ORIGINAL ARTICLE

Resuscitation by video in northern communities

Michael Jong

Memorial University, Labrador Health Centre, Goose Bay, Canada

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ABSTRACT

Objectives. This paper describes the set-up of a videoconference system to support resuscitation in remote communities and the outcome of the video support.
Study design. A case study examining the use of videoconferencing to lead life support remotely.
Methods. Resuscitations in these communities were led remotely by a physician through videoconferencing. The videoconference unit is set up in the corner of the room for optimal viewing of the patient and the monitors. The keys to success are a secure 512 kbps broadband service, user-friendly videoconference units and appropriate training.
Results. Over the past 3 years in Labrador, 6 patients with major trauma, pulseless tachyarrhythmias, cardiogenic shock, septic shock and severe hypothermia were successfully resuscitated.
Conclusion. Oversight of life support via videoconferencing with the right set-up and training can lead to successful resuscitation in remote communities.
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Keywords: videoconferencing, life support, resuscitation, remote communities

INTRODUCTION

As of 2005, 21% of Canada's population lived in rural communities with a population of less than 10,000, and only 9.4% of physicians live and work in these communities. The greatest discrepancies in rural-urban death rates are seen among young people – rural Canadians less than 45 years of age have about a 30% higher mortality rate than urban dwellers of the same age (1). The further one lives away from the city, the higher morbidity and mortality rates are. The highest death rates are in the most remote communities. In fact, the life span of most isolated rural Canadians is 3 years shorter than their urban counterparts (2). Life expectancy in the Canadian male Inuit is 12.6 years less than the general Canadian population, with the greatest disparity in the 20–24 years age group (3).

The difficulty of providing health care services to the circumpolar population has a long history. The ability to manage critically ill patients in remote communities is often compromised because the resident health providers lack the capacity to provide resuscitation beyond basic cardiopulmonary resuscitation (CPR). It is often not possible to maintain CPR for prolonged periods and medical evacuation can take hours or days because of distance and weather. Where broadband is available, videoconferencing permits the provision of advanced resuscitation efforts in communities where this is otherwise not feasible.

There is very little literature on resuscitation or advanced life supports via video. Most of the reported experience is on video instruction for simulated resuscitation. Video audits have been found to be useful for assessing proficiency during simulated training in adult basic resuscitation, critical care, trauma resuscitation and pediatric trauma resuscitation (4–8). In simulated CPR, video communication can delay the commencement of CPR but improves the rate and depth of chest compressions (9). The delay may be related to the set-up and team preparedness. In simulated CPR with Resusci® Anne, audiovisual animated CPR through a cellular phone resulted in better scores with a checklist assessment (10). Supervising simulated trauma life support by telemedicine at 384 kbps was found to be satisfactory (11). In simulated cardiac arrests, dispatchers found video-calls provided adequate functionality to support CPR and found that the CPR might be of better quality, but there was a risk of "noise" (12). It may be possible to use 3G videophones for simulated CPR (13). However, simulated dispatcher-assisted CPR delivered by untrained students, guided by video or audio calls using 3G mobile videophones, did not improve CPR (14). Remote real-time telesonography during acute trauma resuscitation helped to enhance clinical care in a remote site where the expertise in ultrasonography was limited (15).

The context

Labrador, with a geographic area of 294,300 square kilometres, is slightly larger than the United Kingdom. The remote communities can only be accessed by air from the regional health centre in Happy Valley-Goose Bay. Family physicians based in the regional centre visit these communities for 5 days every 4 to 6 weeks. Regional nurses provide primary health care for residents in remote communities. As in most small communities in Canada, all the staff, nurses, nursing aides and maintenance personnel are part of the resuscitation team.

Oversight of resuscitation by video evolved as family physicians grew accustomed to showing regional nurses how to perform procedures that they had never done before. This included suturing complex lacerations and minor surgery. We have used video-facilitated resuscitation for the 7 most northern remote communities in our region over the past 3 years.

METHODS

Videoconference set-up

Telehealth equipment must be accessible if it is going to be used. Given the urgency of resuscitation situations, this is crucial. The non-robotic videoconference units are permanently stationed in a room at the centre of the regional emergency department. Mobile videoconference units are located in the resuscitation room of all the remote nursing stations. They are set to the height of a tall person to permit easier viewing by all participants involved in the resuscitation. The mobile units in the remote centres are wheeled to other rooms for regularly scheduled elective consultations and for non-critical acute consultations. This set-up permits for maximum usage of each of the videoconference units.

A split screen is used on the units, with the larger image showing the remote site and the smaller image showing the command centre, allowing for visualization of both images at both sites. At the site of the resuscitation, the larger of the 2 images is of the command centre, allowing the resuscitation participants to see what the team leader is demonstrating to them. The smaller image shows the remote site as it is being seen by the team leader. This gives the resuscitation team the ability to see what the team leader is seeing, and if need be, to step out of the way.

The physician at the regional centre must be able to control the video camera remotely. The camera needs the ability to zoom, to rotate 180 degrees sideways, and 45 degrees up and down. It is preferable that the physician remotely presets a wide view of the room, the cardiac monitor and a close-up of the patient's upper torso.

The resuscitation team is usually too busy to fiddle with camera settings, and there is no need for the remote team to control the video camera at the command centre. Autofocus is important at both sites.

The videoconference units require a good audioconference sound system. The team leader at the distant command centre may have a headset to reduce the distraction of the background noise in the emergency department.

IT infrastructure

All health information transmissions are conducted through a secure and dedicated line from a local phone carrier via microwave transmission using high symmetric digital subscriber lines with a minimum bandwidth of 256 kbps. The IT infrastructure is part of a Local Area Network (LAN). A secure digital line means no one else except the health centre can use this line. This has prevented the choppiness and blurring of picture quality with movements that we used to experience when we had an encrypted signal but no personal secure digital pipe. In small communities, it is unlikely for others to be using other IT applications because all able bodies are involved in resuscitation. This means that the full bandwidth of 256 kbps is available for videoconferencing.

We used the Tandberg 2000 MXP videoconference hardware and software. This did not include an electronic medical record.

Room set-up

The best view of the resuscitation effort is from an oblique angle at the end of the bed (See Fig.1). The video camera sits on top of the videoconference unit, ideally at about 2.13 metres high so the camera has a clear view of the person managing the airway at the end of the bed and the person doing chest compressions who stands on the opposite side of the bed from where the videoconference unit is located. The height of the camera allows for the leader at the distant command centre to see the whole scene an angle above the patient. The video screen needs to be high enough to enable all the resuscitation team members to see the team leader.

The videoconference unit is usually in one corner of the room. The bed and the defibrillator with its monitor are best located in the opposite corner diagonally from the videoconference unit. Other monitors are ideally located at head height at the end of the bed so they can be viewed by the resuscitation team and the remote team leader via the video camera.

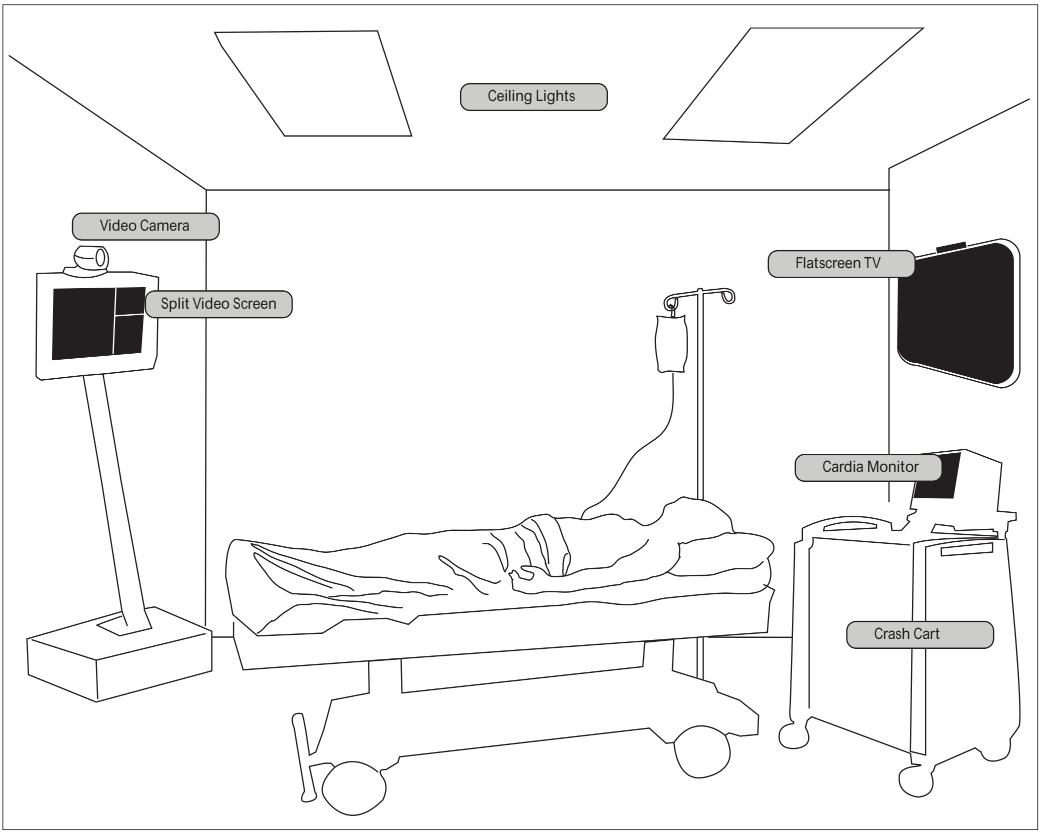

Figure 1. Room setup.

RESULTS

In the 7 remote communities with a total population of 3,200 people, we facilitated the resuscitation of 2 patients per year through videoconferencing. So far, all who have needed life support were resuscitated successfully. The remote team, consisting of regional advanced care nurses, nursing aides and maintenance personnel, resuscitates and stabilizes the patients until the medevac team can get to the community. In our most northern community the plane is not able to land at night. Other challenges include inclement weather that can delay the arrival of the medevac team for as long as 3 days. For our patients, the duration before arrival of the medevac team in good weather is 2 to 8 hours, with a mean duration of 3 hours. These 6 patients may not have survived without the advanced resuscitation (see Table I). In the past, with only telephone consults, it would have been difficult to lead the resuscitation efforts. Videoconferencing has made this easier.

Case 1

A young patient with a gunshot wound to the chest was brought to a remote nursing station

Table I. Case studies.

Case	Age range	On-site team members	Supporting clinician at distant site	Distance from referring facility by plane	Diagnosis	Life support	Interventions
1	Young adult	3 nurses, 2 nursing aides 1 maintenance personnel	Family physician	260 km	Gunshot, Hypoxia, Shock	ATLS	CPR Endotracheal intubation Bilateral needle thoracocentesis followed by chest tubes IV fluids Nasogastric tube Urinary catherization
2	Middle age adult	2 nurses 1 nursing aide	Family physician	200 km	Myocardial Infarction Ventricular fibrillation	ACLS	CPR Defibrillation SL & IV medications
3	Elderly	2 nurses 1 nursing aide 1 maintenance personnel	Family physician	250 km	Myocardial Infarction Pulseless VT	ACLS	CPR Defibrillation IV medications
4	Elderly	2 nurses 1 nursing aide	Family physician	250 km	COPD Heart failure	ACLS	Inhaled & IV medications
5	Teen	3 nurses I nursing aide	Family physician	260 km	Septic shock Rhabdo-myolysis	APLS	IV fluid resuscitation and medications
6	Elderly	3 nurses 1 nursing aide 1 maintenance personnel	Family physician	260 km	Hypothermia Alcohol intoxication	ATLS	Active rewarming

in shock with a Glasgow Coma Score (GCS) of 3. There was poor air entry on both sides of the chest. While 2 litres of normal saline were running full, a nurse at the remote site was shown how to perform a needle thoracocentesis using the finger of a rubber glove as a flutter valve. This resulted in improvement of oxygen saturation to 90%. There was blood on the right side and air in the left. While the patient was still intoxicated, an endotracheal tube was inserted and assisted ventilation provided. Further sedation was provided with intravenous (IV) administration of midazalom and fentanyl. Two chest tubes were subsequently inserted with improvised underwater drains. About 900 ml of blood was removed from the right pleural space and 20 ml of blood from the left. The medevac team picked up the patient to transfer him to the hospital in the morning at first light, 8 hours later. The patient was breathing spontaneously but sedated, and was in stable condition with normal vitals and urinary output. Imaging at the referral hospital showed chest tubes, endotracheal tube and nasogastric tube in proper positions, 2 fractured ribs, numerous bullet fragments, pulmonary contusion and minimal pleural effusions.

Case 2

A middle-aged patient presented at the nursing station with chest pain. The patient was given 4 l/min of oxygen by nasal cannula, nitroglycerin 0.4 mg S/L and IV access. While the EKG was being faxed, the patient arrested. A video link was established when CPR was initiated. The patient had ventricular fibrillation and was successfully defibrillated with monophasic 360 joules according to directions from the remote physician. The EKG showed ST elevation and anterior myocardial infarction. The patient had recurrent non-sustained ventricular tachycardia, and this was observed. He received 300 mg aspirin orally, 10 mg morphine IV, 50 mg dimenhydrinate IV, 100 mcg lovenox S/C, 5 mg metoprolol IV, 50 mg ranitidine IV, 5 mg ramipril orally and 80 mg atorvastatin orally. There were no thrombolytics in the remote communities and he received tenecteplase after the medevac team arrived just before 6 hours post onset of chest pain. He was transferred to hospital.

Case 3

An elderly patient presented with generalized weakness and shortness of breath. The faxed EKG showed acute anterior myocardial infarction. When a video link was established, the patient was pale and dyspneic. During the video link she had pulseless ventricular tachycardia. CPR was initiated and she was defibrillated with monophasic 360 joules. CPR was continued for another 2 minutes. She received intranasal oxygen, S/L nitroglycerin 0.3 mg X 3, morphine 5 mg IV and dimenhydrinate 50 mg IV. The patient remained stable until the medevac team picked her up 5 hours later.

Case 4

An elderly patient with known COPD and an old inferior myocardial infarction presented at the nursing station with increasing shortness of breath. Oxygen 4 l/min by nasal cannula was given and IV access started when the video link was established. The patient was hypoxic and in shock. Salbutamol inhaler 4 puffs and ipratropium inhaler 4 puffs every 5 minutes were delivered by aerochamber with mask. EKG was read immediately by video and showed no new myocardial infarction. Dopamine drip was started and titrated. Dobutamine was added to dopamine when the systolic pressure reached 100 mmHg. The patient was subsequently given 100 mg hydrocortisone IV, 400 mg ciprofloxacin IV and 25 mg captopril orally. Monitoring of the patient and titration of the medications was easier because of the ability to correlate the vitals, see and talk to the patient. The medevac team picked him up 4 hours later.

Case 5
A teen was brought in to the nursing station with fever. When the video link was connected, the patient had oxygen 4 l/min by nasal cannula and IV access. The video allowed rapid confirmation of septic shock and purpura. Blood culture was taken and the patient was given 2 mg ceftriaxone IV and a 1 litre bolus of normal saline followed with 250 ml/hour. The 90 ml of catheterized urine was tea-coloured and was positive for blood and protein on a dipstik. His glucometer was 5.8 mmol/l. He was started on a dopamine drip, 250 mg hydrocortisone IV and 100 mmol sodium bicarbonate IV. When the medevac team picked him up 4 hours later, his systolic blood pressure was above 100 mmHg and was he was diuresing at >100 ml/hour. He had pneumococcal septicemia and rhabdomyolysis. Management of new findings in the patient was much easier by video and made it less likely to miss the purpura and the tea-coloured urine.

Case 6
An elderly woman was intoxicated, found lying in a snow bank and brought in unconscious. Her GCS was 5, blood pressure 102/74 mmHg, respiratory rate 8/min and oxygen saturation 60%. Through a video link, it was made clear that she was dry, cold and cyanotic. High-flow oxygen with rebreather mask was started. A low temperature thermometer was found and instruction was provided on how to insert the probe into the rectum. The rectal temperature was 28°C. Warm blankets were used to cover the trunk and a toque was placed on the head. When the nurses managed to get IV access, normal saline warmed by microwave to 32°C was given at 150 ml/h. Her glucometer reading was 8.4 mmol/l. A urinary catheter provided 300 ml of clear urine. 500 ml of 32°C normal saline was instilled in her bladder every 20 minutes. Warm IV bags were placed in her axillae and over her groin. A long oxygen tube coiled through hot water in a basin provided warmed oxygen. She was monitored and as her temperature crept up about 1°C per hour she only had premature ventricular ectopics and no malignant arrhythmias. She recovered uneventfully with active and passive rewarming, and requested to go home after 12 hours in the nursing station.

DISCUSSION

Advantages of videoconferencing
Videoconferencing allows for a rapid assessment of the situation, assignment of tasks and demonstration of procedures. It works just as well as being in the room but forces the remote team leader to assign tasks and not be involved in any procedures. With the capability to zoom, the team leader does not have to walk closer to the monitors to see the vitals, rhythm and drip rate. Control of the camera is managed with the hands and can be faster than walking back and forth. The big view of the room provides for better control of ongoing activities. It also allows the remote team leader to help locate things in the room for the resuscitation team.

There are good opportunities to summarize the situation with an action plan and provide feedback. The remote team can hear the instructions and watch the demonstration of a procedure when required. When the situation is under control, the patient is just like any other patient in one of the trauma/resuscitation bays. Once the patient is stable, he/she can be observed virtually until the medevac team arrives.

Pitfalls to avoid

During the initial stages of video facilitated resuscitation, we often attract onlookers at the command centre. The background chatter and movements of the onlookers are distracting for the remote resuscitation team. A wireless headset and microphone help to reduce the background noise. The ability to close the door in the videoconference room is also useful.

Good lighting at the remote resuscitation room is important. The lights should be diffuse and should not reflect on the monitor screens, obscuring the team lead's view. It is useful to check these beforehand and, if necessary, to mark the locations for the monitors and set the angle of the monitor screen for best visualization locally and remotely. We mark the best location for the resuscitation bed on the floor. When equipment and beds are moved for cleaning and other purposes they must be returned to the right locations.

Training

All staff members, including the maintenance and clerical personnel in the remote communities need to be trained in basic resuscitation (BCLS and BTLS). All nursing staff must be trained in advanced resuscitation (ACLS plus a modified version of ATLS for remote practice). In addition, we conduct simulation exercises for our physicians to lead the resuscitation in remote sites via video and for the remote team to practise life support skills.

The physician leading the resuscitation needs to be proficient in controlling the remote video camera. With experience it is possible to acquire unconscious competence in the control of the camera.

Conclusion

Oversight of life support via videoconferencing can facilitate resuscitation in remote communities. It brings the physician virtually to remote communities to lead the resuscitation team consisting of nurses, nursing aides and maintenance personnel.

Financial and interpersonal conflict of interest
None declared.

The Labrador-Grenfell Health Ethics committee approved this paper.

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REFERENCES

1. DesMeules M, Pong R. How healthy are rural Canadians? An assessment of their health status and health determinants. Ottawa, ON: CIHI; September 2006 [cited 2006 Sept 19]. Available from: http://www.phac-aspc.gc.ca/publicat/rural06/pdf/rural_canadians_2006_report_e.pdf
2. Statistics Canada. "Life expectancy" health reports, 11(3) (Winter 1999). Ottawa, ON: Statistics Canada, Catalogue 82-003. [cited 2009 Nov 16]. Available from: gc.ca/Collection-R/Statcan/82-003-XIE/0039982-003-XIE.pdf
3. Peters P. What age groups and which cause of death contribute most to the lower life expectancy on the Inuit-inhabited areas of Canada? [abstract]. In: Abstract book, 14th International Congress on Circumpolar Health. Securing the IPY legacy: from research to action. Yellowknife: ICCH14; 2009. p. 100.

4. Vnuk A, Owen H, Plummer J. Assessing proficiency in adult basic life support: student and expert assessment and the impact of video recording. Med Teach 2006; 28(5):429–434.
5. Yang CW, Wang HC, Chiang WC, Chang WT, Yen ZS, Chen SY, et al. Impact of adding video communication to dispatch instructions on the quality of rescue breathing in simulated cardiac arrests – a randomized controlled study. Resuscitation 2008;78(3):327–332.
6. Kim J, Neilipovitz D, Cardinal P, Chiu M, Clinch J. A pilot study using high-fidelity simulation to formally evaluate performance in the resuscitation of critically ill patients: the University of Ottawa critical care medicine, high-fidelity simulation, and crisis resource management I study. Crit Care Med 2006;34(8):2167–2174.
7. Fitzgerald M, Gocentas R, Dziukas L, Cameron P, Mackenzie C, Farrow N. Using video audit to improve trauma resuscitation – time for a new approach. Can J Surg 2006;49(3):208–211.
8. Oakley E, Stocker S, Staubli G, Young S. Using video recording to identify management errors in pediatric trauma resuscitation. Pediatrics 2006;117(3):658–664.
9. Yang CW, Wang HC, Chiang WC, Hsu CW, Chang WT, Yen Zs, et al. Interactive video instruction improves the quality of dispatcher-assisted chest compression-only cardiopulmonary resuscitation in simulated cardiac arrests. Crit Care Med 2009;37(2):490–495.
10. Choa M, Park I, Chung HS, Yoo SK, Shim H, Kim S. The effectiveness of cardiopulmonary resuscitation instruction: animation versus dispatcher through cellular phone. Resuscitation 2008;77(1):87–94.
11. Tachakra S, Jaye P, Bak J, Hayes J, Sivakumar A. Supervising trauma life support by telemedicine. J Telemed Telecare 2000;6(Suppl 1):S7–S11.
12. Johnsen E, Bolle SR. To see or not to see – better dispatcher-assisted CPR with video-call? A qualitative study based on study based simulated trials. Resuscitation 2008;78(3):320–326.
13. Tränkler U, Hagen O, Horsch A. Video quality of 3G videophones for telephone cardiopulmonary resuscitation. J Telemed Telecare 2008;14:396–400.
14. Bolle SR, Scholl J, Gilbert M. Can video mobile phones improve CPR quality when used for dispatcher assistance during simulated cardiac arrest? Acta Anaesthesiol Scand 2009;53(1):116–120.
15. Dyer D, Cusden J, Turner C, Boyd J, Hall R, Lautner D, et al. The clinical and technical evaluation of a remote telementored telesonography system during the acute resuscitation and transfer of the injured patient. J Trauma 2008;65(6):1209–1216.

Michael Jong
Professor of Family Medicine
Memorial University, Labrador Health Centre
PO Box 7000, Stn. C
Goose Bay, NL, A0P 1C0
CANADA
Email: mjong@hvgb.net