

The Surgeon's Guide to

# LIFE-SAVING CHECKLISTS







# To err is human, but at what cost?

Surgery is intended to help patients, not harm them. “First, do no harm,” is the bedrock of medical ethics. Global surgical volume now exceeds 300 million procedures annually, Americans undergo an average of seven operations in their lifetime. We continue to have more than 150,000 deaths following surgery every year in the United States—more than three times the number of road traffic fatalities.<sup>1</sup> Complications after inpatient surgery occur in 3-17% of patients, according to the World Health Organization (WHO).<sup>2</sup>

Surgery is indeed risky. WHO reports that current estimates of morbidity and mortality following surgery indicate that over 7 million people worldwide will suffer complications following surgery, and 1 million of these people will die as a result.<sup>2</sup>

How can these alarming statistics be improved? One way that has been introduced within the last decade is the use of safety checklists, notably WHO’s Surgical Safety Checklist.

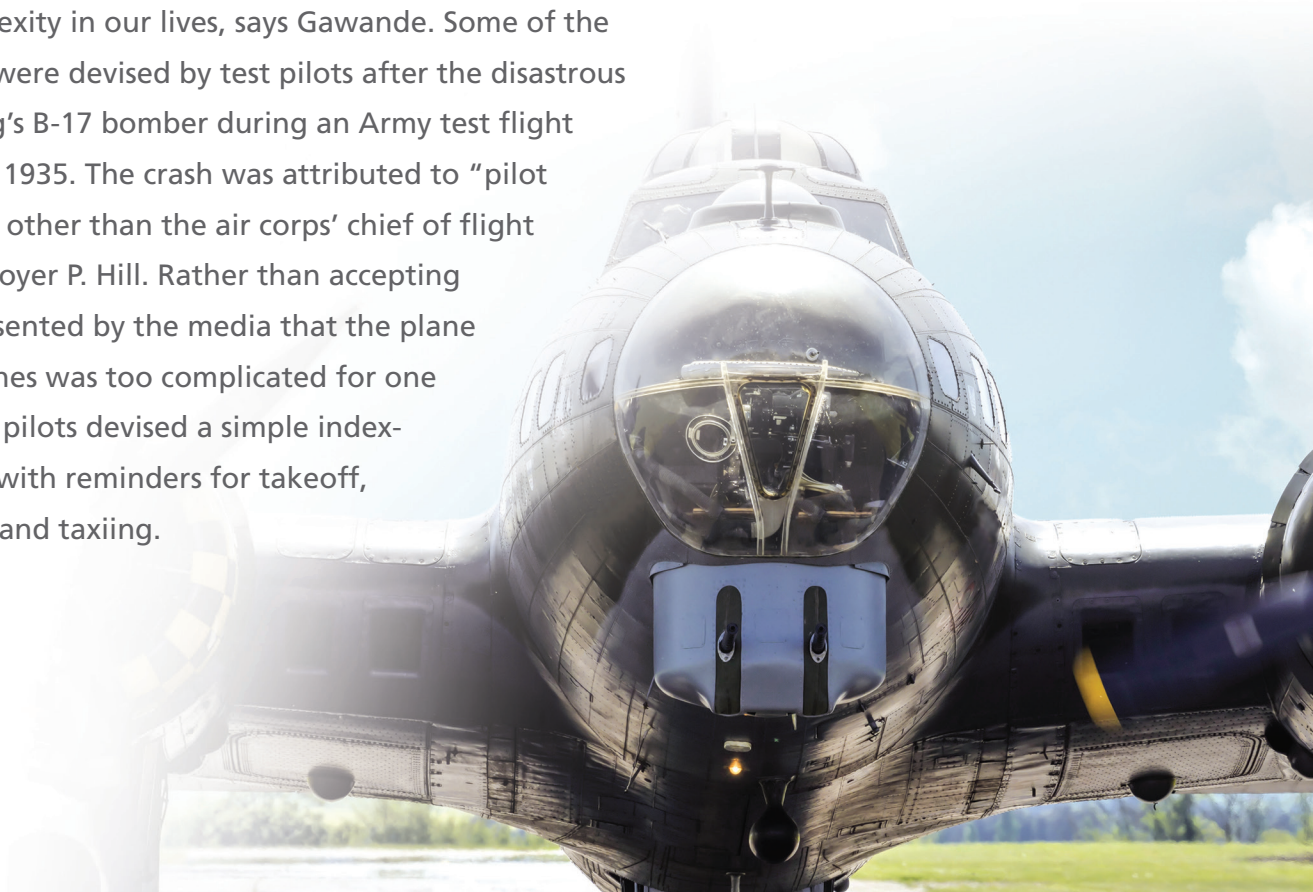
# The Impact of Checklists

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From our personal shopping list for groceries to our list of chores, from work instructions for every small task in a manufacturing process to safety checklists and care plans for clients and patients, checklists seem to exist everywhere—at home, in our offices and workplaces. Our lives are now governed by checklists. They help us remember each detail of what we want or should do. They help us avert inadvertent memory lapses. They prevent error. Admittedly, it is one thing to forget a grocery item at the store, but it is altogether another to leave a sponge in a patient in the operating room.

## Test Crash Leads to Pilot Checklist

Checklists were not always the norm. In his 2010 best-seller *The Checklist Manifesto: How to Get Things Right*,<sup>2</sup> Dr. Atul Gawande, an endocrine oncology surgeon at Harvard's School of Public Health, describes the advent of critical checklists. Checklists evolved to manage complexity in our lives, says Gawande. Some of the first checklists were devised by test pilots after the disastrous crash of Boeing's B-17 bomber during an Army test flight competition in 1935. The crash was attributed to "pilot error" by none other than the air corps' chief of flight testing, Maj. Ployer P. Hill. Rather than accepting the notion presented by the media that the plane with four engines was too complicated for one man to fly, the pilots devised a simple index-sized checklist with reminders for takeoff, flight, landing and taxiing.



# Checklist Pioneer

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Peter Pronovost, an anesthesiologist and intensivist at Johns Hopkins Medical Center, with a PhD from Johns Hopkins Bloomberg School of Public Health, began studying hospital infections.

In 2001, Pronovost tackled the common problem of central venous catheter-related bloodstream infections. At that time, the rate of infections was 19 per 1,000 catheter days. Each year in the United States, central venous catheters cause an estimated 80,000 catheter-related infections in the blood and, as a result, up to 28,000 deaths among patients in intensive care units. Given that the average cost of care for a patient with this infection is \$45,000, three such infections could cost the healthcare system a total of \$2.3 billion annually.

## CVC Checklist

Drawing on the wealth of data and examples from the aviation industry, Pronovost devised a simple five-step checklist for doctors to follow when inserting a CVC:<sup>3</sup>



**1. Wash their hands with soap.**



**2. Clean the patient's skin with chlorhexidine antiseptic.**



**3. Put sterile drapes over the entire patient.**



**4. Wear a sterile mask, hat, gown and gloves.**



**5. Put a sterile dressing over the catheter site.**

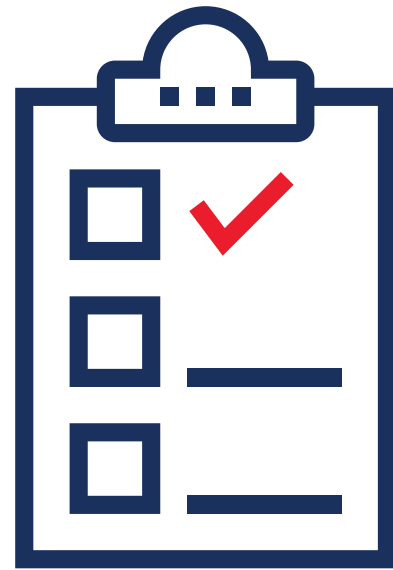
Once he had created the checklist, Pronovost then persuaded the Johns Hopkins administration to allow him to institute it. Its success depended on empowering nurses to remind the doctors if they were remiss in following any one of the five steps. The administration complied and the results after one year's monitoring of CVC infections were astounding. The 10-day line infection rate dropped from 11% to zero. Skeptics asked if these findings were too good to be believed.<sup>4-6</sup>



## Michigan's Keystone Initiative

To verify the Johns Hopkins findings, Pronovost and colleagues went to Michigan to participate in the 2003 Keystone Initiative to study the extent to which CVC infections could be reduced. Again the results were amazing.

- The median rate of infections at a typical ICU dropped from 2.7 per 1,000 patients to zero after three months.
- In the first three months of the project, the infection rate in Michigan's ICUs decreased by 66%.
- In the initiative's first 18 months, they estimated it saved 1,500 lives and \$175 million.
- This level of improvement was maintained for three years.
- Michigan's infection rates fell so low that the state's ICUs outperformed 90% of ICUs nationwide.



The Michigan results, published in the 2006 issue of the New England Journal of Medicine, proved that the use of a simple checklist in a routine procedure worked.<sup>7</sup> This led to a cascade of additional checklists—including checklists for safe childbirth, operating room crises and H1N1 influenza management, to name a few.<sup>2</sup>



# The Making of WHO's Surgical Checklist

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The success of the Central Venous Catheters Checklist also caught the attention of Dr. Margaret Chan, the former Director of Health in Hong Kong. Chan had recently become the Director General of the World Health Organization (WHO), the United Nations agency that focuses on international public health issues.

## Initiative: Safe Surgery Saves Lives

While surgery has been an essential component of healthcare worldwide for over a century and saves millions of lives annually, unsafe surgical care can and does cause substantial harm. WHO reports that:

- The reported crude mortality rate after major surgery is 0.5-5%
- In industrialized countries, nearly half of all adverse events in hospitalized patients are related to surgical care
- At least half of the cases in which surgery led to harm are considered preventable



As the momentum for increased surgical safety and quality measures grew, Chan reached out to an international group of experts in 2007. She asked them to develop a solution to the problem of unsafe surgery as part of WHO's Second Global Patient Safety Challenge, Safe Surgery Saves Lives. Anesthetists, operating room nurses, surgeons, safety experts, patients and other professionals came together to define a core set of safety standards that could be applied in all 194-member WHO states. The WHO Surgical Safety Checklist was the result.

## Teamwork, Communication Key

Poor teamwork and communication were identified as two major causes of safety failures. Improving each of these soon became key goals for the checklist. WHO's three-part Surgical Safety Checklist recommended that, during its course, surgery would be interrupted three times so that team members would verbally communicate pertinent information about the patient, their roles and the procedure to one another.<sup>8</sup>

### "Sign In"

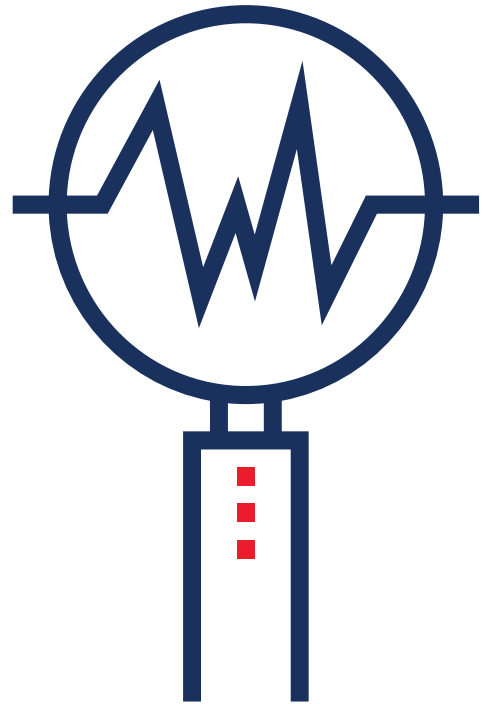
The anesthesiologist or nurse anesthetist and patient were tasked with carrying out the "sign in." Its purpose was to verbally confirm the patient's identity, the procedure, surgical site and the patient's consent. It also checks whether there is a functional pulse oximeter on hand and if the patient has any known allergy, and if there is a difficult airway or aspiration risk. The final sign-in check is to ask if there is a risk of more than 500 mL of blood loss in adults (7 mL/kg in children). If the answer is affirmative in either of the last two instances, they are to check if there is proper equipment on hand, assistance available, intravenous access and fluids if an emergency arises.

## Atul Gawande, MD, PhD

Atul Gawande, MD, MPH, is a surgeon, writer and public health researcher. He practices general and endocrine surgery at Brigham and Women's Hospital. He is Professor in the Department of Health Policy and Management at the Harvard T.H. Chan School of Public Health and the Samuel O. Thier Professor of Surgery at Harvard Medical School. He is also Executive Director of Ariadne Labs, a joint center for health systems innovation, and Chairman of Lifebox, a nonprofit organization making surgery safer globally. ([www.gawande.com](http://www.gawande.com)) Gawande has been a staff writer for The New Yorker magazine since 1998 and has written four New York Times best-sellers: "Complications," published in 2002, "Better," in 2007, "The Checklist Manifesto" in 2010, and most recently, "Being Mortal: Medicine and What Matters in the End." He has won numerous awards—including a MacArthur Fellowship and the Lewis Thomas Award for writing about science. In 2007, he became director of the World Health Organization's effort to reduce surgical deaths, and in 2009 he was elected a Hastings Center Fellow.

## **“Time Out”**

“Time out” takes place just before the patient has been opened. All team members are to introduce themselves and name their roles in the procedure. The surgeon, anesthesia professional and nurse verbally confirm the patient’s name, site and procedure. The surgeon reviews the critical or unexpected steps to anticipate any crises. They project length of the surgery and the anticipated blood loss. The anesthesia team notes whether there are any patient-specific concerns and the nursing team reviews the sterility of the site and if there are any equipment issues or concerns. Finally, the team confirms that an antibiotic has been administered within the past hour and essential imaging is on display in the OR.



## **“Sign Out,” the Final Checks**

Before the patient leaves the operating room, “sign out” is a verbal recap of the procedure with the nurse naming the procedure, confirming that instrument, sponge and needle counts are correct or not applicable, the specimen is labelled correctly with the patient’s name and whether there were any equipment problems. The surgeon, anesthesiologist and nurse review the key concerns for recovery and post-op management of the patient.





# Testing the Checklist

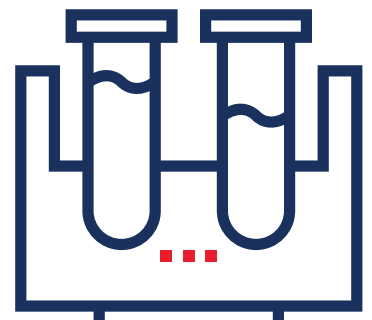
To check whether the Surgical Safety Checklist would work, eight hospitals from around the globe were selected to trial the checklist. They represented hospitals from well-to-do developed countries such as the United States, Canada, Britain and New Zealand to less developed or poor countries in Southeast Asia and Africa (see sidebar, Page 12). The hospitals varied greatly in the number of beds (range 371 to 1,800), the number of ORs (range three to 39), and the income level of the country (four low, four high).<sup>9</sup> Prior to introduction of the WHO checklist, baseline data for 3,733 patients were collected for the three months prior to using the checklist; 3,955 afterward. Perioperative morbidity and mortality up to discharge or within 30 days of surgery was assessed.

## Dramatic Results

Despite the wide socioeconomic diversity among the pilot hospitals, the results showed that the use of WHO's simple surgical checklist, during major operations can lower the incidence of surgery-related deaths and complications by 33%. The results published in the January 2009 New England Journal of Medicine reported that the rate of morbidity following surgery fell from 11% in the baseline period (411 in 3,733 cases) to 7% (288 in 3,955) after introduction of the checklist, a decline of 36%. Inpatient deaths following major operations fell by more than 47% from 1.5% (56 in 3,733 cases) to 0.8% (32 in 3,955 cases).<sup>6</sup>

## Checklist Forces Consistency

Many hospitals were already executing most of the items on the list but not reviewing them as a team. But they found that if there is no designated point when these items are reviewed, it was common to find that they were verified most of the time, but not every time. There was not consistency. The results of the WHO pilot study confirmed the conclusions of a number of earlier studies that indicated that preoperative team introductions and briefings and postoperative debriefings contribute to improved processes and outcomes.



# Surgical Checklist Recommended

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Based on the positive results of the pilot study, WHO recommended the checklist be integrated into all surgical procedures and training. As with any new tool, one of the biggest challenges of the Surgical Safety Checklist was to ensure its successful implementation. WHO thus launched an implementation manual alongside the checklist to aid its introduction. The checklist was not intended to be comprehensive and additions and modifications to fit local practice were encouraged.

## Key to Success

Having a key, influential clinical leader endorse and champion the checklist was found to be key to its successful implementation. They not only needed to explain why the checklist is needed but also show how to use it.<sup>10</sup> Also:

- The staff needs to be fully engaged in bringing about local modifications to the checklist and the implementation process.
- Workshops and wider safety education alongside use of the checklist are helpful.
- Senior hospital leaders need to be seen as committed to implementing the checklist.
- It must be recognized that successful implementation of the checklist does take time.

### Other factors for successful implementation of the checklist include:

- Early engagement of staff
- Extensive discussion, education and training
- Multidisciplinary involvement
- Coaching
- Ongoing feedback
- Local adaptation and modification of the checklist for implementation in an individual hospital.

## OR Culture Change Demanded

To make the checklist work in many hospitals, there had to be a dramatic change in the culture of safety and teamwork. This created a stir. While there was enthusiasm among many clinicians, others did not see the value of this initiative. In the operating room where the surgeon has been the sole director for decades, the checklist was suddenly dictating teamwork and communication among everyone in the room. Although there are myriad reasons why there could be resistance to checklist implementation, for some physicians, it was a challenge to adjust to a more team-based approach.





# The Impact of a Surgical Checklist

The WHO Surgical Safety Checklist has been successfully adapted for implementation in a wide variety of settings, including all surgical specialties, academic and community hospitals, in industrialized and developing countries. Walker reports that as of 2012, more than 4,000 hospitals in 122 countries have registered as users of the WHO checklist, and 1,790 hospitals have used the checklist in at least one operating room.<sup>11</sup> In the May issue of the *Annals of Surgery*, 2015, Hugen et al., from the Department of Anesthesia and Intensive Care, Haukeland University Hospital, Bergen, Norway, found that in 2,263 procedures in which the checklist was used versus 2,212 procedures during which the checklist was not used, complication rates decreased from 19.9% to 11.5%. Mean length of stay decreased by 0.8 days and in-house mortality decreased significantly from 1.9% to 0.2%. They concluded that “implementation of the WHO Surgical Safety Checklist was associated with robust reduction in morbidity and length of in-hospital stay and some reduction in mortality.”<sup>12</sup>

## Peter Pronovost, MD, PhD

Peter J. Pronovost is a practicing anesthesiologist and critical care physician at Johns Hopkins Hospital in Baltimore, dedicated to finding ways to make hospitals and healthcare safer for patients. He is a Professor at the Johns Hopkins School of Medicine in the Departments of Anesthesiology and Critical Care Medicine, and Surgery, Professor of Healthcare Management at the Carey Business School, Professor of Health Policy and Management at the Johns Hopkins Bloomberg School of Public Health, and is Medical Director for the Center for Innovation in Quality Patient Care.

He introduced an intensive care checklist protocol that during an 18-month period saved 1,500 lives and \$100 million in the state of Michigan. According to Atul Gawande in *The New Yorker*, Pronovost’s “work has already saved more lives than that of any laboratory scientist in the past decade.” In 2008, Pronovost was awarded a MacArthur Fellowship.

Pronovost chronicled his work to improve patient safety in his 2010 book, *Safe Patients, Smart Hospitals: How One Doctor’s Checklist Can Help Us Change Health Care from the Inside Out.*

# Checklists Are Here to Stay

Numerous subsequent publications have also reported that urgent surgery and safety attitudes have improved through use of the Surgical Safety Checklist. From Pronovost's simple five-point checklist for catheter insertion to WHO's Surgical Safety Checklist, checklists have become a valuable clinical safety tool. In our ever more complex world, checklists are here to stay.

## Test Sites for WHO's Surgical Checklist



### Southeast Asian Region

St. Stephen's Hospital, New Delhi, India serves the needs of around 5 million people. Of its patients, 25% occupy the private beds and 75% use the general wards. An overwhelming majority of patients come from low-income groups, who are given full medical treatment at subsidized rates. The hospital has four large operation theatres and there is an eight bed post-operative intensive care unit for surgical patients.



### Western Pacific

Pilot sites were the brand new Auckland City Hospital in Auckland, New Zealand, which opened in 2003 and the 100-year-old Philippines General Hospital (PGH), in Manila, Philippines. PGH is the national tertiary referral centre and teaching hospital with 19 clinical departments and 1,500 patient beds.



### Africa

St. Francis Designated District Hospital, Ifakara, Tanzania, functions as a public district hospital with a capacity to handle 370 permanent patients. Six hundred adults per day are given outpatient treatment, while the pediatric ward treats 300 children daily. The hospital has only one ambulance so access is difficult for many.



### North America

University of Washington Medical Center, Seattle (UWMC) is a 450-bed major teaching and research hospital that has more than 700 attending physicians. In Canada, Toronto General Hospital, part of the University Health Network, (UHN) was chosen for the pilot. The hospital has 29 staffed operating rooms, with surgical teams performing more than 25,000 surgeries a year.



### Eastern Mediterranean Region

Prince Hamzah Hospital, Amman, Jordan is a 450-bed public facility that opened in June 2006 to receive around 1,500 patients per day. Staffed by nearly 900 employees, the hospital consists of 33 clinics, used around the clock by doctors from different specialties.



### Europe

St. Mary's Hospital, London, part of Imperial College Healthcare NHS Trust, is a general acute hospital that diagnoses and treats a range of adult and pediatric conditions.



## References

1. Weiser TG, Haynes AB, Molina G, Lipsitz SR, Esquivel MM, Uribe-Leitz T, Fu R, Azad T, Chao TE, Berry WR, Gawande AA, "Size and distribution of the global volume of surgery in 2012," *Bull World Health Organ*. 2016 Mar 1;94(3):201-209F.
2. Gawande AA, *A Checklist Manifesto: How to Get Things Right* Metropolitan Books, New York: Holt and Company, 2009," *Int J Qual Health Care*. 2010 Oct;22(5):365-70.
3. Pronovost PJ, Vohr E, *Safe Patients, Smart Hospitals: How One Doctor's Checklist Can Help Us Change Health Care from the Inside Out* Penguin Books Ltd, London, Plume 2011.
4. Pronovost P, Needham D, Berenholtz S, Sinopoli D, Chu H, Cosgrove S, Sexton B, Hyzy R, Welsh R, Roth G, Bander J, Kepros J, Goeschel C, "An intervention to decrease catheter-related bloodstream infections in the ICU," *N Engl J Med*. 2006 Dec 28;355(26):2725-32
5. Pronovost PJ, Marsteller JA, Goeschel CA, "Preventing bloodstream infections: a measurable national success story in quality improvement," *Health Aff (Millwood)*. 2011 Apr;30(4):628-34.
6. Sawyer M1, Weeks K, Goeschel CA, Thompson DA, Berenholtz SM, Marsteller JA, Lubomski LH, Cosgrove SE, Winters BD, Murphy DJ, Bauer LC, Duval-Arnould J, Pham JC, Colantuoni E, Pronovost PJ, "Using evidence, rigorous measurement, and collaboration to eliminate central catheter-associated bloodstream infections, *Crit Care Med*. 2010 Aug;38(8 Suppl):S292-8.
7. Haynes AB1, Weiser TG, Berry WR, Lipsitz SR, Breizat AH, Dellinger EP, Herbosa T, Joseph S, Kibatala PL, Lapitan MC, Merry AF, Moorthy K, Reznick RK, Taylor B, Gawande AA; "A surgical safety checklist to reduce morbidity and mortality in a global population," *N Engl J Med*. 2009 Jan 29;360(5):491-9.
8. Fudickar A, Hörle K, Wiltfang J, Bein B, "The effect of the WHO Surgical Safety Checklist on complication rate and communication.," *Dtsch Arztebl Int*. 2012 Oct;109(42):695-701.
9. Treadwell JR, Lucas S, Tsou AY, "Surgical checklists: a systematic review of impacts and implementation," *BMJ Qual Saf*. 2014 Apr;23(4):299-318z.
10. Conley DM, Singer SJ, Edmondson L, Berry WR, Gawande AA, "Effective surgical safety checklist implementation," *J Am Coll Surg*. 2011; 212(5): 873-9.
11. Walker A, Reshamwalla S, Wilson IH., *Surgical safety checklists: do they improve outcomes?*, *Br J Anaesth*. 2012 Jul;109(1):47-54.
12. Haugen AS, Sjøfteland E, Almeland SK, Sevdalis N, Vonen B, Eide GE, Nortvedt MW, Harthug S. "Effect of the World Health Organization checklist on patient outcomes: a stepped wedge cluster randomized controlled trial." *Ann Surg*. 2015 May;261(5):821-8.
13. Weiser TG, Haynes AB, Dziekan G, Berry WR, Lipsitz SR; Gawande AA, "Effect of A 19-Item Surgical Safety Checklist During Urgent Operations in A Global Patient Population," *Annals of Surgery* 2010; 251(5): 976-980.





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