

Evidence check

20 March 2020

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Telemedicine in intensive care units – An evidence check

Question

What telemedicine models or interventions are associated with improved outcomes for people in the intensive care unit?

In brief

- In the setting of intensive care units (ICU), telemedicine generally uses audio visual technologies to assist in patient care by connecting an intensive care specialist who is not on site
- There are two models of telemedicine in ICUs that are most commonly described; hub-and-spoke model and virtual consultations
- Hub-and-spoke models describe a model which uses a single remote centre (hub) in a fixed location to provide tele-critical care services to multiple local locations (spokes) simultaneously. Differences in definitions of the model make it challenging to draw conclusions on outcomes, but some studies show a reduction in hospital mortality
- Virtual consultations involves a remote intensivist virtually reviewing one patient at a time using audio-video connectivity. It has shown some improvement in reducing ICU and total hospital mortality, but no significant difference in length of stay in pre/post studies

Background

Telemedicine is a proposed solution to address inadequacies in resources, access to specialist expertise and variability in clinical outcomes in ICU. (1) In the ICU setting, telemedicine generally uses audio visual technologies to assist in patient care where there is not an intensive care specialist on site. Internationally, care models range from simple video consultation liaison services to complex and expensive remote 24 hour bedside surveillance. (2) Tele-critical care continues to evolve in multiple domains, including organizational structure, technologies, expanded-use case scenarios, and novel applications. (3)

Methods

PubMed was searched to identify the peer reviewed literature using the following search strings on 20th March 2020. A supplementary search was done to identify and studies specifically on telemedicine in Covid-19.

PubMed search string: (((("intensive care"[title/abstract] OR "ICU"[title/abstract] OR "critical care"[title/abstract] OR "Intensive Care Units"[MeSH Terms])) AND ((telemedicine[MeSH Terms] OR (telemedicine[Title/Abstract] OR telehealth[Title/Abstract] OR virtual[Title])) AND (2010:2020[pdat])) AND (((systematic[tiab] AND review[tiab]) OR guideline[pt] OR Practice Guidelines as Topic[mh])) = 41 hits on 20 March 2020

Supplementary search string: ((2019-nCoV[title/abstract] or nCoV[title/abstract] or covid-19[title/abstract] or covid19[title/abstract] or "covid 19"[title/abstract] OR "coronavirus"[MeSH Terms] OR "coronavirus"[title/abstract])) AND ((telemedicine[MeSH Terms] OR telemedicine[Title/Abstract] OR telehealth[Title/Abstract] OR virtual[Title]))

Inclusion criteria

- Systematic reviews and guidelines
- Telemedicine used in the Intensive care unit setting
- 2010 to current

Exclusion criteria

- Paediatric/neonate intensive care units (PICU and NICU)
- Clinicians attitudes towards telemedicine
- Cost effectiveness studies
- Studies not published in English

Results

Peer reviewed literature

Eight systematic reviews were included, with the majority of included studies being pre/post studies. A recent narrative review has also been used as background for definitions/backgrounds on some of the models. Overall, virtual consultations and the hub-and-spoke' model were the most commonly described tele-health structures in this setting. A variation of the hub-and-spoke model was also described, a hub-node-spoke model, which included an additional level where multiple remote nodes providing tele-critical care clinician services to multiple local spokes. (3) Tele-critical staffing structure, which is introducing an advanced practice provider role compared to usual staffing, is an emerging research area. (3)

Hub and spoke model or 'Tele-ICU'

A centralised hub-and-spoke program uses a single remote centre (hub) in a fixed location to provide tele-critical care services to multiple local locations (spokes) simultaneously. The hub has dedicated staff, and a software solution providing the tele-critical care team with real-time remote access to patients' electronic medical records and video-teleconferencing to patient's rooms. (3) Clinical practice adherence improvement has been shown with this model. (4) In another review, the results of the two included studies showed a reduction in hospital mortality in patients receiving the telemedicine with clinical decision support for critical care. Here telemedicine/hub-and-spoke model was described as continuous electronic recording of patients' vital signs at the bedside linked to a computer system enabling display of real-time data for a remotely located team of critical care specialists including doctors, available 24/7. (1)

Although the following review did not use the same terminology, the principals of hub-and-spoke model were described and therefore results included here. The review included a variety of tele-ICU models ranging from exclusively reactive systems, where tele-ICU staff was available via telephone on an as-

needed consultative basis, to the more commonly used proactive systems, where patients were continuously monitored in real time via videoconferencing, telemetry, and access to the electronic medical record. Tele-ICU coverage was associated with lower ICU mortality and length of stay but not with lower in-hospital mortality or hospital length of stay. (5)

Another review included multiple models and although not exclusively hub-and-spoke models, results have been included here as the predominant model used. The review included a variety of telemedicine studies including: video teleconferencing, a robotic telepresence program, audio video monitoring and a data-monitoring system that generated alerts and a program of intensivist-led remote monitoring. Telemedicine was associated with lower ICU and hospital mortality among critically ill patients, although effects varied among studies and may be overestimated in nonrandomized designs. (6)

Telehealth/virtual consultations

Virtual consultations were also described as a de-centralised program structure and a point-to-point system. This generally involves audio-video connectivity where a remote intensivist virtually reviews one patient at a time at a local location. (3) A recent (2019) systematic review was undertaken evaluating telehealth chronic care consultations. In this study, telehealth consultations were defined as the use of telehealth to facilitate collaboration between two or more providers, often involving a specialist, across time and/or distance. These consultations reduced ICU and total hospital mortality with no significant difference in ICU or hospital length of stay. (7) In another systematic review, both the Centralized Monitoring and Virtual Consultant Models showed clinical practice adherence improvement. (4)

Outcomes for telehealth (when the model was not explicitly described)

A recent (2019) systematic review exploring the effect of tele-ICU implementation with regard to ICU mortality. 13 pre-post studies were included, and tele-ICU implementation was associated with an overall reduction in ICU mortality. The definition of tele-ICU was not explicitly defined. In twelve studies a centralised model was used, and in one a virtual consultant. (8)

One systematic review and meta-analysis provided limited evidence that tele-ICU approaches may reduce the ICU and hospital mortality, shorten the ICU length of stay, but there was no significant effect in hospital length of stay. Implementation of Tele-ICU programs substantially costs and its long-term cost-effectiveness is still unclear. (9) Only the abstract was available and the telemedicine programs were not described here.

Grey literature

Google was searched using the following terms “how has technology been used in intensive care units” and “telemedicine in the intensive care unit”.

The [College of Intensive Care Medicine of Australia and New Zealand](#) released guidelines in 2013. It describes telemedicine as using audio visual technologies to assist in patient care where the ICU does not have an intensive care specialist on site. Minimum standards include a formal agreement between the site providing the ICU specialist and the site receiving the support, good quality equipment, trained staff, documentation and quality assurance.

News articles have reported how hospitals have used telemedicine to improve patient care. [A small hospital in Florida](#) partnered with Advanced ICU Care to give patients in the hospital’s 12-bed Intensive Care Unit quick access to intensivists via a tele-ICU platform. It has enabled better staff ICUs during nights and weekends, allows the hospital to keep their patients in the community and has improved

response time. [Another system in Carolina](#) monitors ICUs in ten of its hospitals from a command centre which is staffed 24/7 with a rotating crew nurses and doctors who specialize in critical care.

Telemedicine in ICUs in Covid-19

For this section, no restrictions on study design were applied. A google search plus the supplementary PubMed string was undertaken.

Electronic intensive care unit monitoring programs are described which allow nurses and physicians to remotely monitor the status of 60-100 patients in ICUs in multiple hospitals. This is ideal for monitoring sicker patients. It can reduce health care workers' contact with infected patients in the ICU, however technological and staffing complexities make it impossible to create such a program on short notice. (10)

Video should be used with telephone for telemedicine in Covid-19. This approach may form part of a wider strategy of remote care for covid-19 that includes automated triage, isolation of potentially contagious patients within care facilities, and electronic monitoring in intensive care units monitoring. (11)

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Appendices



Health

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Study	Study design	Aim	Telehealth mode	Results
Totten 2019	Systematic review (233 included studies)	Effectiveness of telehealth consultations	Telehealth consultations	Remote intensive care unit (ICU) consultations likely reduce ICU and total hospital mortality with no significant difference in ICU or hospital length of stay.
Ramnath 2014	Systematic review (91 included studies)	Compares the Centralized Monitoring and Virtual Consultant tele-ICU Models.	Centralized Monitoring and Virtual Consultant tele-ICU Models	Both the Centralized Monitoring and Virtual Consultant Models showed clinical practice adherence improvement.
Mackintosh 2016	Systematic review (2 included studies)	Determine the impact of critical care telemedicine (with clinical decision support available 24/7) on intensive care unit (ICU) and hospital mortality and length of stay	Continuous electronic recording of patients' vital signs at the bedside which was linked to a computer system enabling display of real-time data and, and use of clinical decision-making algorithms and electronic alerts by a remotely located team of critical care specialists including doctors, available 24/7	The results of the two included studies showed a reduction in hospital mortality in patients receiving the intervention.
Fusaro 2019	Systematic review (13 included studies)	To explore the effect of tele-ICU implementation with regard to ICU mortality	In twelve studies a centralised model was used, and in one a virtual consultant.	Tele-ICU implementation was associated with an overall reduction in ICU mortality. The definition of tele-ICU was not explicitly defined.
Chen 2018	Systematic review (19 included studies)	To evaluate the impact of telemedicine programs in intensive care unit (Tele-ICU) on ICU or hospital mortality or ICU or hospital length of stay	Not further described	Tele-ICU approaches may reduce the ICU and hospital mortality, shorten the ICU length of stay, but have no significant effect in hospital length of stay.

<p>Young 2011</p>	<p>Systematic review (13 included studies)</p>	<p>To examine the impact of telemedicine ICU (tele-ICU) coverage on mortality and length of stay</p>	<p>Exclusively reactive systems, where tele-ICU staff was available via telephone on an as-needed consultative basis, to the more commonly used proactive systems, where patients were continuously monitored in real time via videoconferencing, telemetry, and access to the electronic medical record.</p>	<p>Tele-ICU coverage was associated with lower ICU mortality and length of stay but not with lower in-hospital mortality or hospital length of stay.</p>
<p>Wilcox 2012</p>	<p>Systematic review (11 included studies)</p>	<p>To evaluate the impact of telemedicine on patients' outcomes</p>	<p>Video teleconferencing, a robotic telepresence program and a clinical information system as a co-intervention, audio video monitoring and a data-monitoring system that generated alerts based on abnormal vital signs or laboratory or radiologic tests, VISICU software eICU program of intensivist-led remote monitoring.</p>	<p>Telemedicine was associated with lower ICU and hospital mortality among critically ill patients, although effects varied among studies and may be overestimated in nonrandomized designs.</p>
<p>Hollander 2020</p>	<p>Perspective</p>	<p>Leveraging tele-medical innovations for the response to Covid-19</p>	<p>Electronic intensive care unit monitoring programs, which allow nurses and physicians to remotely monitor the status of 60 to 100 patients in ICUs in multiple hospitals are ideal for monitoring sicker patients.</p>	<p>Technological and staffing complexities make it impossible to create such a program on short notice, but rapid deployment of the two-tablet approach can reduce health care workers' contact with infected patients in the ICU.</p>

<p>Greenhalgh 2020</p>	<p>Editorial</p>	<p>Video consultations for covid-19</p>	<p>Video – video should supplement, not replace, the telephone, for which there is a considerable evidence base from research studies and some guidance.</p>	<p>It may form part of a wider strategy of remote care for covid-19 that includes automated triage, isolation of potentially contagious patients within care facilities, and electronic monitoring in intensive care units monitoring.</p>
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