Examining the Evidence: *N95 respirators vs surgical masks to prevent transmission of respiratory tract infections to staff in primary care*

Michael Tam

Staff Specialist, SWSLHD & Ingham Institute;
Conjoint Senior Lecturer; UNSW Sydney

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Clinical scenario

The new decade has commenced with uncertainty and concern for Australian general practice. News of the new coronavirus outbreak in Wuhan featured strongly in medical social media discussions. Among this were practical issues of clinic preparedness, including the challenges surrounding the availability of personal protective equipment recommended by public health authorities. GPs described the lack of access to N95 respirators, reporting that medical supply companies were out of stock. Some of this was explained by the horrendous 2019-2020 Australian bushfire season, which drove the high demand for clinical masks by the general public.

In these discussions, I recalled that a large study comparing N95 respirators to standard "medical masks" (I will use the terms "medical masks" and "surgical masks" synonymously in this article) was published in *JAMA* recently [1] – though I hadn't read it in detail. I wondered: how much better are N95 respirators compared to surgical masks at protecting GPs and their staff from the transmission of respiratory tract infections? What is the evidence?

Clinical question

Do N95 respirators reduce the risk of respiratory tract infection transmission to clinic staff compared to surgical masks in primary care (and other outpatient) settings?

What does the research evidence say?

Step 1: The Cochrane Library

Searching the term "N95" in the Cochrane Library identified an older Cochrane systematic review published in 2011 on "physical interventions to interrupt or reduce the spread of respiratory viruses" [2]. This systematic review concluded that both surgical masks and N95 respirators may be beneficial [2]. However, only limited conclusions can be drawn about their comparison. At the time of this paper, there was relatively little head-to-head data.

Step 2: TripDatabase

Next, I conducted a search using the TripDatabase PICO search tool with the following search terms (Participant: blank, Intervention: "N95", Comparator: "mask", Outcomes: "respiratory infection"). The results looked promising!

The first hit was a cost-effectiveness analysis of N95 respirators vs surgical masks in protecting clinicians in China [3]. Hmm, pass – this isn't the outcome of interest and the context of the study (Chinese health system) isn't directly applicable to the Australian primary care setting.

Going next to the third hit was a another systematic review and meta-analysis, this time directly comparing the effectiveness N95 respirators with surgical masks in the prevention of respiratory tract infections in clinicians, published in 2016 [4]. Unfortunately, although it does identify that N95 respirators are likely superior in controlled laboratory settings, there was insufficient data at the time of this paper to determine whether this advantage held in real clinical settings [4].

Finally, the second hit was the previously mentioned paper in *JAMA*, published in 2019 [1]. This was a pragmatic cluster randomised trial that compared the effectiveness of N95 respirators against surgical masks, at preventing influenza in health care workers. Let's look at Radonovich et al. (2019) in detail.

Critical appraisal

I will use the randomised controlled trial appraisal sheet from the Centre for Evidence Based Medicine [5].

PICO

P*articipants: who was studied?*

There were a total of 2862 health care personnel participants, of whom 2371 completed the protocol, and 1416 participated for more than one intervention season (maximum of four). Each intervention period was 12 consecutive weeks during which the incidence of viral respiratory illness and infections was predicted by the ALERT algorithm [6] to be highest for that year. The study ran from 2011-2016.

The mean participant age was 43 years, and most of the individual participants were women (82.8%). Exclusion criteria: medical conditions precluding safe participation (third-trimester pregnancy) and anatomic features that interfered with device fit (facial hair).

Of the *clusters*, these were 137 outpatient study sites at 7 US "medical centres" (local health system network or hospital), including primary care facilities, dental clinics, adult and paediatric clinics, dialysis units, urgent care facilities, emergency departments, and emergency transport services. The average cluster size was 35 participants. Roughly 70% of the participant-seasons was in primary care.

I*ntervention: what was the exposure?*

N95 respirator. During the 12-week intervention period, whenever the participant was within 6 feet of patients with suspected or confirmed respiratory illness, they wore a new device. Hand hygiene was recommended to all participants and infection prevention policies were followed at each site.

C*omparator: what was the control/alternative?*

Surgical mask. Apart for the equipment type, the same instructions were given.

Outcomes: what was measured?

Primary outcome: laboratory-confirmed influenza.

This was defined as detection of influenza A or B by PCR from an upper respiratory specimen collected within 7 days of symptom onset; OR detection of influenza from a randomly obtained swab from an asymptomatic participant; OR ≥ 4-fold increase in hemagglutination inhibition antibody titres for influenza A or B virus between pre-season and post-season serology.

The investigators prespecified that a "clinically significant difference" in this study was a 25% relative reduction in the incidence of laboratory-confirmed influenza.

Internal validity: are the trial results valid?

Randomised patient assignment?

Yes. "Constrained" randomisation was undertaken. Within each medical centre, pairs of clusters (clinics and other settings) were matched to balance the number of participants, health services delivered, patient population, and additional personal protective equipment. These clusters were randomised to receive either N95 respirators or surgical masks. Computer-generated random sequences created by an individual not involved in the study implementation or data analysis were used for group allocation.

Groups similar at the start?

Yes. There does not appear to be any important differences between the groups.

Groups treated equally apart from assigned treatment?

Yes.

All patients accounted for?

Yes, mostly. Of the 380 clusters randomised, 4 discontinued due to the small number of participants in the cluster. Data was missing in 6.4% of participants due to early withdrawal.

Measures objective? Or patients and clinicians kept blinded?

Probably, yes. Although the participants were not blinded, the primary outcome measure is relatively objective.

What were the results?

Primary outcomes – incidence of laboratory-confirmed influenza infection:

- N95 respiratory group: 8.2% (207 of 2512 participant-seasons)
- Surgical mask group: 7.2% (193 of 2668 participant-seasons)
- Comparison:
    - Absolute difference: 1.0% [95% confidence interval, -0.5% to 2.5%], or
    - Adjusted odds ratio: 1.18 [95% CI, 0.95 to 1.45]
- Interpretation:

- The point estimate of the difference in influenza incidence *favours surgical masks* by a small magnitude of unclear clinical significance.
- The distribution of uncertainty of the effect-size estimate (the confidence interval) does not support the hypothesis that N95 respirators are superior to surgical masks for the primary outcome.
- The hypothesis that there is no clinically meaningful difference between the intervention and control is not excluded.

Discussion and conclusion

N95 respirators have been demonstrated to be superior to surgical masks at preventing respiratory tract infections in controlled conditions [4], and there is a clearly plausible rationale why this is the case. Where surgical masks reduce exposure to droplets and sprays, N95 respirators also reduce exposure to aerosols through filtration. However, efficacy is not the same as effectiveness (see StatFacts) and "real-world" implementation and naturalistic use can reduce the theoretical potential of interventions. N95 respirators are more cumbersome to wear correctly and are less comfortable. In contemporary Australian general practice, cost and availability is also a challenge.

This well-conducted, large, cluster randomised trial, undertaken substantially in US primary care, did not identify a meaningful benefit from N95 respirators when compared to surgical masks for the prevention of influenza in staff. Indeed, the results plausibly support the notion that there may be no clinically important difference in this context.

A potential pragmatic interpretation is that greater priority needs to be placed, at the clinic level, on the other interventions that can protect staff from the transmission of acute respiratory tract infections. For instance, frequent handwashing, gloves and gown, and use of isolation for higher risk patients (e.g., children) with suspected respiratory infection [2]. Where N95 respirators are indicated, they need to be fitted properly, and probably should not be used in isolation.

Stat Facts

Efficacy vs Effectiveness

Although these two terms are often used synonymously, they refer to separate concepts. "Efficacy" is whether an intervention has an effect in a controlled setting. This is useful in our attempts to discover the mechanism of a single variable or factor (for instance, the effect of a medication on a biological measure). "Effectiveness" is whether an intervention has an effect in less controlled, pragmatic, "real-world" environments. Unexpected mechanisms can diminish the effectiveness of otherwise efficacious interventions – for instance, suboptimal use of a mask due to discomfort. The causal mechanisms of reality are often more complex than accounted for in our endeavours to translate research into practice. Hence, both efficacy and effectiveness research are required.

References

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