published between January 2000 and August 2022
- Quantitative or mixed methods studies reporting rates of phenomena of interest (as below) occurring in a known number of patients in intervention and nonintervention groups

Phenomena of Interest

- Patient mortality rates
- Other reported patient outcomes occurring during clinical care (e.g., longer hospital stay, adverse events, or failure to achieve desired therapeutic outcome)

C. Exclusion criteria

- Case reports, discussion papers, simulation only studies, letters, editorials, reviews, and qualitative studies

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outcome during care than the 4129 patients in the conventional care group—risk ratio 0.77 (95% CI, 0.67–0.88), $P < 0.0001$, Figure 2B. Both meta-analyses demonstrate heterogeneity parameters within acceptable limits (Fig. 2). While our I^2 values show moderate heterogeneity, the more critical τ^2 parameters remain substantially below the 0.1 threshold, indicative of good precision in our effect estimates (τ^2 of 0.06 and 0.04).

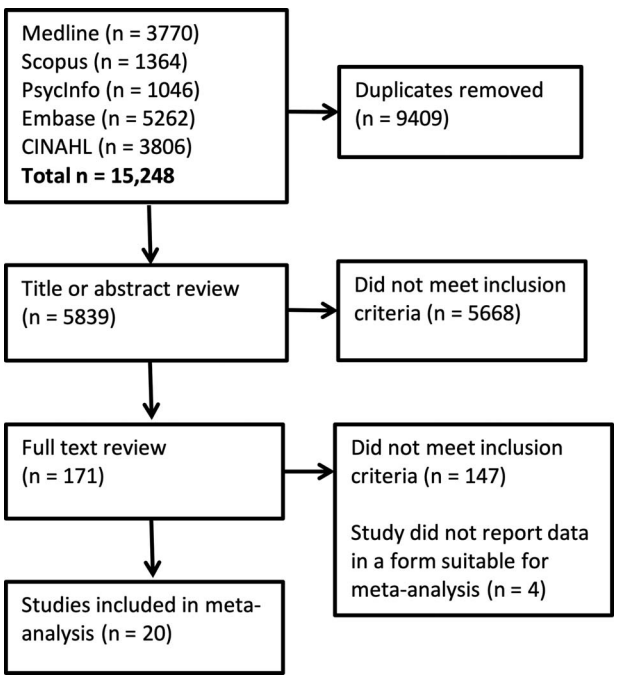


FIGURE 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram of screening process.

Sensitivity Analysis

To confirm the precision and the reliability of our findings, we conducted an additional sensitivity analysis in which we excluded 3, or the 20% of studies, from each meta-analysis with the widest 95% CIs, and recalculated our meta-analyses results (Table 3). This demonstrated that the finding for death did not change, while the finding for other treatment-related outcomes shifted slightly from 0.77 to 0.76, suggesting a larger 24% reduced risk of experiencing an adverse outcome the intervention group (Table 3). The stability of the results of our sensitivity analysis suggests that our original findings in Figure 2 are reliable, and all studies should be admitted as per our original inclusion criteria.[55,56]

DISCUSSION

We conducted a systematic review of 22 years of the refereed literature to identify original studies of interventions comprising IPL intended to improve the performance of multidisciplinary healthcare teams in the clinical setting and which reported quantitative outcomes suitable for risk ratio meta-analysis (Table 2, Fig. 2). We conducted 2 meta-analyses demonstrating significant effects favoring the IPL group, namely, a 28% reduced risk of patient death, and a 23% reduced risk of experiencing an adverse outcome (including failure to achieve the therapeutic outcome) in comparison with conventional patient care.

In the context of recent quantitative research into the benefits of good teamwork in health care, our findings should perhaps not seem surprising. A recent comprehensive meta-analysis study of 31 reports comprising 1390 healthcare teams published in 2019

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TABLE 2. Studies Included in Meta-analysis

Study (Year)	Study Location	Design	Patient Participants	IPL Intervention	Other Outcomes	Death Outcomes	CQES Quality Score (Out of 9)
1. Aguiar et al[30] (2018)	Brazil	Randomized, controlled	Adults with uncontrolled type 2 diabetes	Pharmacist/physician collaborative care, including nurse and nutritionist outpatient care team	Controlled diabetes*	—	9
2. Altman et al[31] (2012)	United States	Prospective, controlled	Adults undergoing cardiac resynchronization therapy	Multidisciplinary care in team-based clinic involving physicians, cardiologists, and electrophysiologists	Heart failure	Death	9
3. Barceló et al[32] (2010)	Mexico	Controlled before-after study	Adult patients with diabetes	Multidisciplinary care teams, with formal diabetes training for members including physicians, nurses, nutritionists, and psychologists	Good glycemic control (A1c <7%)*	—	9
4. Asare et al[46] (2017)	Ghana	Before-after	Pregnant women with sickle cell disease	Multidisciplinary care team of obstetricians, hematologists, pediatrician, nurses, and intensivists, including weekly review meetings and standard protocol development	—	Maternal or perinatal death	8
5. Caplan et al[33] (2004)	Australia	Randomized, controlled	Patients 75 y and older discharged from emergency department	Comprehensive geriatric care delivered by interdisciplinary team of general practitioner, geriatrician, nurses, physiotherapist, and occupational therapist	Emergency readmission within 30 d	Death	9
6. Connolly et al[34] (2015)	New Zealand	Randomized, controlled	Patients in residential age care facilities	Gerontology education, and clinical coaching in multidisciplinary care team of gerontology nurse specialist, geriatrician, primary care physician, pharmacist, and facility nurse	Acute hospitalization	Death	9
7. Copson et al[35] (2017)	Australia	Retrospective cohort	Births at tertiary referral hospital	Multidisciplinary case-based simulation training involving obstetric consultants, medical officers, midwives, and anesthetists	Apgar score <7 at 5 min	Perinatal death	8
8. Elgalib et al[36] (2018)	Oman	Longitudinal cohort	Patients in tertiary hospital HIV clinic	Multidisciplinary team of physicians, pharmacists, nurses, counselors, psychologists, and social workers	Viral load reduced to undetectable levels (<20 viral copies/mL)*	—	8
9. Ersson et al[37] (2018)	Sweden	Retrospective cohort	Adult patients in tertiary hospital ICU	Multidisciplinary teams of intensivists, critical care nurses, assistant nurses, physiotherapists, and social counselors, with all-staff training seminars and synchronization of workflows	—	Death within 30 d of ICU stay	8
10. Ferman et al[38] (2012)	Australia	Retrospective before-after	Patients hospitalized with Crohn disease	Multidisciplinary care team involving gastroenterologist, surgeons, radiologist, nurses, dieticians and psychologists	Clinical remission*	—	8
11. Folbert et al[39] (2012)	The Netherlands	Prospective cohort	Patients with hip fractures, 65 y and older	Multidisciplinary fast-tracked care pathway involving nursing, geriatrician, anesthesia and trauma surgery staff	Readmission within 30 d	Death	8
12. Goldstein et al[40] (2004)	Canada	Controlled, cohort	Patients undergoing dialysis for at least 3 mo in renal disease clinic	Multidisciplinary care by dietician, nephrologist, nurse educator, pharmacist, and social worker	—	Death during 3-y study period or within 1 y after	9

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13. Kalina et al[41] (2009)	United States	Controlled, cohort	Pediatric patients in hospital	Multidisciplinary care by pediatric hospitalist, care coordinator, pediatric nurse, and pharmacist	Medication administration errors	—	9
14. Kasper et al[42] (2002)	United States	Prospective, randomized controlled	Patients with chronic heart failure	Intervention team comprising nurse coordinator, chronic heart failure nurse, cardiologist, and patient's primary physician	Rehospitalization within 6 months	Death	9
15. Kesson et al[47] (2012)	Scotland	Retrospective, controlled	Patients with breast cancer	Multidisciplinary team care involving cancer surgeons, pathologists, oncologists, radiologists, and specialist nurses, with evidence-based guidelines and weekly review meetings	—	Survival*	9
16. Loftus et al[43] (2017)	United States	Retrospective cohort	Adult patients with GI bleeding	Multidisciplinary protocol-based care plan by gastroenterology, interventional radiology, and acute care surgery teams	Readmission with GI bleed	Death	8
17. Michalets et al[44] (2015)	United States	Before-after	Patients in community hospital	Pharmacist included as member of hospital rounds team	Adverse drug events	—	8
18. Taylor et al[45] (2007)	United States	Before-after	Adults with diabetes	Crew resource management training, including standardized communication strategies and checklist, used with all staff	Controlled diabetes*	—	8
19. Win et al[48] (2018)	United Kingdom	Retrospective cohort	Patients admitted for burns in any of 13 critical care services	Multidisciplinary care involving surgeon, intensivist, nurses and allied health professionals using UK Burn Care Review recommendations	—	Survival*	8
20. Yopp et al[49] (2014)	United States	Before-after	Patients with hepatocellular carcinoma	Multidisciplinary care, including nursing, physicians, surgical oncologist, transplant hepatology, interventional radiology, and medical oncology	—	Survival*	8

*Outcomes reported positively have been reverse coded for the purposes of meta-analysis.

CQES, Checklist for Quasi-Experimental Studies; GI, gastrointestinal; ICU, intensive care unit.

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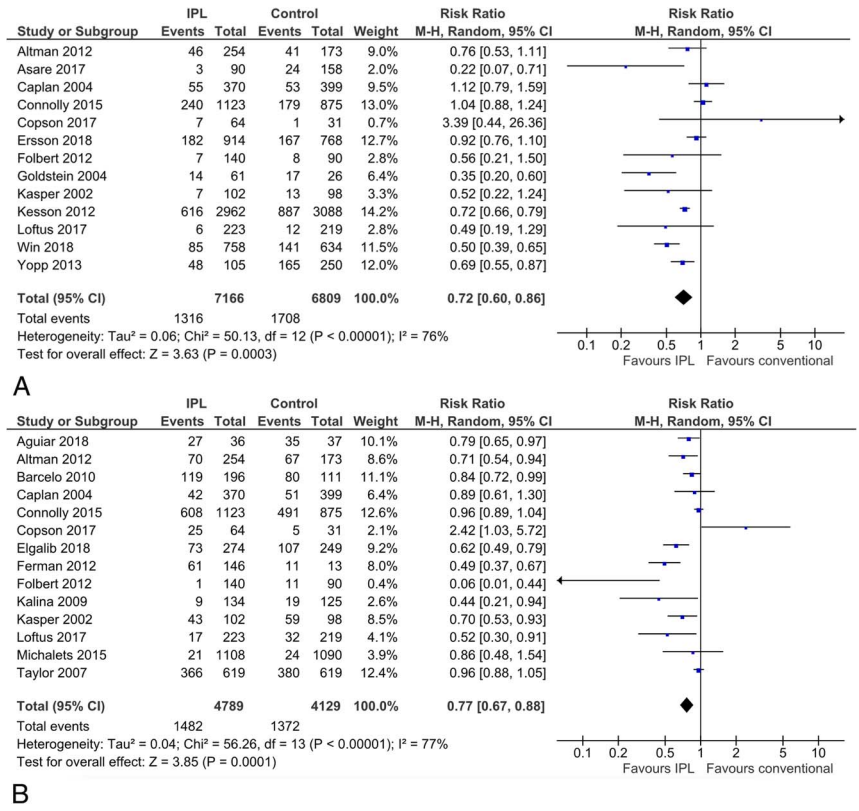


FIGURE 2. Forest plots for meta-analyses, showing (A) death outcomes and (B) other treatment-related outcomes (see text). The IPL column indicates the intervention group, and the Control column indicates the group receiving conventional care.

demonstrates that teams who engage in effective teamwork processes are 2.8 times more likely to achieve levels of high performance than teams who do not, and such improved performance would be expected to directly translate into better patient outcomes.[57] One of the most celebrated initiatives to improve healthcare teamwork and which achieved the demonstration of improved patient outcomes was published in 2009 and showed that in 7688 patients, a simple checklist facilitating communication at 3 key points during surgery in the operating room reduced patient deaths by 47% and postoperative complications by 36%.[58,59] In his book *The Checklist Manifesto,* Atul Gawande describes the initial surprise that a relatively simple intervention such as a checklist could yield such substantial improvements in patient outcomes.[58(p154)] The WHO Surgical Safety Checklist has subsequently gone on to be adopted throughout the world.[60] Our present results provide further evidence that relatively simple targeted initiatives to improve teamwork functioning within multidisciplinary teams can yield substantial benefits for patients. Such results may indicate that we are at the beginning of a new era of evidence-based patient safety. However, further carefully designed

TABLE 3. Sensitivity Analysis

	IPL	Control	Risk Ratio (95% CI)	τ^2	I^2	χ^2 (*P*)	Studies Excluded*
Death outcome							
Total events	1296	1687	0.72 (0.60–0.87)	0.06	81%	46.92 ($P < 0.00001$)	Copson et al[35] (2017), Folbert et al[39] (2012), Loftus et al[43] (2017)
Total patients	6739	6469					
Other outcomes							
Total events	1427	1324	0.76 (0.66–0.87)	0.03	79%	47.76 ($P < 0.00001$)	Copson et al[35] (2017), Kalina et al[41] (2009), Michalets et al[44] (2015)
Total patients	3483	2883					

*The 20% of studies with the widest 95% CIs have been excluded.

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and prospective quantitative work is needed to confirm and validate such benefits.

Our study is the first that we know of to demonstrate significant quantitative benefits in terms of patient outcomes for interventions comprising IPL in health care. We were interested in IPL interventions in the clinical workplace as we expected that this would give us the best chance of detecting improvements, given the close proximity of interventions to the context in which the outcomes could manifest. While continuing education for qualified healthcare practitioners is clearly important, demonstrating the benefits of IPL in the undergraduate curriculum in terms of patient outcomes will likely be more difficult given the greater distance between the intervention and the clinical workplace. However, we know that undergraduate healthcare students, particularly those late in their educational programs, are highly receptive to IPL activities and report substantial perceived benefits in terms of preparing them for the clinical workplace, and so further work is needed to identify the downstream benefits of undergraduate IPL.[18,61]

Our approach of identifying studies from which we could extract proportions of the number of deaths, or other adverse outcomes, allowed us to perform meta-analyses without relying on data from a large number of randomized or controlled trials. The advantage in this approach can be seen when we compare our results to 2 previous, inconclusive, Cochrane reviews considering the effects of interprofessional collaboration. The first, published in 2000, included only 2 studies involving 1945 patients and concluded that no mortality benefit could be determined for improved interprofessional collaboration.[26] The second Cochrane review, published in 2017, included 9 studies involving 6540 patients and concluded that meta-analysis of study outcomes was not possible because of the small number of included studies, that all included studies were from high-income countries, and that no conclusions on mortality could be made.[25] Evidence-based medicine is in fact defined as locating "the best external evidence with which to answer our clinical questions"[62(p72)] and so is not restricted to evidence drawn only from RCTs. Our study achieved this by also admitting quantitative studies other than RCTs and hence arrived at useful findings consistent with evidence-based medicine.

The meta-analysis finding regarding mortality in our study seems to be the most convincing, as it deals with a clear and identically defined outcome in all included studies. Future work to better define the benefits of IPL in outcomes other than mortality should consider mixed-methods study designs, because these typically yield stronger evidence than quantitative or qualitative methods used in isolation.[27,63] Our quantitative findings add to the existing qualitative evidence demonstrating the benefits of IPL in improving patient outcomes and provide cogent justification for the presence of IPL activities in healthcare curricula, continuing education, and clinical practice. Determining the ideal proportion and positioning of IPL within health care will require additional research, but to be most convincing, this future work should use mixed-methods or quantitative designs rather than being purely qualitative.

Strengths and Limitations

The main strength of our study is that our approach allowed the inclusion of a good number of relevant studies and meaningful meta-analyses of data from many thousands of patients. It is also the only study that we know of able to offer evidence for the translation of IPL into improvements in patient outcomes. A further strength was our a priori choice of a random effects model, given that we could not assume a uniform sample population from which our included studies were drawn.

A potential weakness of our study is I^2 values demonstrating moderate heterogeneity. However, given that we are studying learning interventions, we would expect heterogeneity to be higher than in biomedical studies such as clinical drug trials (the domain in which the heuristics for interpreting heterogeneities were developed).[64] There is in fact no agreed-upon acceptable level of heterogeneity in meta-analysis studies.[65] Higgins,[56,66] one of the developers of the I^2 statistic and co-author of the *Cochrane Handbook for Systematic Reviews of Interventions*, states that any amount of heterogeneity is acceptable so long as the study eligibility criteria are clear and reported (which we have done). However, a more relevant measure of heterogeneity in meta-analyses is the τ^2 statistic, as this is a measure of the between-study variance. Small τ^2 values in meta-analysis, particularly those below the 0.1, are considered to indicate precise effect estimates. We confirmed the precision of our effect estimates with a sensitivity analysis, the results of which also suggest that our findings are reliable.

Conclusions

We conducted a systematic review and meta-analysis of studies reporting quantitative outcomes of IPL interventions in multidisciplinary healthcare teams, demonstrating significant benefits for patients in terms of a 28% reduced risk of death and a 23% reduced risk of treatment-related adverse events. Our results are cogent evidence for the efficacy of IPL to translate into changes in clinical practice and improved patient outcomes. Our results reinforce earlier qualitative work that IPL is a valuable element of safe and quality health care, but further prospective quantitative and mixed-methods research is needed to better define such benefits.

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