Evidence check

8 March 2021

Rapid evidence checks are based on a simplified review method and may not be entirely exhaustive, but aim to provide a balanced assessment of what is already known about a specific problem or issue. This brief has not been peer-reviewed and should not be a substitute for individual clinical judgement, nor is it an endorsed position of NSW Health.

Thermal imaging for detection of fever

Evidence check question

Is mass thermal imaging an effective way of identifying people with COVID-19?

In brief

- Infrared thermal detection systems have been used to quantify skin temperature and provide an assessment of internal body temperature; they have shown reasonable diagnostic accuracy in the detection of fever but are not able to distinguish the cause of fever.
- While fever is a common symptom of COVID-19, it is not always present.
- In addition, presymptomatic and asymptomatic cases are potentially infectious but would not be detected by thermal screening. Virus can initially be detected in upper respiratory samples 1-2 days prior to symptom onset, with potential pre-symptomatic transmission.(1) A recent systematic review found about one third of SARS-CoV-2 infections are asymptomatic.(2)
- Thermal detection systems have been used in border screening at airports for COVID-19 and in previous pandemics.
- A study of airport screening for COVID-19 estimated that using thermal screening, 46% of infected travellers would not be detected.(3)
- A 2020 systematic review reported that thermal screening – including the use of non-contact infrared thermometers and thermal scanners – demonstrated reasonable diagnostic accuracy in the detection of fever. However, it noted that screening efficacy may be subject to changes in subject characteristics, setting, index test and the reference standard used.(4)
- One rapid review found that thermal screening proved ineffective in identifying infectious individuals and limiting the spread of disease. However, evidence in this review was limited to points of entry (i.e. airports) with uncertain applicability to other community settings.(5)
- In settings with good compliance with public health advice (e.g. COVID-19 testing in response to any symptoms; stay at home if unwell), the impact of thermal screening on preventing transmission would be limited.
- The World Health Organisation recommends that thermal screening is considered as part of a package of measures to prevent and control COVID-19 at the workplace, including workers self-monitoring their health, a “stay home if unwell policy” and flexible sick leave policies.(6)

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Limitations

Evidence on this topic is emerging rapidly. Some studies included in the review were not specific to the context of the COVID-19 pandemic, but rather were reports of findings from other outbreak settings including H1N1, SARS, and MERS epidemics. Thus, providing clear guidance in thermal screening policies for COVID-19 is hindered.

Background

Infrared thermal detection systems quantify skin temperature and provide a correlation with internal body temperature. The ability to provide quick, non-invasive temperature measurements is under consideration for use in mass fever screening during the COVID-19 pandemic.

Epidemiological studies have shown that not everyone who has an infection or is infectious will have a fever.(7) Additionally, fevers can be lowered by using antipyretic medications.(8)

Border screening at airports has been used in COVID-19 (9) and in previous pandemics such as Middle East respiratory syndrome (MERS) coronavirus (10), dengue fever (11), and H1N1 influenza.(12)

Currently, the technology is in used in airports in at least 20 countries, including Australia, Canada, Italy, Japan, Singapore and the USA.

Methods (Appendix 1)

Google and PubMed were searched on 9 April 2020. The search was re-run on the 19 February 2021 and new systematic review articles were included in this evidence check. Individual studies published past the 9 April 2020 were not included in this update.

Results

Table 1

<table>
<tr><th>Source</th><th>Summary</th></tr>
<tr><td colspan="2">Peer reviewed sources</td></tr>
<tr><td>Diagnostic accuracy of non-contact infrared thermometers and thermal scanners: a systematic review and meta-analysis

Aggarwal, et al. 2020 (4)</td><td>
A systematic review and meta-analysis to investigate the diagnostic accuracy of infrared thermal screening for the detection of fever. Thirty studies included for qualitative analysis and 19 in the meta-analysis.
Non-contact infrared thermometers (using forehead as the site of measurement):
Pooled sensitivity: 0.808 (95%CI 0.656–0.903)
Pooled specificity: 0.920 (95%CI 0.769–0.975)
Thermal scanners:
Pooled sensitivity: 0.818 (95%CI 0.758–0.866)
Sensitivity decreased in an outbreak/pandemic setting
Pooled specificity: 0.923 (95%CI 0.823–0.969)
Low positive predictive value, especially at the initial stage of an outbreak
Negative predictive value high even at later stages of an outbreak
Thermal screening has reasonable diagnostic accuracy in the detection of fever. Varies with changes in subject characteristics, setting, index test and the reference standard used.
</td></tr>
<tr><td>The effectiveness of non-contact thermal screening as a means of identifying cases of Covid-19: a rapid review of the evidence

Cardwell, et al. 2020 (5)</td><td>
Rapid review of literature to summarise the evidence on non-contact thermal screening as a method through which to identify cases and reduce the spread of COVID-19. Eleven studies were included, three of which were conducted in the context of COVID-19.
Evidence on the effectiveness of thermal screening limited to points of entry (i.e., airports); applicability to other community settings is uncertain.
Thermal screening, implemented as part of a composite of screening measures (self-report of relevant symptoms, contact/travel history), was ineffective in identifying infectious individuals and limiting the spread of disease.
Based on limited, low certainty evidence, non-contact thermal screening is ineffective in limiting the spread of Covid-19.
</td></tr>
</table>

Source	Summary
Peer reviewed sources	
Effectiveness of airport screening at detecting travellers infected with novel coronavirus (2019-nCoV) Quilty, et al. 2020 (3)	• Despite limited evidence for its effectiveness, airport screening has been previously implemented during the 2003 SARS epidemic and 2009 influenza A (H1N1) pandemic to limit the probability of infected cases entering other countries or regions. Here we use the available evidence on the incubation time, • The effectiveness of thermal passenger screening for 2019-nCoV infection at airport exit and entry to inform public health decision-making. In our baseline scenario, we estimated that 46% (95% confidence interval: 36 to 58) of infected travellers would not be detected, depending on incubation period, sensitivity of exit and entry screening, and proportion of asymptomatic cases. Airport screening is unlikely to detect a sufficient proportion of 2019-nCoV infected travellers to avoid entry of infected travellers.
Evaluation of an Infrared Thermal Detection System for Fever Recognition During the H1N1 Influenza Pandemic Hewlett, et al. 2015 (13)	• Infrared thermal detection systems (ITDSs) have been utilised in several countries to screen for fever in travellers. This study assessed the in a clinical setting. This prospective study conducted during the H1N1 influenza pandemic assessed the utility of the ITDS technology in a clinical setting. The sensitivity, specificity, positive predictive value, and negative predictive value of the ITDS to detect temperatures of ≥38.1° C in all enrolled patients were 0.58, 0.96, 0.40, and 0.98, respectively, and for temperatures of ≥38.3°C were 0.60, 0.97, 0.43,and 0.98,respectively.
Respiratory viruses in airline travellers with influenza symptoms: results of an airport screening study Jennings, et al. 2015 (14)	• Study investigates the use of a respiratory symptom screening tool at the border in predicting which travellers are more likely to be infected with specific respiratory viruses. • The positive predictive value (PPV) of any symptom for any respiratory virus infection was low at 26%.
Non-Contact Thermometers for Detecting Fever: A Review of Clinical Effectiveness Canadian Agency for Drugs and Technologies in Health 2014 (15)	• The main types of non-contact thermometers are non-contact infrared thermometers, tympanic thermometers, and thermal scanners. Non-contact infrared thermometers are held three to 15 cm away from the patient and typically measure temperature on the forehead or temple. Tympanic thermometers measure the thermal radiation from the tympanic membrane and within the ear canal. Handheld thermal scanners can be used to take a person's temperature from a greater distance than other non-contact thermometers, which may make them a good candidate for use in mass screening situations. The optimal cut-off temperature for determining fever differs for each device. However, not everyone who has an infection or is infectious will have a fever. Additionally, fevers can be lowered by using antipyretic medications. The objective of this report is to determine the effectiveness and

Source	Summary
Peer reviewed sources	
	accuracy of non-contact thermometers for the detection of febrile individuals.
Thermal Image Scanning for Influenza Border Screening: Results of an Airport Screening Study Priest, et al. 2011 (16)	• Infrared thermal image scanners (ITIS) performed moderately well in detecting fever but in this study, during a seasonal epidemic of predominantly influenza type B, the proportion of influenza-infected travellers who were febrile was low and ITIS were not much better than chance at identifying travellers likely to be influenza-infected.
Coronavirus disease-2019: Is Fever an Adequate Screening for the Returning Travelers? Bwire, et al. 2020 (9)	• Temperature screening is the major test performed at points of entry in countries with limited resources, however, recent reports on asymptomatic contact transmission of COVID-19, and of travellers who pass the screening but test positive for COVID-19 using reverse transcription polymerase chain reaction (RT-PCR) challenge this approach. Body temperature screening may miss travellers incubating the disease or travellers concealing fever during travel.
Epidemiological trends and the effect of airport fever screening on prevention of domestic dengue fever outbreaks in Taiwan, 1998-2007. Kuan, et al. 2010 (11)	• A total of 10,351 dengue cases, including 7.1% of imported cases were investigated between 1998 and 2007. The majority of indigenous dengue cases (98.5%) were significantly clustered in southern Taiwan; 62.9% occurred in the metropolitan areas. The seasonality of dengue cases showed a peak from September to November. Airport fever screening was successful in identifying 45% (244/542; 95% confidence interval 33.1-57.8%) of imported dengue cases with fever. However, no statistical difference was found regarding the impact on community transmission when comparing the presence and absence of airport fever screening.
Mass Thermography Screening for Infection and Prevention: A Review of the Clinical Effectiveness Canadian Agency for Drugs and Technologies in Health 2014 (8)	• Infrared thermography (IRT) may be influenced by several confounding factors including age and outdoor temperature. In addition, results from studies looking at IRT as a tool to detect fever tend to have small PPVs due to the small prevalence of febrile passengers. However, advantages of using IRT include its ability to screen mass numbers of individuals and reduce close contacts with infected individuals. • One prospective study found that infrared thermography readings correlated moderately well with temperature readings taken using a conventional method (oral, aural, or axillary). One prospective study and four retrospective studies found that fever screening using a combination of infrared thermography, health declaration forms, and a conventional method at international airports had low sensitivity for detecting influenza viruses and dengue fever.
Screening for Middle East Respiratory Syndrome Coronavirus Among	• A report of screening 28,197 returning pilgrims for Middle East respiratory syndrome coronavirus (MERS-CoV). Those with a body temperature of >38°C and respiratory symptoms were sent

Source	Summary
Peer reviewed sources	
[Febrile Indonesian Hajj Pilgrims: A Study on 28,197 Returning Pilgrims] Amin, et al. 2018 (10)	to the airport clinic to have an oropharyngeal swab and a bacterial culture. Fifteen pilgrims had fever (>38°C) accompanied by respiratory symptoms; of these, 12 patients were diagnosed with upper and lower respiratory tract infections and three patients with pneumonia. However, none of them were found to be infected with MERS-CoV.
[Fever Screening During the Influenza (H1N1-2009) Pandemic at Narita International Airport, Japan] Nishiura, et al. 2011 (12)	• Narita International Airport used an infrared thermoscanner (n = 1,049) from September 2009 to January 2010 to detect fever (38.0°C) in order to identify H1N1-2009 cases upon arrival. The sensitivity of fever for detecting H1N1-2009 cases upon arrival was estimated to be 22.2% (95% confidence interval: 0, 55.6) among nine confirmed H1N1-2009 cases, and 55.6% of the H1N1-2009 cases were under antipyretic medications upon arrival. The sensitivity and specificity of the infrared thermoscanners in detecting hyperthermia ranged from 50.8-70.4% and 63.6-81.7%, respectively. The PPV appeared to be as low as 37.3-68.0%.

Appendix 1

PubMed search terms

((((((((((((("diagnosis"[MeSH Subheading] OR "diagnosis"[All Fields]) OR "screening"[All Fields]) OR "mass screening"[MeSH Terms]) OR ("mass"[All Fields] AND "screening"[All Fields])) OR "mass screening"[All Fields]) OR "early detection of cancer"[MeSH Terms]) OR (("early"[All Fields] AND "detection"[All Fields]) AND "cancer"[All Fields])) OR "early detection of cancer"[All Fields]) OR "screen"[All Fields]) OR "screenings"[All Fields]) OR "screened"[All Fields]) OR "screens"[All Fields]) AND ((((("pandemic s"[All Fields] OR "pandemically"[All Fields]) OR "pandemicity"[All Fields]) OR "pandemics"[MeSH Terms]) OR "pandemics"[All Fields]) OR "pandemic"[All Fields])) AND (((((("temperature"[MeSH Terms] OR "temperature"[All Fields]) OR "body temperature"[MeSH Terms]) OR ("body"[All Fields] AND "temperature"[All Fields])) OR "body temperature"[All Fields]) OR "temperatures"[All Fields]) OR "temperature s"[All Fields])

324 hits on 12 February 2021

Inclusion and exclusion criteria

Inclusion	Exclusion
• Population: People entering settings that require infection prevention and screening	• Non-empirical studies

Inclusion	Exclusion
• Intervention: Temperature/thermal screening • Outcomes: Sensitivity in identifying infected persons or other related outcomes	

Original search 9 April 2020	Updates
19 February 2021	• Search re-run • New relevant systematic review articles added to table • In-brief updated to reflect new evidence • New World Health Organisation publication added to in-brief

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