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Research

Most medical practices are not parachutes: a citation analysis of practices felt by biomedical authors to be analogous to parachutes

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Abstract

Background: In a 2003 paper in *BMJ*, the authors made the tongue-in-cheek observation that there are no randomized controlled trials (RCTs) of parachutes. This paper has been widely read, cited and used to argue that RCTs are impractical or unnecessary for some medical practices. We performed a study to identify and evaluate claims that a medical practice is akin to a parachute.

Methods: Using Google Scholar, we identified all citations to the 2003 paper. We searched for claims that a specific practice was akin to a parachute. For each practice, we identified the desired outcome of the practice, and searched Google Scholar and ClinicalTrials.gov for RCTs that were conducted, ongoing, halted, planned or unpublished.

Results: Of 822 articles citing the original paper, 35 (4.1%) argued that a medical practice was akin to a parachute. Eighteen of the 35 (51%) concerned mortality or live birth, and 17 (49%) concerned a lesser outcome. For 22 practices (63%), we identified 1 or more RCTs: in 6 cases (27%), the trials showed a statistically significant benefit of the practice; in 5 (23%), the trials rejected the practice; in 5 (23%), the trials had mixed results; in 2 (9%), the trials were halted; and in 4 (18%), the trials were ongoing. Effect size was calculated for 5 of the 6 practices for which RCTs gave positive results, and the absolute risk reduction ranged from 11% to 30.8%, corresponding to a number needed to treat of 3–9.

Interpretation: Although there is widespread interest regarding the *BMJ* paper arguing that randomized trials are not necessary for practices of clear benefit, there are few analogies in medicine. Most parachute analogies in medicine are inappropriate, incorrect or misused.

In a widely cited 2003 *BMJ* article, the authors made the tongue-in-cheek observation that there are no randomized trials of parachutes.[1] In an era in which proponents of evidence-based medicine increasingly rely on randomized controlled trials (RCTs) to show treatment efficacy, Smith and Pell[1] argued that some medical practices are so beneficial that it would be silly to subject them to an RCT. The use of a parachute during free fall, such as a controlled jump from an airplane, is an example. Without the use of a parachute, the chance of death approaches nearly 100%, although there are scattered case reports of people surviving such a fall.[2] With a parachute, the risk of death decreases dramatically, with recent estimates of 1.1 deaths per 100 000 jumps, a rate of 0.0011%.[3] Of course, there are several limits to the parachute analogy in medicine. The first difference is etiology. Falling from an airplane has only 1 causal pathway leading to harm. In contrast, most human diseases have multifactorial etiologies,[4] and any 1 practice may be unlikely to single-handedly reverse the outcome. The second limitation is the effect size. Parachutes improve survival from nearly 0% to nearly 100%. Empirical analyses show that few medical practices offer so large a magnitude of benefit. For instance, in a review of over 80 000 medical

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practices from the Cochrane database, Pereira and colleagues[5] found only 1 medical practice that reliably had a large effect on overall mortality, and the absolute risk reduction (ARR) of this practice was about 33%.[6]

Despite the limits to the parachute analogy, the article by Smith and Pell[1] has gained popularity in the medical community and is often used to criticize the need for RCTs of a specific practice. For instance, in a 2016 update to guidelines put forth by the US Department of Agriculture and Department of Health and Human Services, daily flossing was no longer recommended, as it lacked rigorous data showing benefit.[7] In opposition, Holmes[8] argued that long-term flossing was akin to a parachute and may not ethically be tested in randomized fashion. Whether daily flossing is a parachute may be debated, and the analogy may be exaggerated. We performed a study to determine how often researchers claim their medical practice is a parachute when it is in fact no such thing.

Methods

We identified on Google Scholar all articles that cite the paper by Smith and Pell.[1] Our search was conducted from Jan. 1 to Mar. 31, 2016. We selected Google Scholar because of its extensive citation network and coverage,[9] which are known to be superior compared to other citation engines, particularly its citation analysis.[10,11] One reviewer (M.J.H.) screened titles and abstracts of identified articles for full-text review, excluding all articles in languages other than English, published in non–peer-reviewed journals or not related to human clinical medicine (e.g., veterinary medicine). Selected full-text articles were individually reviewed in full by 2 authors (M.J.H. and V.P); as there were no disagreements, all subsequent analyses were based on the reviews of 1 reviewer (M.J.H.). We included articles that used the paper by Smith and Pell[1] to argue that a specific medical practice was like a parachute in that it could not ethically or practically be tested in an RCT. We did not include articles that used the paper to argue against the principles of evidence-based medicine in general. We defined a medical practice as any medication, procedure or system-based change intended to help prevent or treat a medical condition.

For all included articles, we searched Medline for RCTs or systematic reviews of RCTs that had investigated the subject referenced by the article. If multiple large RCTs were readily identifiable, they were each included in our analysis. A detailed search strategy for these RCTs is given in Appendix 1 (available at www.cmajopen.ca/content/6/1/E31/suppl/DC1), and all articles selected were reviewed by M.J.H. and V.P. For these RCTs, we ascertained whether studies gave a positive result (net benefit of the proposed practice), negative result (no benefit or net harm of the proposed practice) or mixed result (inconsistent evidence supporting the use of the proposed practice). For practices for which no RCT could be found, we searched ClinicalTrials.gov to identify any ongoing or unpublished RCTs available. For studies with no published or unpublished RCTs, we summarized the nature of the practice, and M.J.H. and V.P. determined whether an RCT was clinically feasible.

Statistical analysis

We performed descriptive statistics. We calculated the ARR by subtracting the risk in the control arm from that in the experimental arm at whatever time point was reported by the author.

Ethics approval

This study of published reports did not require institutional board review approval. A protocol can be requested from the corresponding author.

Results

At the time of our investigation, the article by Smith and Pell[1] had 822 citations on Google Scholar. Of the 822 articles, 35 (4.3%) directly compared a medical practice to a parachute or used the parachute argument to defend implementation of that practice (Figure 1). These were included in subsequent analysis. We did not identify any prior citation analyses for the article by Smith and Pell.[1]

Of the 35 medical practices, 22 (63%) involved RCTs that were completed, ongoing, halted or planned (Table 1). Examples include stenting for renal artery stenosis, insulin analogues for the treatment of type 1 diabetes, simulation training for providers working in critical care medicine and metastasectomy for isolated pulmonary metastatic colorectal cancer. In 6 cases (27%), RCTs showed a statistically significant benefit of the practice; in 5 (23%), RCTs rejected the practice; in 5 (23%), RCTs gave mixed results; in 2 (9%),

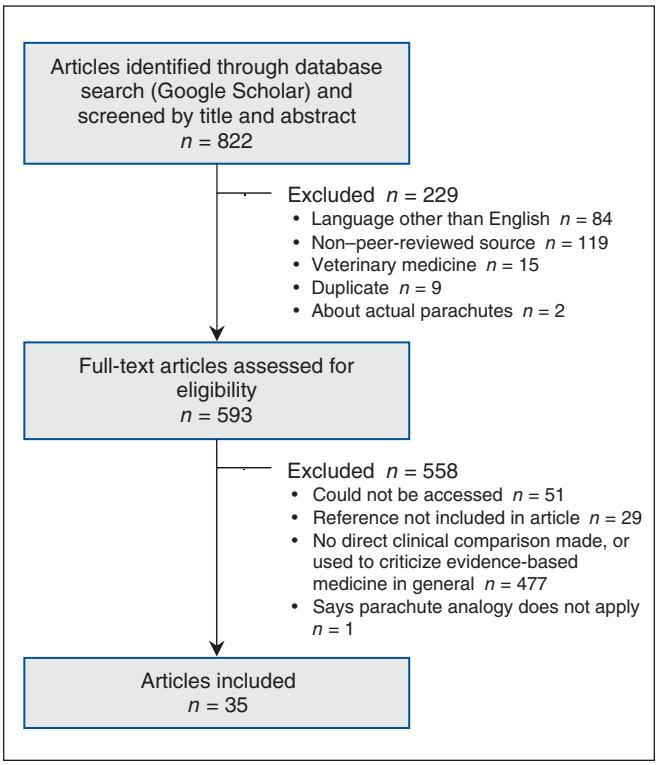

Figure 1: Flow chart showing selection of articles on medical practices analogized to parachutes.

Table 1 (part 1 of 2): Medical practices analogized to parachutes that have been tested with a randomized controlled trial(s)

Author	Claim	RCT	Clinical outcome of medical practice	Trial outcome	Magnitude of benefit/outcome met in trial
Falchook,[12] 2015	Nivolumab for metastatic melanoma has so impressive a response rate and progression-free survival that, akin to a parachute, examining overall survival is not necessary	Nivolumab versus chemotherapy in patients with advanced melanoma who progressed after anti-CTLA-4 treatment (CheckMate 037): a randomised, controlled, open-label, phase 3 trial[13] [nivolumab was superior to decarbazine in CheckMate 66[14] (and choice of comparator seemed a straw man, given year trial was performed)]	Reduction in mortality	Supported practice	1-yr overall survival rate increased from 42.1% to 72.9%; ARR 30.8%, NNT 3
Schaan et al.,[15] 2015	Insulin analogues are superior to regular human insulin for achieving glycemic control in type 1 diabetes	Several, including large meta-analyses such as Systematic review and meta-analysis of short-acting insulin analogues in patients with diabetes mellitus[16] and Long-acting insulin analogues vs. NPH human insulin in type 1 diabetes. A meta-analysis[17]	Reduction in diabetes-related events (cardiovascular/ renal/ocular/ neurologic)	Mixed	–
Montresor et al.,[18] 2015	Empirical deworming therapy of children in endemic areas has clinical benefit	Cochrane reviews of multiple RCTs, including Deworming drugs for soil-transmitted intestinal worms in children: effects on nutritional indicators, haemoglobin, and school performance[19]	Clearance of parasites	Refuted claim	–
Luft et al.,[20] 2014	Stenting for renal artery stenosis benefits some patients so greatly that it is a parachute	Stenting and medical therapy for atherosclerotic renal-artery stenosis[21]	Reduction in cardiovascular events	Refuted claim	–
White,[22] 2011	Stenting for renal artery stenosis benefits some patients so greatly that it is a parachute	Stenting and medical therapy for atherosclerotic renal-artery stenosis[21]	Reduction in cardiovascular events	Refuted claim	–
Bender et al.,[23] 2015	Simulation-based training for medical personnel obviously improves patient outcomes in critical care medicine	Multiple, including Simulation improves procedural protocol adherence during central venous catheter placement: a randomized controlled trial[24]	Reduction in mortality	Mixed	–
Lighthall et al.,[25] 2007	Simulation-based training for medical personnel obviously improves patient outcomes in critical care medicine	Multiple, including Simulation-based training of internal medicine residents in advanced cardiac life support protocols: a randomized trial[26]	Reduction in mortality	Mixed	–
Cefalu et al.,[27] 2015	Recognition and treatment of prediabetes leads to improved patient outcomes	Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin[28]	Reduction in diabetes-related events (cardiovascular/ renal/ocular/ neurologic)	Supported practice	Cumulative incidence of diabetes at 3 yr decreased from 28.9% to 14.4%; ARR 14%, NNT 7
Scheen et al.,[29] 2014	Treating diabetes with agents that lower blood glucose will invariably lead to improved cardiovascular outcomes	Action to Control Cardiovascular Risk in Diabetes,[30] UK Prospective Diabetes Study,[31] Veterans Affairs Diabetes Trial[32]	Reduction in cardiovascular events	Refuted claim	–
Gleicher et al.,[33] 2016	Most of current in vitro fertilization use and application is so obviously beneficial at conceiving children it does not require randomized trials	A multicentre randomized controlled trial of expectant management versus IVF in women with fallopian tube patency[34]	Increased rates of live birth	Supported practice	Live birth rate improved from 1% to 29%, ARR 28%, NNT 3

Table 1 (part 2 of 2): Medical practices analogized to parachutes that have been tested with a randomized controlled trial(s)

Author	Claim	RCT	Clinical outcome of medical practice	Trial outcome	Magnitude of benefit/outcome met in trial
Bush,[35] 2008	The use of pancreatic enzyme replacement for patients with cystic fibrosis and pancreatic insufficiency has clear clinical benefit	Efficacy and safety of Pancreaze® for treatment of exocrine pancreatic insufficiency due to cystic fibrosis[36]	Weight gain/ absorption/ nutrition	Supported practice	Measures of fat absorption improved, but ARR and NNT could not be calculated
Mattei,[37] 2013	Intracranial pressure monitoring for severe traumatic brain injury provides useful information that improves outcomes	A trial of intracranial-pressure monitoring in traumatic brain injury[38]	Reduction in mortality	Refuted claim	–
Eljamel,[39] 2010	Photodynamic therapy improves outcomes in glioblastoma multiform	ALA and malignant glioma: fluorescence-guided resection and photodynamic treatment[40]	Reduction in mortality	Supported practice	Progression-free survival at 6 mo increased from 21% to 41%; ARR 20%, NNT 5
Primrose et al.,[41] 2010	Metastasectomy improves outcomes in pulmonary colorectal cancer	Pulmonary metastasectomy in colorectal cancer: the PulMiCC trial[42]	Reduction in mortality	Ongoing	–
Schellinger et al.,[43] 2006	Intra-arterial thrombolysis improves clinical outcomes in acute basilar artery thrombosis	Results of a multicentre, randomised controlled trial of intra-arterial urokinase in the treatment of acute posterior circulation ischaemic stroke[44]	Reduction in mortality	Halted (low recruitment)	–
Hofman et al.,[45] 2014	Peptide receptor radionuclide therapy for neuroendocrine tumours is of clear benefit	NETTER-1 phase III in patients with midgut neuroendocrine tumors treated with 177Lu-DOTATATE: efficacy and safety results[46]	Reduction in mortality	Supported practice	Overall mortality rate decreased from 23% to 12%; ARR 11%, NNT 9
Friedman et al.,[47] 2006	Hyperbaric oxygen therapy improves skin graft healing and survival	Influence of hyperbaric oxygen on the survival of split skin grafts,[48] Changes in arterial flow after flap grafting under various tensions[49]	Rates of skin graft rejection	Mixed	–
Yehai,[50] 2006	Use of ultrasonographic guidance during embryo transfer in in vitro fertilization is obviously beneficial	Ultrasound-guided embryo transfer: a prospective randomized controlled trial[51]	Increased rates of live birth	Mixed	–
Baca et al.,[52] 2011	The benefit of hyperthermic intraperitoneal chemotherapy in peritoneal mesothelioma is so obvious that it is akin to a parachute	Surgery plus intraoperative peritoneal hyperthermic chemotherapy (IPHC) to treat peritoneal carcinomatosis[53]	Reduction in mortality	Completed, no results published	–
McCullough, 2014[54]	The use of sucralfate for oral mucositis is of such great benefit that it should be considered level 1A evidence based on observational studies	Magic mouthwash plus sucralfate versus benzydamine hydrochloride for the treatment of radiation-induced mucositis[55]	Decreased mucositis pain/ discomfort	Ongoing	–
Sharif et al.,[56] 2010	Repair of defective dental restorations with composite restoration should be considered over replacement strategies, despite lack of RCT data	Study of the success and survival of dental composite restorations being repaired instead of being replaced[57]	Dental outcomes	Halted (low recruitment)	–
Cannon et al.,[58] 2005	Use of hygiene education interventions for the prevention of cytomegalovirus transmission is beneficial, akin to a parachute	Clinical trial of behavioural modification to prevent congenital cytomegalovirus[59]	Reduced infection transmission	Completed, no results published	–

Note: ALA = 5-aminolevulinic acid, ARR = absolute risk reduction, IVF = in vitro fertilization, NNT = number needed to treat, NPH = neutral protamine Hagedorn, RCT = randomized controlled trial.

RCTs were halted; and in 4 (18%), RCTs were ongoing. If mixed data were accepted as showing a significant benefit, 11 practices (50%) were supported by identified RCTs.

The remaining 13 medical practices (37%) had not been tested in an RCT (Table 2). Several are long-standing practices, including mechanical ventilation for acute lung injury, emergency airway management and surgical management of acute epidural hematoma; others are recent practices, such as infection-control strategies for the prevention of perioperative skin and soft-tissue infections, perispinal etanercept administration for poststroke neurologic dysfunction and repair strategies for defective dental restorations.

Table 2: Medical practices analogized to parachutes for which no ongoing or unpublished randomized controlled trial was identified

Author	Claim	Clinical outcome of medical practice	Practice could/should be tested by RCT
Diogo et al.,[60] 2015	Having an intensive care unit in a hospital is of benefit	Reduction in mortality	No
Bryce et al.,[61] 2015	Positive results from an observational trial of nasal photodisinfection and chlorhexidine wipes for prevention of skin/soft-tissue infections are sufficient for implementation of practice	Reduced skin infections	Could be subject to RCT
Shah,[62] 2015	Endoscopic decompression of symptomatic cystic duct obstruction is beneficial, akin to a parachute	Reduction of symptoms in symptomatic gallbladder disease	–
Mhyre et al.,[63] 2009	Emergency airway management is a form of "parachute medicine"	Reduction in mortality	–
Tsui,[64] 2014	The benefit of cerebrospinal fluid lavage following intrathecal injection of excess or wrong drugs is so beneficial that it is akin to a parachute	Reduction in mortality	–
Seto et al.,[65] 2015	The use of covered stents for coronary artery perforation is beneficial, despite lack of RCT data	Reduction in mortality	–
Nelson et al.,[66] 2014	Surgical management of acute epidural hematoma is beneficial, despite lack of RCT data	Reduction in mortality	–
Ignatowski et al.,[67] 2014	Perispinal etanercept in the setting of poststroke neurologic dysfunction has therapeutic benefit, despite lack of RCT data	Reduction of neurologic and cognitive dysfunction	Could be subject to RCT
Evers,[68] 2013	In vitro fertilization is effective in couples without a chance of spontaneous pregnancy, akin to a parachute	Increased rates of live birth	–
Harbarth,[69] 2013	Requiring short fingernails among providers will decrease rates of infection transmission	Reduction in infection transmission	Could be subject to RCT
North et al.,[70] 2014	Use of new adhesive for spinal cord stimulator implantation was effective and can be safely implemented under guise of "mechanism-based medicine," akin to a parachute	Reduced stimulator lead migration	Could be subject to RCT
Landucci,[71] 2004	Mechanical ventilation in lung injury is beneficial	Reduction in mortality	–
Sennerby,[72] 2000	Osseointegrated dental implants are beneficial for treating total or partial edentulism, akin to a parachute	Dental outcomes	–

Note: RCT = randomized controlled trial.

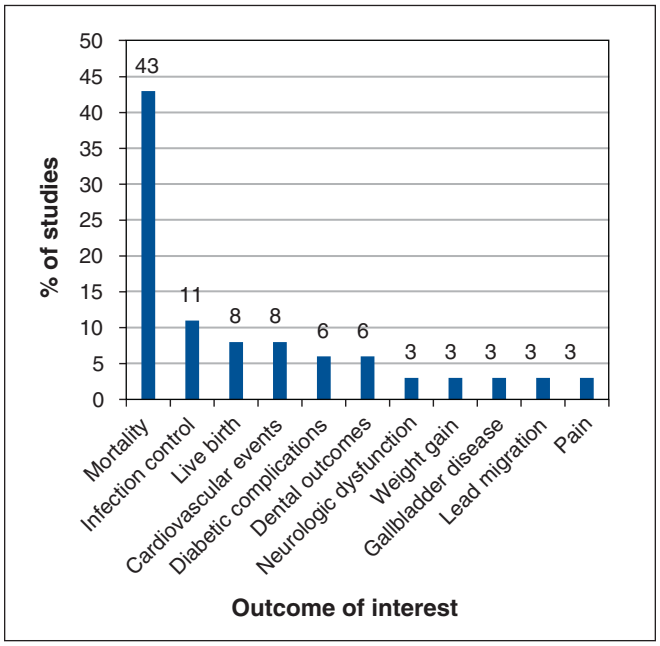

Figure 2: Outcome of interest for medical practices analogized to parachutes.

Mortality or live birth was the clinical outcome of interest for 18/35 practices (51%). A lesser outcome, including infection control, reduced diabetic complications, cardiovascular events, clearance of parasites, pain or discomfort, weight gain, lead migration and effective dental restoration, was the outcome of interest for the remaining 17 practices (49%) (Figure 2).

Among the 6 practices with positive evidence in RCTs, the ARR could be calculated for 5 and ranged from 11% to 30.8%, corresponding to a number needed to treat (NNT) of 3–9. Notably, 3 of the 5 studies concerned mortality or live birth, and 2 reported the ARR for other outcomes.

Interpretation

Over a decade after publication of the article by Smith and Pell,[1] which concluded that RCTs of parachutes or other highly effective practices would be ludicrous, we found few papers citing the article that argued that a medical practice is a parachute. Among those practices, only half referred to a practice whose clinical outcome was mortality or live birth. Of identified practices, more than half have been tested in an RCT, which undermines the claim that the practice is a parachute. Among the remaining practices, RCTs seem possible, even desirable, for several.

In this respect, our findings are similar to those of other empirical analyses. Glasziou and colleagues[73] compiled a list of 16 examples of treatments that are universally considered beneficial and that lack randomized study. Djulbegovic[74] extended this list to nearly 50 examples. Yet what must be acknowledged is that this set of interventions is a tiny fraction of all medical practices: as there are at least 80 000 practices,[5] 50 practices account for just 0.06% of medical interventions.

The proportion of purported parachutes for which RCTs gave a positive result in our study, 50% if mixed trial results are interpreted as positive, is similar to the reported rate of trials with positive results in the setting of genuine therapeutic uncertainty, just over 50%.[75] This suggests that analogizing a medical practice to a parachute is done for practices that are, on average, no more likely to be beneficial than a typical medical practice tested in randomized fashion.

Moreover, previous parachutes in medicine have been shown to be overstated. The philosopher of science John Worrall commented, after listing several medical treatments, including appendectomy for acute appendicitis, "no RCT has ever been performed on any of these treatments and none presumably ever will."[76] Yet there are now 4 RCTs of appendectomy versus antibiotics,[77–80] which suggests that there may be a subset of patients who can be spared surgery. Another example is precision oncology. Experts have claimed that the use of next-generation sequencing to pair patients with cancer with targeted therapies is a medical practice of such great promise that RCTs are unethical.[81] To date, 1 RCT has been conducted for this practice, yielding negative results.[82] In both of these cases, the presence of a RCT, particularly one that gives a negative result, undermines the parachute analogy.

In cases in which the magnitude of benefit was estimable, we found NNT values of 3–9 and ARR values of 11%–30.8%. These gains are smaller than those with parachutes, which have ARR values greater than 99% and NNT values approaching 1. These results suggest that, even when RCTs support the use of the practice, the use of the parachute analogy is inappropriate.

Although more RCTs are being performed per annum than ever before,[83] the idea of the RCT as the pinnacle of evidence-based medicine has been criticized.[84] Moreover, there is growing interest in the use of observational data, including big data and real-world data, to make causal inferences about the efficacy of novel treatments.[85,86] One justification for this interest is that it may not be feasible or ethical to conduct RCTs for highly promising medical practices. Our results provide a reassuring note. Few medical practices have large treatment effects,[5] and even practices believed to be parachutes often are not.

Limitations

Although we performed an exhaustive search of references to the seminal paper by Smith and Pell[1] using a search engine with the widest citation network,[10,11] we may not have captured all instances in which researchers likened a particular practice to a parachute, as many such instances may not have been captured by the use of a single search engine or may have predated the 2003 paper.

Second, and notably, only a small proportion of papers citing the article by Smith and Pell[1] drew a specific comparison to a medical practice. This is largely in part because many researchers cite the paper to criticize generally the importance of RCTs. Nevertheless, this fact is also noteworthy. In over a decade since publication of the article, and although it has generated widespread discussion and interest, few citing papers argue that a practice in medicine is akin to a parachute.

Third, our paper does not imply that RCTs are always feasible, possible, necessary or ethical. We tried to be as objective as possible in our determination of which practices could be tested in RCTs in the future, but we acknowledge the subjective nature of this assessment and the inherent challenges of performing rigorous RCTs. In fact, it is inevitable that there will be situations in medicine in which decisions have to be made in the absence of randomized data.[87] Moreover, as noted by Djulbegovic,[74] there are indeed examples of practices universally thought beneficial in the absence of RCTs. However, our investigation provides further evidence that the number of such practices is few. We also provide a cautionary note: a researcher's belief that an intervention is a parachute seems a poor predictor of actual parachute practices.

Conclusion

Although there is widespread interest in the idea that some medical practices are like parachutes — with a magnitude of benefit so large and obvious that RCTs are unnecessary — few biomedical authors compare a specific medical practice to a parachute. When they do, over half refer to a practice that has been tested with an RCT, and half refer to an outcome of lesser importance than overall survival, findings that undermine the claim that the practice is a parachute. When RCTs have been conducted and estimate effect sizes, practices analogized to parachutes have ARR values that are smaller and NNT values that are larger than those for parachutes. Although we found that the parachute analogy is seldom used to describe a medical practice, when it is used it is often inappropriate, incorrect or misused.

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