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Detection of Methicillin-Resistant *Staphylococcus aureus* Nasal Carriage Among Hospital Staff

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ABSTRACT

Nurses, doctors, laboratory staff and cleaners work in close contact with patients who carry methicillin-resistant *Staphylococcus aureus* (MRSA), and a nose swab from a member of staff is one of the simplest tests in hospital infection control. This narrative review asks what such a swab can and cannot tell us. It draws on published work on the biology of nasal carriage, the origin and spread of MRSA lineages, the part played by healthcare workers in transmission, and the laboratory methods used to detect carriage, and it reports no new data and no results from any single hospital. Carriage is common in staff as in the general population, but it is a dynamic state rather than a fixed trait, and a positive swab is better read as a marker of exposure and possible risk than as evidence that a person has passed the organism on. Reported carriage depends heavily on where the swab is taken, how it is cultured and how methicillin resistance is confirmed, so figures from different studies are seldom comparable. Screening of staff is best reserved for situations in which transmission is already linked to them. The review closes with the reporting items that a credible carriage study should supply.

Keywords: MRSA; Nasal carriage; Healthcare workers; Infection control; Screening methods; *Staphylococcus aureus*; Narrative review

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Article Class: Narrative Review

1. Introduction

Few organisms have followed medicine as closely as *Staphylococcus aureus*. It lives harmlessly in the nose of many healthy people, and it also causes skin infections, pneumonia, bloodstream infection and infections of wounds and implanted devices (1). When the strain carries

resistance to methicillin and related antibiotics it becomes MRSA, and treatment grows harder and costlier (2). Hospitals have long tried to keep it out of wards, and one recurring idea has been to test the nose of the staff who work in them. The logic seems simple. Staff touch many patients in a day, some carry MRSA, and



staff who carry it might pass it on or fall ill themselves (3). The difficulty is that carriage is a looser concept than it sounds, and the result depends on how, where and when the swab was taken.

This article reviews what the published literature says about MRSA nasal carriage among hospital staff and about the detection of carriage. It does not report a survey. No staff members were swabbed for it, no hospital is described, and no local prevalence is offered; the title names a topic, and the review treats it as such.

2. Literature Review

2.1 Nasal Carriage of *S. aureus*

The anterior nares are the main reservoir of *S. aureus* in people, although the skin, throat and perineum are also colonised (4, 5). Surveys of the general population in the United States found that roughly a third of adults carried the organism in the nose and that a small share carried MRSA, with the MRSA share rising over a few years in the early 2000s (6, 7). Carriage is thus the ordinary state of much of the population, from which hospital staff are drawn.

Carriage is not a fixed trait. Early work divided people into persistent carriers, intermittent carriers and non-carriers, and a later reclassification argued that two groups, persistent and non-persistent, describe the pattern better (8). Repeated cultures can be used to predict a person's status (9). Host factors and bacterial adhesion both appear to matter, among them teichoic acids on the bacterial wall that help it bind to nasal epithelium (10, 11). The practical lesson is that a single swab is a snapshot of something that moves. For the carrier there is a price: higher risk of infection with the organism they carry, including MRSA (12, 13). A positive swab is a starting point for a question, not an answer to it.

2.2 From Methicillin Resistance to Established Lineages

Methicillin resistance is conferred by a mobile genetic element, the staphylococcal cassette chromosome *mec*, which carries the resistance gene *mecA* (14). Population genetic work suggests that this element entered *S. aureus* several times, and that a limited number of successful lineages account for most hospital MRSA worldwide (2, 15). Typing methods differ between laboratories, which is one reason that comparing strains from different places remains awkward (16). Resistant shares differ widely between European countries, and invasive MRSA became a heavy burden in the United States (17, 18, 19). Community-associated strains with the Panton-Valentine leukocidin genes cause disease outside hospitals (20, 21, 22), so a nasal isolate from staff may come from either source, and a swab cannot say which (23).

2.3 Healthcare Workers: Victim, Vector or Source?

Albrich and Harbarth framed the question in three words, and the answer in their review was that staff can be all three (3). Staff often acquire MRSA from patients, can carry it transiently on their hands or in the nose, and occasionally carry it long enough to seed an outbreak. A systematic evaluation of outbreak reports found that asymptomatic staff were identified as the source in only a minority, and usually after other measures had failed (24). The finding does not prove that staff never matter; it suggests that they are seldom the first explanation to reach for. Staff are rarely the only people in the ward who carry the organism.

Most transmission, on the best current account, runs through the hands of staff and through contaminated surfaces and equipment, not through a carrier's nose as



such (25, 26). Hand hygiene programmes have been linked to reduced MRSA transmission (25), and ward contamination is well described (26). These routes explain why a member of staff who is not a nasal carrier can still carry the organism between beds for a short time. Guidelines accordingly advise screening staff when there is evidence that they are linked to transmission, not as a blanket measure (27, 28).

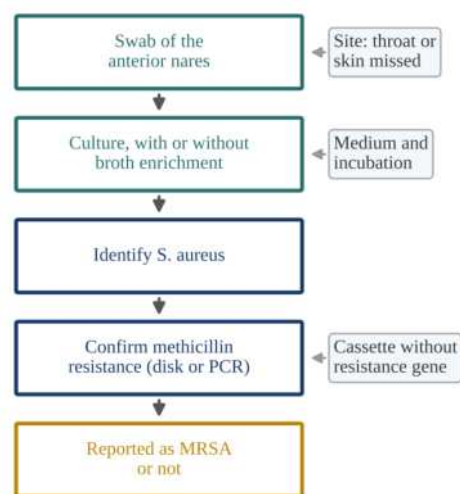
2.4 Detecting MRSA in a Nasal Sample

Laboratories have several ways to find MRSA in a swab, summarised in Table 1 and sketched in Figure 1. The classical approach is culture on selective medium, sometimes preceded by broth enrichment, followed by identification of *S. aureus* and a test for methicillin resistance (29). Cefoxitin disk diffusion has become a preferred phenotypic test for resistance because it is more reliable than oxacillin on many agars (30).

Table 1. Laboratory approaches to detecting MRSA in a nasal swab, with what each offers and where it falls short.

Approach	Principle	Strength	Limitation
Selective culture	Growth on agar containing an antibiotic or chromogen (29)	Gives an isolate to test	Slow; some strains grow poorly
Broth enrichment	Pre-growth before plating (29)	Raises the chance of detection	Adds a day
Cefoxitin disk	Zone size around a disk (30)	Reliable for resistance	Needs a pure isolate
Real-time PCR	Detects resistance cassette and species gene (31)	Result within hours	No isolate; false calls possible (32)

Note: Qualitative summary of the cited guidance; no performance figures are given because they vary with the product, the population and the prevalence.



schematic, not data

Figure 1. From nasal swab to a reported MRSA result, with the points at which the result can be altered (schematic, not data).

3. Materials and Methods

3.1 Scope and Question

The review asks what the literature establishes about MRSA nasal carriage among people who work in hospitals, how carriage is detected, and what a positive result implies.

3.2 Literature Assembly

This is a narrative synthesis. No formal systematic search was made, no database list or search string is claimed, and no screening or quality scoring was carried out in the manner of a systematic review (33). Sources were chosen by the authors for relevance, influence and clarity of method, and all were published in or before 2014. The selection therefore reflects judgement and will have missed relevant work. Reviews of this kind are most useful when they say plainly where the evidence stops.

3.3 Appraisal Framework

To compare reports of different kinds, we asked the same six questions of each, set out in Table 2. They are adapted from general reporting guidance for



observational studies (34) and are used to read the literature, not to score it. A report that answers few of them is not thereby wrong, but its figures should be held loosely.

Table 2. Questions used to appraise a published report of staff carriage.

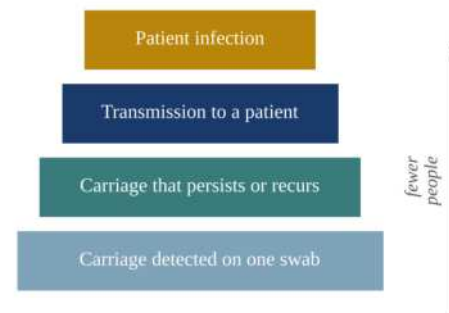
Question	What to look for	Why it matters
Who was sampled?	Roles, wards, how staff were chosen (34)	Volunteers differ from all staff
Where was the swab taken?	Nose only, or throat and skin as well (35)	Single-site swabs miss carriers
How was it cultured?	Medium, enrichment, incubation (29)	Changes the yield
How was resistance confirmed?	Disk, PCR or both (30, 31)	Defines what counts as MRSA
Was timing described?	One visit or repeated swabs (8)	Carriage comes and goes
Was transmission examined?	Typing linked to patients (3)	Carriage alone is not spread

Note: The questions are the authors' adaptation of general reporting guidance for observational studies, not a validated scoring tool.

4. Results

4.1 What a Positive Swab Does and Does Not Mean

Read against the questions in Table 2, a positive nasal swab establishes one thing with confidence: on the day of sampling, an organism that grew on the medium and passed the resistance test was present in the nose. Everything beyond that is inference. Whether the person is a persistent carrier, whether the strain is a hospital or community lineage, and whether the person has ever transmitted it to a patient are separate questions, each needing its own evidence (Figure 2). None of this makes carriage unimportant; it makes it harder to interpret than a single swab suggests.



schematic, not data; no counts implied

Figure 2. Layers between a positive swab and harm to a patient; each step is conditional on the one below it (schematic, not data).

4.2 How Method Shapes the Reported Figure

The reported proportion of carriers depends on the method as much as on the people. Sampling the throat as well as the nose finds carriers whom a nasal swab alone would miss (35). Enrichment broth raises the yield compared with direct plating, and the choice of medium and incubation time also matters (29). Rapid molecular tests and culture can disagree for reasons that are partly biological and partly technical (31, 32). Figure 3 sets out what each approach requires and yields. Two studies of the same hospital can thus give different answers and both be right.

	Needs a prior isolate	Yields an isolate	Rapid result
Selective culture	no	yes	no
Culture after enrichment	no	yes	no
Cefoxitin disk (on isolate)	yes	no	no
Real-time PCR	no	no	yes

qualitative matrix; not data

Figure 3. What each laboratory approach requires and yields (qualitative matrix, not data).



4.3 Consequences of Finding a Carrier

Table 3 gathers what follows from a positive result. The strongest evidence concerns the carrier's own risk. Evidence that carriers spread MRSA to patients is weaker and mostly drawn from outbreak reports (3, 24). Evidence that screening staff prevents infection is weaker still, partly because the best trials have studied patients and not staff (36, 37). Universal admission screening of surgical patients, for example, did not by itself clearly reduce infection (36), and a systematic review of isolation measures found the evidence for them to be of limited quality (38). A staff member who carries the organism is not, for that reason alone, a hazard to patients.

Table 3. What follows from finding a carrier among staff, and how firm the evidence is.

Consequence	Reading of the evidence	Firmness
Later infection of the carrier	Carriers face a higher risk than non-carriers (12, 13)	Fairly firm
Spread to patients	Documented in outbreaks, rare as a cause (3, 24)	Mixed
Benefit of staff screening	Argued for, tested mostly in patients (36, 37)	Weak
Benefit of decolonization	Short-term clearance, uncertain durability (39, 40)	Mixed
Mupirocin resistance	Follows widespread use (41)	Fairly firm

Note: Strength of evidence is the authors' qualitative reading of the cited literature, not a formal grading.

Decolonisation is the usual response to a positive swab. Topical mupirocin with antiseptic washing clears carriage in the short term, but the longer-term durability is less certain (39). Large trials in intensive care and surgery suggest that decolonisation can reduce infection in patients (40, 42), although those trials treated patients, not staff. Resistance to mupirocin has followed from its

widespread use (41).

4.4 Strength of the Evidence

Taking the six questions together, the literature is strongest on biology and detection and weakest on the very question the title raises: what a carrier on the staff means for patients. Studies often sample volunteers at one site and do not link staff strains to patient strains, so carriage figures describe a population but say little about transmission. It is a modest standard, but a good many published reports do not yet meet it.

5. Discussion

5.1 Interpretation

The central point is a mismatch between what is easy to measure and what is worth knowing. A nasal swab is easy to take and a prevalence figure is easy to quote. What infection control needs to know is whether, and how often, a member of staff is the link in a chain of transmission, and that is harder to show. Nothing here argues against screening, only against treating its result as self-explanatory.

5.2 Limitations

This review shares the limitations of its form. Selection was by judgement, no systematic search was run, and relevant work, particularly from low- and middle-income settings where data are sparse, will have been missed. No numerical results are quoted. It does not describe any hospital, and nothing in it should be taken as a measure of carriage anywhere in particular. Readers should take the examples here as illustrations of the problem, not as a census.

5.3 Future Work

Studies of staff carriage should state who was sampled, from which sites, by which method and how often, so that figures can be compared. They should type the isolates



and, where possible, link them to those from patients. And trials of staff screening and decolonisation should be designed around the outcomes that matter, namely infections in patients and harms to staff. Progress is more likely to come from careful, comparable studies than from larger ones.

6. Conclusion

MRSA carriage in the nose is common enough, and changeable enough, that a single swab from a member of staff says less than it seems to. What the literature supports is a modest reading: carriage marks exposure and some personal risk, it only occasionally explains an outbreak, and the reported rate depends strongly on the method used to find it. Screening is most defensible when it follows evidence that staff are linked to transmission, and least defensible as a routine headcount. The most useful contribution of a future study would be a clear description of method and, wherever possible, a link between the strains of staff and patients.

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9. Conflict of Interest

The authors declare no conflict of interest.

10. Author Contributions

E.P. conceived the review and wrote the sections on epidemiology and infection control. M.R.T. wrote the sections on laboratory detection and appraisal. F.L. wrote the sections on carriage biology, limitations and future work. All authors

revised the manuscript and approved the final version.

11. Ethics Statement

This is a review of published literature. No human participants, samples or hospital records were involved and no ethical approval was required.

12. Data Availability

No new data were generated. All sources are cited in the reference list.

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