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Editorial

The economics of global COVID vaccine administration during a pandemic – Why continue skin alcohol preparation as a costly but ineffective practice?



In addition to the considerable morbidity and mortality due to COVID-19, the pandemic has consumed medical resources at an alarming rate. The need for a truly mass global immunization program will consume billions of dollars. As one example, nurses, already in short supply prior to the pandemic, have been in particularly high demand. This has resulted in nurses being offered additional shifts with large bonuses and incentivized travel-nursing opportunities with pay rates double the pre-pandemic rates, which significantly add to healthcare costs [1]. This specific example is but one aspect of vaccine delivery that underscores the imperative of national and global cost and resource efficiency as we battle this pandemic. As vaccines are rolled out, given the global scale of this pandemic, efficiencies of effort and process have rarely been so important.

In the US, we have become accustomed to and expect cleansing/preparation of the skin with alcohol swabbing prior to vaccination. While preventing infection is a paramount consideration for patients and healthcare providers, there are in fact no data to support routine skin preparation using alcohol swabbing for subcutaneous or intramuscular injections. Absent visibly dirty skin, there is no need to prepare the injection site with alcohol or other anti-septic cleansing prior to vaccination [2–4]. Although omitting the skin-preparation step prior to vaccination has been recommended by UK [5] and Australian Health Authorities [6], as well as the World Health Organization (WHO) since 2003 [7,8], the Centers for Disease Control and Prevention (CDC) continues to recommend the use of an alcohol or other antiseptic wipe on the skin prior to immunization (or other small-volume therapeutic self-injections) [9]; and the US Advisory Committee on Immunization Practices (ACIP) has remained silent on this issue [10]. Skin preparation by alcohol swabbing, which persists as standard practice for administering vaccines and self-injection of therapeutics in many regions worldwide, is simply not evidence-based and is likely to be unnecessary [11,12].

- Healthcare providers in the United States are taught—and a recent check among the major U.S. pharmacy chains confirms—a protocol of wiping the skin for 30 s with an individual alcohol wipe and letting it dry for 30 s. Incomplete drying of skin before needle injection may introduce alcohol into the tissue and consequently increase the level of injection-associated

pain [13]. We estimate that skin preparation adds roughly 90 s to each injection, including vaccinations. To date, no study has demonstrated any value to antiseptic skin preparation prior to injection with a vaccine, and one study has demonstrated that it leads to increased pain [14]. Although the approximately 60 total seconds recommended for alcohol (or other antiseptic) wiping/drying and 30 additional seconds for the associated process for each patient prior to vaccination seems trivial, consider this in the current context of a pandemic. Because COVID-19 immunization is likely to require two intramuscular immunizations, there are a significant number of injections required nationally and globally to immunize the population. The unnecessary step of skin preparation adds an avoidable, massive amount of time and effort, which may lead to either the reduction or omission of the required drying period. This could potentially result in increased pain and local vaccine injection site side effects. Furthermore, we should not overlook the risks associated with contamination of disinfectants and conceivable problems caused by their unsafe use across various healthcare settings [15,16]. Nonetheless, others have pointed out that deimplementation of established but ineffective practices is difficult in general [17–20], and discontinuing the unfounded use of alcohol swabs pre-injection is no exception: 78% of healthcare workers surveyed at a UK hospital persisted with this procedure despite issuance of a local policy to halt it eight years prior [21]. Other examples in vaccine practice include the difficulty in abandoning aspiration and “skin bunching” during routine IM immunization—techniques still regularly observed despite evidence of no benefit and possible harms [9,22,23].

- The necessity of skin preparation before injection of any kind has long been a topic of debate [24,25]. Randomized trials evaluating the efficacy of skin preparation for SQ/IM injections are sparse, but the totality of the evidence generated through both randomized and non-randomized uncontrolled studies supports the futility of skin preparation [7]. The first study questioning its benefits did not report any cases of infection when >5,000 injections were administered without prior skin disinfection [2]. Several other studies, which evaluated the safety of omitting alcohol swabbing before insulin injection, did not identify evidence of any increased incidence of infectious complications [26,27]. Despite demonstrating an 82–91% decrease

in skin bacterial counts after isopropyl alcohol preparation, neither local nor systemic signs of infection were evident across 1,700 insulin injections in another study [28]. Similarly, no rise in the number of skin infections has been observed when omitting isopropyl alcohol swabbing before botulinum toxin type A injections [29,30]. Additionally, in a single-blinded study of 196 patients, randomization to skin preparation versus no skin preparation revealed no adverse effects associated with foregoing skin cleansing [31]. A recent randomized controlled trial that assessed the efficacy of the alcohol-wiping practice prior to immunization in 170 children did not demonstrate differences in rates of local skin reactions to vaccine injections between the alcohol swab and control groups [14]. Remarkably, the duration of post-procedural pain was longer in children whose skin was cleansed with alcohol. This in fact was the first randomized study concerning pre-injection swabbing in the context of vaccine administration. Thus, the totality of data taken together fails to demonstrate any benefit of skin preparation or harm in omitting it.

To illustrate the economic costs and futility of this point (see Table), if we assume that 100% of the 350 million US residents were to receive both COVID-19 vaccinations, the alcohol-wipe process would take ~16.5 million hours (i.e., 1,887 person-years). At the global level, this calculation yields a calculation of 385 million hours (over 43,900 person-years). Translating these estimated efforts into projected US-based costs at the low (10th percentile pay or \$25.04 hourly) and median (50th percentile or \$37.24 hourly) nursing wages (excluding the surge pricing currently in effect), the projected cost estimates are \$413 million USD and \$615 million, respectively, in the U.S. alone [32].

Global nursing salaries vary greatly. For example, the low end is \$1.80 USD in the Philippines [33]; however, the global average is \$12.78 per hour [34]. Applying the mean value globally yields a total cost projection of \$4.9 billion. Including the cost of an alcohol swab at \$0.02 adds \$13 million to the US (\$308 million globally) to these costs. Even at a low vaccine-acceptance rate of 60%, the total cost of this procedure is estimated at over \$3.1 billion. Wasting these nursing and economic resources in the midst of a pandemic to accomplish a globally pressing task with no evidence-based support for pre-vaccine skin preparation is negligent and cost-inefficient. In the context of the massive costs and labor required to immunize the world, we call for ending the routine practice of using alcohol swab/wipe skin preparation where the skin is not visibly soiled. In terms of routine immunization, additional research may be helpful.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

- [1] Pennic F. Travel Nurse Pay Nearly Doubles Nationwide from Coronavirus Outbreak. <https://hitconsultant.net/2020/03/27/coronavirus-outbreak-doubles-travel-nurse-pay-nationwide/#.X8fjZORYZaR>. March 27, 2020. Date accessed: December 22, 2020.
- [2] Dann TC. Routine skin preparation before injection: an unnecessary procedure. *Lancet* 1969;2:96–8.
- [3] Workman B. Safe injection techniques. *Nurs Stand*. 1999;13:47–53; quiz 4.
- [4] World Health Organization. WHO best practices for injections and related procedures toolkit. https://apps.who.int/iris/bitstream/handle/10665/44298/9789241599252_eng.pdf;jsessionid=7AA9CF696B6088E1ECCBCC14BF72CE49?sequence=1. March 2010. Date accessed: December 22, 2020.
- [5] Public Health England. Immunization procedures. In *The Green Book*. Chapter 4. March 20, 2013. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/147915/Green-Book-Chapter-4.pdf. Date accessed: December 22, 2020.
- [6] Australian Government. Administration of vaccines. <https://immunisationhandbook.health.gov.au/vaccination-procedures/administration-of-vaccines>. Last updated: April 23, 2019. Date accessed: December 22, 2020.
- [7] Hutin Y, Hauri A, Chiarello L, Catlin M, Stilwell B, Ghebrehiwet T, et al. Best infection control practices for intradermal, subcutaneous, and intramuscular needle injections. *Bull World Health Organ* 2003;81:491–500.
- [8] World Health Organization. Global Advisory Committee on Vaccine Safety, 3–4 December 2003. https://www.who.int/vaccine_safety/committee/reports/dec_2003/en/. 2003. Date accessed: December 22, 2020.
- [9] Wolicki J, Miller E. Vaccine Administration. [Updated November 2020]. In: Hamborsky J, Kroger A, Wolfe S, editors. *Centers for Disease Control and Prevention Epidemiology and Prevention of Vaccine-Preventable Diseases 13 ed*. Washington, D.C.: Public Health Foundation; 2015.
- [10] Centers for Disease Control and Prevention. General Best Practice Guidelines for Immunization: Best Practices Guidance of the Advisory Committee on Immunization Practices (ACIP). Vaccine Administration. <https://www.cdc.gov/vaccines/hcp/acip-recs/general-recs/administration.pdf>. 2019. Date accessed: December 22, 2020.

Cost Estimates for Nursing Hours Incurred by Alcohol Swab/Wipe Skin Preparation

Vaccination rate	Low Cost Global (\$1.80/hr)	Average Cost Global (\$12.78/hr)	Low Cost U.S. (\$25.04/hr)	Median Cost U.S. (\$37.24/hr)	Average for 30 OECD Member Countries (\$47.40/hr) [35]
100%	\$1,000,913,264	\$5,227,846,971	\$427,131,453	\$628,795,684	\$3,137,747,700
60%	\$600,547,958	\$3,136,708,183	\$256,278,872	\$377,277,411	\$1,882,648,620

OECD-Organisation for Economic Cooperation and Development

Disclosures

GAP is the chair of a Safety Evaluation Committee for novel investigational vaccine trials being conducted by Merck Research Laboratories. GAP offers consultative advice on vaccine development to Merck & Co., Medicago, GlaxoSmithKline, Sanofi Pasteur, Emergent Biosolutions, Dynavax, Genentech, Eli

- [11] Dulong C, Brett K, Arguez C. Skin preparation for injections: a review of clinical effectiveness, cost-effectiveness, and guidelines. Ottawa: CADTH; 2020 Mar. (CADTH Rapid Response Report: Summary with Critical Appraisal). <https://cadth.ca/sites/default/files/pdf/htis/2020/RC1218%20Skin%20Prep%20Injection%20Final%20corrected.pdf>. 2020. Date accessed: December 22, 2020.
- [12] Greenwood Dufour B. The alcohol swab before the needle: A point of debate. <https://hospitalnews.com/the-alcohol-swab-before-the-needle-a-point-of-debate/>. Hospital News 2020. Date accessed: December 22, 2020.

- [13] Gittens G, Bunnell T. Skin disinfection and its efficacy before administering injections. *Nursing Standard* 2009;23:42–4.
- [14] Wong H, Moss C, Moss SM, Shah V, Halperin SA, Ito S, et al. Effect of alcohol skin cleansing on vaccination-associated infections and local skin reactions: a randomized controlled trial. *Human Vacc Immunotherapeut* 2019;15:995–1002.
- [15] Sautter RL, Mattman LH, Legaspi RC. *Serratia marcescens* meningitis associated with a contaminated benzalkonium chloride solution. *Infect Control* 1984;5:223–5.
- [16] Reiss I, Borkhardt A, Füssle R, Sziegoleit A, Gortner L. Disinfectant contaminated with *Klebsiella oxytoca* as a source of sepsis in babies. *Lancet* 2000;356:310.
- [17] Prasad V, Ioannidis JP. Evidence-based de-implementation for contradicted, unproven, and aspiring healthcare practices. *Implement Sci* 2014;9:1.
- [18] Ubel PA, Asch DA. Creating value in health by understanding and overcoming resistance to de-innovation. *Health Aff (Millwood)* 2015;34:239–44.
- [19] Gupta DM, Boland Jr RJ, Aron DC. The physician's experience of changing clinical practice: a struggle to unlearn. *Implement Sci* 2017;12:28.
- [20] Cochrane LJ, Olson CA, Murray S, Dupuis M, Tooman T, Hayes S. Gaps between knowing and doing: understanding and assessing the barriers to optimal health care. *J Contin Educ Health Prof* 2007;27:94–102.
- [21] Liauw J, Archer GJ. Swabaholics?. *Lancet* 1995;345:1648.
- [22] Ipp M, Taddio A, Sam J, Gladbach M, Parkin PC. Vaccine-related pain: randomised controlled trial of two injection techniques. *Arch Dis Child* 2007;92:1105–8.
- [23] American Academy of Pediatrics. Red Book: 2018 Report of the Committee on Infectious Diseases. American Academy of Pediatrics 2018.
- [24] Del Mar CB, Glasziou PP, Spinks AB, Sanders SL. Is isopropyl alcohol swabbing before injection really necessary?. *Med J Aust* 2001;174:306.
- [25] Pratt RJ, Hoffman PN, Robb FF. The need for skin preparation prior to injection: point – counterpoint. *British J Infection Control* 2005;6:18–20.
- [26] McCarthy JA, Covarrubias B, Sink P. Is the traditional alcohol wipe necessary before an insulin injection? Dogma disputed. *Diabetes Care* 1993;16:402.
- [27] O'Neill J, Grinager H, Smith SD, Sibley S, Harrison AR, Lee MS. Isopropyl alcohol skin antisepsis does not reduce incidence of infection following insulin injection. *Am J Infect Control* 2013;41:755–6.
- [28] Koivisto VA, Felig P. Is skin preparation necessary before insulin injection?. *Lancet* 1978;1:1072–5.
- [29] Pham T, Perry JD. Botulinum toxin type A injection without isopropyl alcohol antisepsis. *Ophthalmic Plast Reconstr Surg* 2009;25:178–9.
- [30] O'Neill J, Grinager HS, Harrison AR, Lee MS. Re: "Botulinum toxin type A injection without isopropyl alcohol antisepsis". *Ophthalmic Plast Reconstr Surg*. 2012;28:307–8.
- [31] Sutton CD, White SA, Edwards R, Lewis MH. A prospective controlled trial of the efficacy of isopropyl alcohol wipes before venesection in surgical patients. *Ann R Coll Surg Engl* 1999;81:183–6.
- [32] U.S. Bureau of Labor Statistics. Occupational Employment and Wages, May 2019. <https://www.bls.gov/oes/current/oes291141.htm>. Date accessed: December 22, 2020.
- [33] World Salaries.org. Professional Nursing Salaries-International Comparison. <http://www.worldsalaries.org/professionalnurse.shtml>. 2008. Date accessed: December 22, 2020.
- [34] Global Mobility Management. Salaries for Common Jobs Around the Globe. <https://info.caprelo.com/blog/average-job-salaries-around-the-world>. 2018. Date accessed: December 22, 2020.
- [35] Organisation for Economic Cooperation and Development (OECD). Remuneration of nurses. https://www.oecd-ilibrary.org/sites/health_glance-2017-58-en/index.html?itemId=/content/component/health_glance-2017-58-en. 2017. Date accessed: December 22, 2020.

Eric G. Poland^aDarren K. McGuire^bTamar Ratishvili^cGregory A. Poland^{c,1,*}^a Rapid City, SD, United States^b University of Texas Southwestern Medical Center and Parkland Health and Hospital System, Dallas, TX, United States^c Mayo Clinic Vaccine Research Group, Mayo Clinic, Rochester, MN, United States

* Corresponding author.

E-mail address: poland.gregory@mayo.edu (G.A. Poland)

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¹ Address: Mayo Vaccine Research Group, Mayo Clinic, Guggenheim 611C, 200 First Street SW, Rochester, MN 55905, United States.