Clin Orthop Relat Res (2008) 466:2861–2872
DOI 10.1007/s11999-008-0458-2

ORIGINAL ARTICLE

Myths and Legends in Orthopaedic Practice

Are We All Guilty?

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Received: 3 January 2008 / Accepted: 4 August 2008 / Published online: 26 August 2008

Abstract Over years of practice, many beliefs and practices become entrenched as tried and tested, and we subconsciously believe they are based on scientific evidence. We identified nine such beliefs by interviewing orthopaedic surgeons in which studies (or lack thereof) apparently do not support such practices. These are: changing the scalpel blade after the skin incision to limit contamination; bending the patient's knee when applying a thigh tourniquet; bed rest for treatment of deep vein thrombosis; antibiotics in irrigation solution; routine use of hip precautions; routine use of antibiotics for the duration of wound drains; routine removal of hardware in children; correlation between operative time and infection; and not changing dressings on the floor before scrubbing. A survey of 186 practicing orthopaedic surgeons in academic and community settings was performed to assess their routine practice patterns. We present the results of the survey along with an in-depth literature review of these topics. Most surgeon practices are based on a combination of knowledge gained during training, reading the literature, and personal experience. The results of this survey hopefully will raise the awareness of the selected literature for common practices.

Each author certifies that he or she has no commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

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Introduction

During our years of practice, many of our beliefs and practices become entrenched in our system and we subconsciously believe they are based on science. The history of medicine is ripe with examples of these practices such as trephination and blood letting, to name a few. The practice of orthopaedic surgery is no exception. The use of evidence-based medicine is now recommended for our practices, yet we continue to do things for which there may be no available supporting scientific data. Previous studies have examined myths in medicine including public health law [45], the US healthcare delivery systems [24, 111], and disaster management [3].

The purposes of this article were to examine the extent to which a specific selection of such practices was being followed by a group of orthopaedic surgeons and to explore whether these orthopaedists were aware of the scientific literature on these topics. We hypothesized there would be variation in adherence of orthopaedic surgeons to these potentially unproven beliefs, but that community-based surgeons would be more likely to adhere to them. Additionally, we hypothesized that a majority of orthopaedic surgeons questioned generally would be unaware of the literature available in support or rebuttal of these practices. A similar survey on the use of tourniquet pressures showed that most surgeons used pressures higher than necessary to obtain a bloodless field in surgery. This was attributed to one's training and the fact that most surgeons do not see major problems associated with such practice [124]. However, it does raise an important question from the point of scientific practice and in training students and residents not to accept convention, but to question and expect the use of scientifically proven practice.

Materials and Methods

In consultation with colleagues from the department of orthopaedics at our institution, we were able to identify nine common traditional beliefs in orthopaedic surgery for which we could find in limited searches that little or no evidence exists, and in some cases, there is enough evidence to abandon the practice. We also decided to mix some minor issues (change of surgical blade after incision) with major issues (continuation of antibiotics for drain retention beyond the standard postoperative protocol). The idea was to see if orthopaedic surgeons followed certain practices as a matter of habit and usual and customary practice. We are aware there are multiple such practices, but we decided to choose these nine questions as they pertain to the most commonly seen or used practices in day-to-day patient care.

We distributed an Institutional Review Board-approved web-based survey (www.surveymonkey.com) to 250 members of the Orthopaedic Trauma Association and to a sample of academic ($n = 50$) and community-based ($n = 50$) orthopaedic surgeons attending continuing medical education conferences. All responses were collected anonymously and the surgeons were asked if their practice was academic or community based. We asked respondents to reply with a yes or no when questioned whether they follow each of the nine practices in orthopaedic surgery. These questions were: (1) Do you change the scalpel blade after making a skin incision?; (2) Do you bend the patient's knee while applying a thigh tourniquet?; (3) Do you believe patients with deep vein thrombosis should be prescribed bed rest?; (4) Do you use antibiotics in the irrigation solution during surgery?; (5) Do you use any hip precautions after THA?; (6) Do you routinely use antibiotics postoperatively beyond the first 24 hours for wound drainage or drains?; (7) If you use open reduction and internal fixation for fractures in children, do you believe the hardware should be routinely removed?; (8) Do you believe there is a correlation between surgical time (beyond routine time) and infection?; and (9) Do you personally avoid changing dressings on patients on the floor before doing a clean case such as joint arthroplasty?

We also asked them to specify if they were aware of existing literature to support their answer by choosing one of the following four options: (1) I am able to cite literature in support of this answer; (2) I am sure literature exists that supports this answer, but I cannot cite it; (3) there is no literature that supports this answer; or (4) I do not know. Demographic information, including years in practice and whether the self-reported setting of practice was community- or academic-based also was collected.

We analyzed the results using Fisher's exact test (GraphPad Prism software, GraphPad Inc, http://www.graphpad.com/). We examined the percentage of the respondents' adhering to a specific practice, and then further analyzed the percentages of those being academic or community surgeons. Additionally, we looked at the percentages of surgeons reporting knowledge of the literature and examined for any relationships between the practice model and self-reported knowledge of the literature among the respondents. Within academic and community surgeons, percentages were analyzed for each of the following: surgeons who followed a specific practice and believed literature supported their choice; surgeons who did not follow the practice and believed there was literature to support their actions; and surgeons who reported knowledge of the literature and did not follow the practice. Percentages of each in academic and community physicians were compared for any statistical difference.

The two of us conducted a literature search using the PubMed database for each of the nine subjects. The key words used were those used in each question; we also used: "myths in medicine; orthopaedics myths; evidence based medicine." We identified more than 5000 articles, but narrowed these to 850 articles relating to the topics in question. These then were reviewed and the final number (139) is presented in the bibliography. The selection criterion for use of the article was whether it supported, refuted, or was neutral to the topic in question. We used the same criteria for all nine questions individually. Our purpose was not to create an all-encompassing bibliography but rather to determine whether any literature existed on a specific topic, and the overall message of this literature. In some cases, a few current review articles or a recent randomized study would suffice. The key words were those used in the question. The reference sections of each of the articles were reviewed for additional references. Only English-language articles were included.

Results

One hundred eighty-six completed responses were received from the 350 invitations (53% response rate). Of them, 111 (60%) respondents stated their practice was academic-based, and 75 (40%) stated theirs was primarily a community-based practice. Two hundred forty (70% response) actual responses were received; however incomplete responses (54) were eliminated (Table 1).

Fifty-six percent of the respondents reported changing the scalpel blade after the skin incision, and more ($p = 0.0027$) community than academic surgeons ascribed

Table 1. Summary of results

Practice	Surgeons following the practice		Surgeons not aware of existing literature on the topic		Surgeons who follow the practice and believe there is literature to support it		Surgeons who do not follow the practice and believe there is literature to support them doing so		Surgeons claiming knowledge of literature and do not follow the common practice	
	Academic surgeons	Community surgeons	Academic surgeons	Community surgeons	Academic surgeons	Community surgeons	Academic surgeons	Community surgeons	Academic surgeons	Community surgeons
Blade Change	47%	69%*	81%	83%	30%	10%	9%	29%*	26%	63%
Bending the knee with tourniquet	68%	83%*	68%	77%	32%	27%	31%	0%	32%	0%*
DVT and bed rest	71%	68%	51%	67%	52%	38%	48%	30%	67%	67%
Antibiotics in irrigation	36%	57%*	32%	27%	67%	55%	77%	80%	68%	63%
Hip precautions	86%	96%*	37%	30%	65%	71%	50%	67%	12.1%	6.5%
Antibiotics for wound drainage	45%	41%	47%	50%	44%	50%	50%	50%	63%	61%
Hardware removal in pediatrics	45%	53%	66%	58%	44%	30%	27%	55%*	44%	63%
Operative time and infection	90%	91%	26%	26%	76%	79%	50%	25%	6%	3%
Avoiding dressing changes	43%	67%*	81%	84%	24%	22%	15%	6%	44%	14%

*$p < 0.05$; DVT = deep venous thrombosis.

to this practice. Among orthopaedic surgeons who reported not changing the scalpel blade, more ($p = 0.049$) community than academic surgeons believe there is literature to support what they do.

Seventy-four percent of the orthopaedic surgeons reported regularly bending the knee before application of the thigh tourniquet. More ($p = 0.0265$) community than academic orthopaedists regularly follow this practice (Table 1). Of the surgeons who reported knowledge of existing literature on the topic, more ($p = 0.0411$) academic than community surgeons reported not bending the knee before tourniquet application.

Thirty-one percent of the respondents reported regularly prescribing bed rest in the treatment of deep vein thrombosis (DVT). There were no differences between academic and community surgeons with respect to following this practice or their knowledge of the literature.

Fifty-six percent of the respondents regularly use antibiotics in the irrigation solution during surgery, but fewer ($p = 0.0063$) academic than community surgeons do so. Among the surgeons who reported knowledge of existing literature on this topic, the majority of academic and community surgeons did not use antibiotic irrigation solutions.

The majority of orthopaedists (90%) who responded to the question routinely prescribe hip precautions to their patients. A smaller ($p = 0.0377$) percentage of academic orthopaedists compared with community orthopaedists reported doing so (86% versus 96%). Forty-four percent of respondents regularly prescribe antibiotics postoperatively while the wounds are still draining with no difference between academic and community surgeons.

Forty-eight percent of orthopaedic surgeons who responded believe in routine removal of metalwork in pediatric patients and the numbers were similar for academic and community orthopaedic surgeons. Among those who do not routinely remove orthopaedic implants from children, fewer ($p = 0.0331$) academic than community surgeons report being aware of published literature on this topic. Among the surgeons who reported knowledge of the literature, similar numbers of academic and community surgeons leave the implants in.

The majority (91%) of orthopaedic surgeons who responded believe there is an association between longer operative time and infection. There was no difference between academic and community surgeons in this regard.

Fifty-three percent of orthopaedic surgeons reported they routinely avoid changing dressings on their floor patients before scrubbing in the operating room. More ($p = 0.0024$) community than academic surgeons reported doing so. Of those who routinely avoid dressing changes, approximately one quarter believe scientific literature supports doing so.

Literature Review

Blade Change

It is common practice among surgeons of all specialties to discard the scalpel blade used for the skin incision and to use a fresh blade for deeper dissection, the logic being although the skin surface is rendered sterile by preoperative scrubbing, as much as 20% of skin bacteria may remain in skin sweat glands and hair follicles and are potentially the source of wound flora [40, 115, 130]. However, evidence suggests the practice of changing the blade is unnecessary [26, 40, 50, 57, 60, 88, 102, 119].

Investigators cultured skin and deep dissection blades in orthopaedic surgeries and reported no correlations among contaminated skin blades, deep blades, and wound infections [40, 102]. A prospective, randomized study of 586 patients showed no difference in wound infection rates between one- and two-blade surgeries and only one positive blade culture [57].

It is not clear if these data can be extended to contaminated orthopaedic cases such as open fractures. The economic impact of discarding a scalpel blade is minor compared with other surgical costs. Nonetheless, it is a good example of a common practice that continues despite evidence pointing to the contrary.

Bending the Knee

Most orthopaedic surgeons (74%) flex the patient's knee and extend the patient's hip before applying a thigh tourniquet. They do this believing inflating the tourniquet can cause binding of the quadriceps muscle and the femoral nerve. Many surgeons also deflate the tourniquet before assessing patellofemoral stability and extend the knee before application of the tourniquet when operating on the hamstrings [58]. To date, there are no PubMed-indexed studies proving the quadriceps-binding phenomenon exists. To the contrary, Herald et al. reported quadriceps motion is not restricted by a thigh tourniquet [58]. They injected small air bubbles into the quadriceps muscle proximally to the thigh tourniquets. Ultrasound was used to track the movement of the air bubbles as the knees were ranged passively and actively before and during application of the tourniquet. No difference in the translation of the air bubbles was detected as a result of application of the thigh tourniquet showing quadriceps binding does not occur [58].

Deep Vein Thrombosis—Bed Rest

Despite the belief (31% of all respondents) that patients with DVT should be prescribed bed rest in addition to chemical prophylaxis potentially to prevent pulmonary embolism [113], the evidence suggests otherwise. One prospective study examined 126 patients with acute proximal DVT randomized to strict bed rest and elevation or early mobilization and found no difference in the incidence of pulmonary embolus as detected by lung scintigraphy [113]. Two other prospective, randomized trials comparing bed rest with immediate mobilization reported walking made no difference on the incidence of pulmonary emboli [9, 97], and in one study, early mobilization promoted considerably faster resolution of leg pain and swelling [97]. Finally, a large prospective cohort examined 1289 consecutive patients with acute DVT treated with low-molecular-weight heparin, oral anticoagulation, and immediate stocking compression and ambulation and found a low complication rate with this approach leading the authors to recommend their algorithm as safe, effective, and superior to bed rest [96].

Antibiotic Irrigation

A major risk of wound infection exists with open fractures, and a smaller yet still substantial risk of wound infection follows clean orthopaedic surgery, primarily with Gram-positive species [108]. As a result, it is current practice to use antibiotics in combination with wound irrigation. Questions remain regarding the appropriate volume, technique, and antiseptic or antibiotic solutions of the irrigation fluid.

However, in vitro evidence obtained by Anglen et al. argues otherwise [5, 8]. They reported antibiotic solutions were no more effective in removing slime-producing Staphylococcus from stainless steel screws than saline. Similarly, neomycin and bacitracin solutions were no more effective than normal saline in removing bacteria from bone, titanium, and stainless steel [5].

In vivo, power irrigation with bacitracin proved no more effective than normal saline in reducing superficial, deep, or implant infection in a rat paravertebral wound model with a stainless steel implant inoculated with Pseudomonas aeruginosa or Staphylococcus aureus [28]. In a review of animal studies, Dirschl and Wilson reported conflicting evidence to support the use of antibiotics [33]. Several of the studies they reviewed suggested combination solutions reduced rates of infection after antibiotic irrigation [33].

Several reviews of literature [6, 33, 47, 109] suggest many of the available clinical studies are of poor quality and the evidence is not enough to support the use of antibiotics in irrigation solutions. Numerous studies are from general surgery or related fields in which antibiotics are instilled into isolated body cavities, a situation different from orthopaedic surgery [33].

A recent prospective, randomized study of 400 patients examined bacitracin versus sterile soap irrigation of open fractures [7]. There were no major differences in infection rates after a followup of more than 1 year, but the antibiotic group had a considerably higher rate of wound healing problems [7].

Overall, the evidence supporting the use of antibiotics in wound irrigation in orthopaedics is not convincing. Although toxicity and adverse reactions to antibiotics are rare, they do occur [6, 33]. Theoretical concerns of promotion of antibiotic resistance, coupled with major costs of antibiotic irrigation are also important.

Hip Precautions

Hip dislocation is one of the most common complications of THA. The rate of dislocation varies from 0.5% to 11.2% [4, 22, 44, 51, 71, 77, 79, 83, 122, 134, 135]. Various factors contribute to a dislocation, including surgical technique, surgical skill, the type of prosthesis, alignment, surgical approach, revision surgery, and a history of neuromuscular disorders [4, 22, 35, 77, 82, 134]. An exhaustive search of PubMed-indexed articles failed to reveal good evidence supporting hip precautions to decrease the rate of dislocations.

The standard hip precautions limit flexion, internal rotation, and adduction, but the reported protocols may differ in some details [44, 71, 79]. These constitute the mechanisms responsible for the posterior dislocation, which is the dominant mode of hip dislocation after THA [35, 77]. Anterior dislocation occurs rarely with the posterior approach but may be the dominant mode of dislocation if the anterior approach to the hip is used [134]. These two modes of dislocation were examined in a worst-case scenario finite-element computer simulation [83]. Maneuvers studied included those at risk for posterior dislocation (adduction, flexion, internal rotation) and anterior dislocation (extension and external rotation). All of these maneuvers led to a high rate of dislocations lending theoretical credence in support of hip precautions. Further evidence in support of hip precautions comes from observations that patients with cerebral dysfunction (alcoholism, confusion, dementia) have higher rates of dislocations, perhaps as a result of poor compliance with precautions [77, 135].

There are no published data on patient compliance with the precautions. It has been suggested shorter hospital stays may be associated with more frequent dislocations as a result of less patient supervision and subsequent poor compliance [79]. Although the majority of dislocations in that study occurred after discharge, there was no correlation between length of stay and dislocation rate [79].

A prospective series of 499 primary THAs performed through the anterolateral approach were evaluated for dislocation rate within 6 weeks of surgery [122]. The patients were told they had no restrictions and were encouraged to move and sleep in any way they found comfortable. The authors recorded a low rate of early dislocations at 0.6%.

Hip precautions represent a major lifestyle modification to most patients and probably contribute to morbidity after THA. Many orthopaedic surgeons recommend them for all their patients undergoing THA, but there is no scientific evidence available to support such practice. Hip precautions may be warranted in patients with hip arthroplasties prone to dislocation, for example, in patients with poor muscular tone or with an ill-fitted prosthesis.

Antibiotics for Wound Drainage and Drains

The most recent systematic review of closed suction drainage in orthopaedic surgery pointed out too little evidence is available to argue for or against the practice [95]. This practice is based on more than hearsay; we have been able to find at least one instance of a published recommendation to "use prophylactic antibiotics at least until drain removal" [36]. The major evidence for this assertion seems to derive from several bacteriologic and animal studies [23, 76, 103]. Additionally, two retrospective studies suggested an increase in infections associated with the use of drains in general surgery [23, 31].

Positive drain tip cultures and risk of wound infections increase with increasing drainage time over 6 days [117]. Another study examining bacterial flora associated with drains reported that of 32 patients who had bacteria in the drain fluid or the tip of the drain, only one had a wound infection develop, and 16 had wound symptoms not regarded as important to justify treatment [73]. Both studies noted a decrease in bacterial contamination and infection rates if prophylactic antibiotics were used [73, 117], which may have been construed as evidence that antibiotics are needed to prevent drain-related contamination. However, neither of the studies evaluated antibiotic use for the entire duration of drainage, but rather no longer than 12 hours postoperatively [73, 117]. Another article reported an association of less frequent wound breakdown in drained wounds with antibiotic use in obese gynecologic patients [41].

Multiple studies have been published in the orthopaedic literature comparing the results of drainage with no drainage [1, 2, 10, 13–15, 17, 19, 27, 30, 38, 42, 48, 53, 55, 59, 61, 63, 66, 68, 69, 72, 86, 93, 94, 98, 105, 107, 112, 123, 126, 128, 132, 133, 137, 138]. Unfortunately, none compared various antibiotic protocols. A prospective study in cardiovascular surgery reported no benefit to extending

antibiotic use beyond 48 hours [56]. In the orthopaedic literature, one study compared the efficacy of a single preoperative dose of cefazolin with one preoperative and two postoperative doses of cefuroxime at 8 and 16 hours in joint arthroplasties [123]. This retrospective review of 1367 operations reported no difference in infection rates between the two groups. The authors stated drainage tubes were used in all cases, but did not specify the time that the drain tubes remained impanted [123].

The effectiveness of antibiotics in prevention of drain-potentiated wound infections should be questioned because not all antibiotics can effectively penetrate hematoma and wound fluid [85]. If an antibiotic penetrates the wound being drained, its concentration is lower than the serum concentration and may be below the minimum inhibitory concentration [85]. In addition, several studies suggest prolonged use of postoperative antibiotics may actually increase infection rates [78, 127] and promote antibiotic resistance [56].

There is no evidence to support the potentially harmful practice of administering routine antibiotics for the duration of wound drainage.

Hardware Removal in Pediatrics

Removal of orthopaedic implants constitutes a considerable part of the orthopaedic practice [16, 18]. In pediatrics, numerous authors have described routine removal of all implants [20, 21, 114]. The majority of implant removals are elective [64, 114]. However, despite the prevalence of implant removal, there is little hard evidence to support routine implant removal.

The prime reason for fracture fixation implant removal is the periprosthetic bone resorption resulting from stress shielding in accordance with Wolfe's law and the subsequent increased risk of fractures, possible bone overgrowth making subsequent removal difficult. Nonetheless, there have been but a few case reports of fractures associated with implants [106]. In a series of contact sport players who returned to playing rugby within a few months after fracture fixation, only one of 15 athletes sustained a fracture in the area proximal to the radial diaphyseal plate [39]. However, there is some evidence to suggest the refracture rate after plate removal is of major concern and can be as much as 21% [12, 64]. In children, the refracture rate after implant removal has been reported close to 1% [74, 114]. compared with the overall 8% to 11% morbidity rate.

Another issue concerning retained hardware is a possibility of malignancy. Although there is evidence of metal implants causing tumors in animal models, there have been only a few such cases reported [80]. The majority of such cases involve an articulating implant such as a hip or a knee prosthesis, which is more likely to create metal ions, which are carcinogenic in animal models. Nonetheless, McDonald et al. did not elicit any positive association between orthopaedic implants and cancer risk [80]. This risk is even less in the case of static implants such as fracture fixation devices [64], which are more likely in the pediatric setting.

Long-term infection rates associated with hardware are between 1% and 2% [52, 129, 131]. However, it is unclear if this issue is better addressed by preemptive metal removal or removal on the diagnosis of infection. Moreover, the rate of superficial wound infection after implant removal can be quite high [110].

The issues of metabolic toxicity and allergy metal have been discussed in the literature. Metal ions believed associated with implants have been identified in various human tissues and secretions [64], but no cases of proven toxicity have been reported. Likewise, literature examining the issues of hypersensitivity showed no clear evidence of any such effects of these ions [54, 120].

The current literature contains little evidence supporting routine metal removal. Routine implant-removal surgeries are associated with major complication rates [110]. The risks associated with these surgeries, coupled with a major financial burden, call for orthopaedic surgeons to take a closer look at their practice and to reevaluate it based on the available evidence.

Operative Time and Postoperative Infection

The correlation of operative time and postoperative infection is important because numerous factors such as resident teaching, use of new techniques unfamiliar to the surgeon, and the increasing prevalence of bilateral elective procedures may increase operative time. The orthopaedic literature is equivocal on this subject [37, 49, 81, 116, 121, 136]. Two retrospective analyses of infections in patients undergoing TKA, one including 100 patients and another 243 patients, reported no correlation between length of surgery and infection [49, 121]. Similarly, one study of 367 total joint arthroplasties in patients with rheumatoid arthritis and another including 110 patients undergoing lower extremity tumor surgeries examined infection rates, but operative time was not an important factor [37, 81]. Finally, a large prospective study that included 362 knee and 2651 hip arthroplasties did not find operative time a major risk factor for infection [136].

In contrast, operative time was a predictor of infection in a study performed by Peersman et al. that included 6489 TKAs during a 7-year period [99]. A prospective study encompassing 376 patients undergoing various orthopaedic

procedures failed to find operative time to be an independent risk factor for infection with the exception of operative time over 4 hours in spine fusions [116]. In yet another study including 41 patients undergoing spine surgery with infections and 178 noninfected control subjects, operative time was correlated but was not an independent risk factor for infection [91].

de Boer et al. reported contradictory findings in a large multivariate analysis of infection risk factors in TKAs and THAs with infection rates being associated with shorter operative times in TKAs, although no major association was identified for THAs [32].

The studies cited previously seem to suggest operative time is an indicator rather than an independent risk factor for wound infection. Wound infection occurs in a minority of cases and is multifactorial. Operative time is likely a minor player, and thus larger, more powerful studies are needed to elucidate its effects. Moreover, as the value of perioperative antibiotic administration becomes clear, repeat administration of antibiotics during lengthy procedures may further confound the data and possibly diminish whatever the increased risk may be. Additional studies are needed to determine the independent effect of operative time on surgical infections.

Avoiding Dressing Changes

Resident surgeons are routinely taught to avoid changing an infected patient's dressings before operating on a clean case such as a joint arthroplasty on the same day. We were not able to find specific references to such recommendations, yet this practice is real and widespread (53% of all respondents).

The reason behind the practice is changing dressings on the floor will contaminate the surgeon's hands, which then could promote infection in the surgical patient. Tangential support to this argument can be gleaned from the literature [11, 29, 34, 43, 70, 75, 84, 87, 89, 92, 100, 104, 125]. The hands of physicians are a known link in the transmission of nosocomial pathogens [70]. In the absence of gloves, there is a considerable increase in bacterial contamination of healthcare workers' hands after patient contact [75, 87, 100]. Numerous studies have investigated the rates of hand contamination after patient care, and hand contamination may occur even if gloves are worn [11, 29, 34, 43, 75, 84, 87, 92, 101, 125].

The evidence mentioned previously may lead an infection-wary surgeon to suppose patient contact before surgery should be avoided. However, in one study, hands of healthcare workers from different wards cultured immediately after patient care-related procedures had similar rates of contamination whether there was direct patient contact or contact with the patient's environment. Moreover, contamination rates were considerably higher in healthcare workers occupied with nonpatient care tasks such as housekeeping. The authors hypothesized this likely was attributable to decreased frequency of hand washing in the absence of patient contact [75]. They suggest hand contamination on the medical wards may occur regardless of the type of contact, and the hospital environment may be just as contaminated as a patient's wound.

High bacterial colony counts are present on the hands even before patient contact, and these bacteria are frequently potential pathogens [87]. Bacteria are present on the hands of most surgeons before the surgical scrub, and it is vitally important that proper hand scrubbing procedures are followed [25, 89, 118]. Unfortunately, compliance with proper handwashing and scrubbing is poor [65, 67, 139].

Handwashing with soap or various disinfectants generally is effective in removing most bacteria from the hands [46, 62, 90], and a 5-minute scrub is effective and sufficient to disinfect the hands of the surgeon [89]. Avoidance of patient contact may instill a false sense of security and should not be considered part of practice.

Discussion

We wished to examine the extent to which a specific selection of myths in orthopaedics was being followed by orthopaedic surgeons and to explore whether these orthopaedists were aware of the scientific literature on these topics. We hypothesized that there would be variation in adherence of orthopaedic surgeons to these potentially unproven beliefs, but that community-based surgeons would be more likely to adhere to them. Additionally, we hypothesized that a majority of orthopaedic surgeons questioned generally would be unaware of the literature supporting or rebutting these practices.

The survey portion of our study is limited by the relatively small sample of orthopaedic surgeons surveyed, with only a 53% response rate. However, as none of the surveys were sent out again, this is an acceptable first response rate (the total response rate was higher but incomplete responses were eliminated). Nonetheless, our purpose was not to ascertain the practices of the entire profession, but rather to get an overall sense of how frequently the nine myths are followed and what the differences are in adherence and literature knowledge between samples of academic and community-based physicians. Another limitation was the lack of a systematic review of the literature. As we noted, our purpose was not to create an all-encompassing bibliography but rather to determine whether any literature existed on a specific topic, and the overall message of this literature. In some cases, we used a

few current review articles or a recent randomized study. We used only PubMed for the literature search and focused on English-language peer-reviewed literature, and chose PubMed because of its widespread use among physicians. We recognize that we could not have captured the entire body of the literature available as PubMed does not include abstracts from conferences, but we thought it was important to focus on peer-reviewed publications for our literature review. We did not conduct a formal meta-analysis, but we did make an effort to capture all articles that could have supported either side of the argument, and believe our selected review represents a true and even-sided review of the literature. We also recognize the nine topics chosen are not representative of all of orthopaedic surgery. Some of the topics chosen are probably not as clinically relevant as others, for example, changing the knife blade is minor, but the continued use of antibiotics is more problematic. Although our review refuted certain beliefs like bending the knee during tourniquet inflation, or using antibiotics in irrigation solution, we were unable to conclusively define other myths in our literature search. Also, not all topics have clear-cut evidence-based

Table 2. Summary of literature

Practice	Summary of the Literature	
	Supporting the practice	Refuting the practice
Blade Change	Bacteria are retained in hair follicles and sweat glands	Cultured superficial blades are not correlated to infections; a randomized study of one- and two-blade surgeries did not show an increase in infections
Bending the knee with tourniquet	None found	An experimental study showed quad binding does not occur
DVT and bed rest	None found	Several large clinical studies showed early mobilization to be safe, and a randomized prospective trial showed it to promote earlier resolution of leg pain and swelling without an increase of complications
Antibiotics in irrigation	In vitro and several animal studies support the effectiveness of antibiotics in irrigation; some studies from general surgery support its use in body cavities	In vitro studies using bone or metal surfaces failed to show antibiotics' superiority in removing bacteria. A randomized prospective study compared soap with bacitracin irrigation in human orthopaedic surgery and found no difference in infections but higher wound complications with bacitracin.
Hip precautions	Higher rates of dislocation associated with poor compliance or neuromuscular conditions in many series; biomechanical simulation models predict dislocations with high-risk maneuvers.	Prospective study showed low rate of dislocations when no hip precautions were used with an anterolateral approach to the hip
Antibiotics for wound drainage	In vitro and animal studies suggest that suction drains represent an entryway for bacteria and antibiotics may reduce infections. Some clinical studies in gynecologic and general surgery patients support this.	No study evaluated this issue directly, but one study found that extending antibiotics from 8 hours to 16 hours did not make a difference in infections despite the use of drains. Penetration of antibiotic into the hematoma may be insufficient.
Hardware removal in pediatrics	Several case reports of fractures associated with implants and case reports of malignancies associated with implants. Long-term risk of infection associated with implants.	Series reporting high rate of refracture after hardware removal; series with high rates of wound infection after hardware removal; risk of malignancy not detected in large clinical studies; no proven cases of ion hypersensitivity
Operative time and infection	Several studies in general surgery, and one retrospective study in orthopaedic surgery showed a correlation of operative time and infection	Numerous prospective and retrospective studies failed to detect an increase in infection with operative time in orthopaedic surgery
Avoiding dressing changes	Multiple studies show hands to be a leading source of contamination	One study showed higher rates of hand contamination in healthcare workers not involved in patient care; multiple studies showed hand-washing and surgical scrubbing to be effective in decontaminating the hands of surgeons

DVT = deep venous thrombosis.

literature, such as the belief for pediatric hardware removal or the use of hip precautions, and it does not necessarily mean that it is a wrong belief.

As seen in our results, there was substantial variation for some of the practices between surgeons identifying themselves as academic or community practitioners. Community-based physicians were statistically more likely to ascribe to five of these suspect practices than self-described academics. It was not a goal of our study to find causes for such a discrepancy, but we hypothesize that perhaps community-based surgeons have fewer incentives to update their practices, and as such must work harder to not let the pressures of private practice eclipse the basic need for state-of-the-art patient care.

As shown in the results, substantial percentages of surveyed orthopaedic surgeons reported no knowledge of the literature, or believed there was literature to support one of these nine practices. Our literature review (Table 2) shows the lack of convincing evidence for all nine practices, and in some cases, presents clear evidence in rebuttal of the myths.

We conducted this survey using some common beliefs and practices. This can be applied to numerous procedures considered routine or taken for granted and could have been included in this survey instead of some of the procedures we used. Some of the issues are major, ie, use of antibiotics after wound drainage; and some are minor ie, blade change after making an incision. However, the purpose was to show that we apply the same logic to any entrenched practice that continues despite evidence to the contrary. The use of antibiotic irrigation, prolonged postoperative antibiotic use, and excessive removal of hardware all have clinically important side effects, and changing from the wrong way to the right way will have dramatic benefits.

Our survey shows many orthopaedic surgeons, whether community or academic based, continue to follow some of the traditional teachings of the field, in many cases perhaps harking back to the original training during residency. Some of these teachings have since been proven incorrect whereas others remain controversial. In all cases, we could find no definitive scientific evidence to support the practice of any of the nine topics reviewed in this article. However, it is virtually impossible for a surgeon to keep up with the vast amount of new research that is scattered among many orthopaedic and other specialty journals, as seen in our study, because many of the surgeons surveyed were unaware of the available literature on the subjects mentioned here. As the entire field of medicine is moving toward evidence-based practice, orthopaedic surgery must not be far behind. Thus, it is imperative orthopaedic surgeons continue the lifelong practice of learning and adjusting their practice based on available evidence.

Acknowledgments We thank the members of the NYU Hospital for Joint Diseases, Department of Orthopaedic Surgery, for their valuable insight during the brainstorming phases of this project.

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