"Night on Call": Evaluating a Serious Game for Knowledge Application in a Transition to Residency Course at a Regional Medical Campus

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Abstract

Educators are looking for innovations that disrupt education. Games, as an educational learning tool, force learners to apply knowledge in new ways and use critical thinking skills. The interactivity and competition in games are motivating factors. A group of educators in Charlotte, NC, designed an educational game, "Night on Call," as the capstone of the Transition to Residency course for 4th year medical students at a branch campus of the University of North Carolina School of Medicine in Charlotte, NC. This game was designed after escape-room-style games; it featured ten different challenges, each reflecting cases, patient scenarios, or skills critical for success during the intern year. Fourth-year students participated in this game on the last day of their Transition to Residency course. Upon completion of the game, students provided feedback through an anonymous survey and a group debrief session. Overall, the students felt that this serious game was a fun way to end the Transition to Residency course and that educational games help with knowledge retention and application and the challenges reflected tasks they may see in intern year.

Introduction

Currently, the model of medical education is being challenged.[1,2] Educators are looking for innovations that disrupt education and create a new model for competency-based learning. Adult learners benefit from active engagement. "Serious games," or games used as educational learning tools, have been shown to increase learner satisfaction and knowledge over traditional methods.[3] Traditional teaching is based on knowledge dissemination and rote memorization whereas games offer engaging stimulation in which the student has to apply knowledge. Through this engagement, students may utilize a higher level of learning, such as application and analysis.[3,4] As an example, games have been used in medical education, including point-of-care ultrasound, for both the resident learner through SonoGames and the student learner through SonoSlam.[5,6]

Games in medical education do not have to be just a quiz-show style review of material. Creative games can force learners to apply knowledge in new ways and use critical thinking skills, thereby reinforcing knowledge. The interactivity and competition in games are motivating factors. Games also offer a safe environment for learners to practice.[4] According to Gorbenev, games, as opposed to conventional lectures and teaching, present students with an interesting problem and offer ways to explore the situation. In games, students have the opportunity to achieve a higher level of learning, such as application and analysis.[4] Games have a feedback mechanism, can be designed with different levels of difficulty, and serious games have a pedagogical purpose.[4] Out-of-the-box applications associated with games force a different type of learning, stimulation, and assimilation of skills and knowledge due to the

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required data understanding and manipulation inherent to approaching a novel game.

Well-designed games can introduce motivational factors and cognitive scaffolds that will help keep the learner engaged and motivated.[3] Games can break down complex tasks into more manageable concepts and can scale up in difficulty.[7] Simulated or computer-based games have the added bonus of allowing the learner to control their own pace of learning and receive immediate feedback.

A group of medical educators at Atrium Health Carolinas Medical Center, a branch campus of the University of North Carolina School of Medicine, developed a serious game as part of the Transition to Residency course. This ten-challenge contest, inspired by escape-room-style games, was called "Night on Call." This game was designed to challenge students to apply knowledge and skills gained in both the Transition to Residency course as well as throughout their four years of medical school. The challenges represented cases, patients, or skills an intern may experience, deemed important for success in intern year. We will describe the creation of the "Night on Call" escape room style challenge as well as student feedback based on an overall assessment by means of a Likert Scale and free responses.

Methods

At the conclusion of a month-long Transition to Residency course, we divided fourteen students into four groups of three and one group of two. One student was unable to attend. Each group completed all ten rooms of the "Night on Call" escape-room-style challenge. Each room or challenge represented knowledge or skill that students should have learned throughout their four years in medical school deemed important for intern year.

Planning for the Transition to Residency started eight months prior to the course, and discussion and recruitment of interested faculty started approximately three months prior to the course. Faculty members involved in undergraduate medical education as well as residents and chief residents were polled for interest. Brainstorming sessions were held with interested faculty and residents in conjunction with the Transition to Residency planning meetings. The goal of these brainstorming sessions was to discuss important topics that should be applied by a graduating medical student and to weave those topics into an escape-room-style game. The brainstorming sessions not only allowed faculty and residents to generate ideas for the game, but facilitated multidisciplinary discussions and a high level of comradery. Faculty members unable to participate were able to help recruit residents from all specialties with an interest in teaching. Faculty were also able to approach residents on an elective or educational month to help with the game. Residents from all disciplines in particular demonstrated a high level of interest in planning and proctoring the game.

The group made the decision to have the game take place over four hours including time for instructions, a break, and transitioning from room to room. A rotation and timing schedule for the morning was developed (Table 1). For each room, faculty and residents were instructed to design a challenge lasting no more than eighteen minutes. If students completed the task before the eighteen-minute cutoff, room proctors were told they could give feedback to the teams. At the end of the eighteen-minute time period, teams were given an envelope with the location of the next challenge and a clue to the next task. One faculty member was designated as the timer, who sent a group text to all the proctors to begin and end the challenge. This same faculty member also collected score sheets at the end of each time period.

Table 1: Rotation Schedule for Teams (A-E) in "Night on Call" escape room challenge.

	Time (AM)									
Room	**8:05-8:23**	**8:25 - 8:43**	**8:45 - 9:03**	**9:05 - 9:23**	**9:25-43**	**Break**	**10-10:18**	**10:20-38**	**10:40 - 58**	**11-11:18**	**11:20 - 38**
1 (IV Access)	A	E	D	C	B						
2 (Antibiotic)	B	A	E	D	C						
3 (ECG/TFCPR)	C	B	A	E	D						
4 (Hand-off)	D	C	B	A	E						
5 (Airplane)	E	D	C	B	A						
6 (Agitated Patient)							A	E	D	C	B
7 (DDR)							B	A	E	D	C
8 (Prioritization Room)							C	B	A	E	D
9 (Chutes and Ladders)							D	C	B	A	E
10 (Heads Up)							E	D	C	B	A

When discussing potential topics for challenges, our group decided to have challenges representing different procedures, antibiotic knowledge, critical EKGs, out-of-hospital scenarios, imaging interpretation, caring for an agitated patient, prioritization, and communication. Each faculty or resident designing a challenge had to provide written instructions for the challenge as well as collect or create any needed equipment. Scoring was based on time, and the time to complete each task was recorded by each proctor. Some challenges had time bonuses and delays. The ten challenges are listed below in Table 2. Appendix A details the design,

equipment, and instructions for two individual challenges.

Table 2: Ten challenges and objective for the escape room challenge

Room	Challenge	Overall Goal/Knowledge Tested
1	A is for Access	Identifying difficult IV access and using ultrasound for peripheral and central line placement
2	Antibiotic Scramble	Matching antibiotics and dosages to common illnesses
3	EKG Room	Recognition of critical EKG's and Team-Focused CPR
4	Hand-off & Phone Call Challenge	Performing appropriate hand-offs on critical patients
5	Is there a Doctor on the Plane?	Encountering common medical emergencies in an out-of-hospital scenario
6	Agitated Patient	Responding to an agitated patient
7	Dance Dance Revolution	Dance challenge with performance of common procedures
8	Prioritization Room	Prioritizing care for more critical patients and recognizing the potential for deterioration
9	Imaging Chutes and Ladders	Interpretation of critical imaging findings on X-Ray, CT, and ultrasound
10	"Heads Up" Game	Medical and Non-Medical Communication

Prior to the "Night on Call" game, room proctors were recruited from interested faculty and residents. If the faculty or resident who planned the challenge was also available to be the room proctor, then they were responsible for their own room. Otherwise, room proctors were sent the room instructions the day before. Actors in the out-of-hospital scenario were recruited from interested administrative staff.

The morning of the game, each room was set up with the proper equipment and designated with a "Night on Call Room x" sign. Proctors were given envelopes for each team containing the team's next room assignment. Proctors were also given a scoresheet for their room (Table 3). When each proctor received the "start" text from the designated timer, they started their stopwatch. When the team correctly completed the challenge, the room proctor stopped their stopwatch and recorded the time. They also record any time bonuses or delays and the total time. This total time took bonuses and delays into account. The designated timer collected all time sheets for each room and calculated each team's total time at the end of the game. These calculations were confirmed and validated by another member of the planning committee. The team with the lowest overall time was the winner.

At the conclusion of the game, students reconvened for a debriefing of the game and announcement of the winner and other awards. Students also completed an anonymous survey regarding the overall effectiveness of the game with responses based on a 5-point Likert scale and free response (Appendix B). This survey was approved through the Atrium Health Carolinas Medical Center Institutional Review Board as part of an overall study of the effectiveness of a four-week Transition to Residency course.

Table 3: Scoresheet for each room in "Night on Call" escape room challenge.

Room	Team	Time (min)	Bonus Time (total)	Time Delay	Total Time (Time - Bonus+Delay)
	A				
	B				
	C				
	D				
	E				

Results

Overall, students felt the "Night on Call" escape-room-style challenge was a fun and effective way to end the Transition to Residency course. Feedback on the overall game (Table 4) noted students' perception that educational games help with knowledge retention and application, and the challenges reflected tasks they may see in intern year.

Students ranked the challenges that involved EKG interpretation and team-focused CPR, appropriate antibiotic selection, patient hand-offs, and prioritization as their favorite challenges (Table 5).

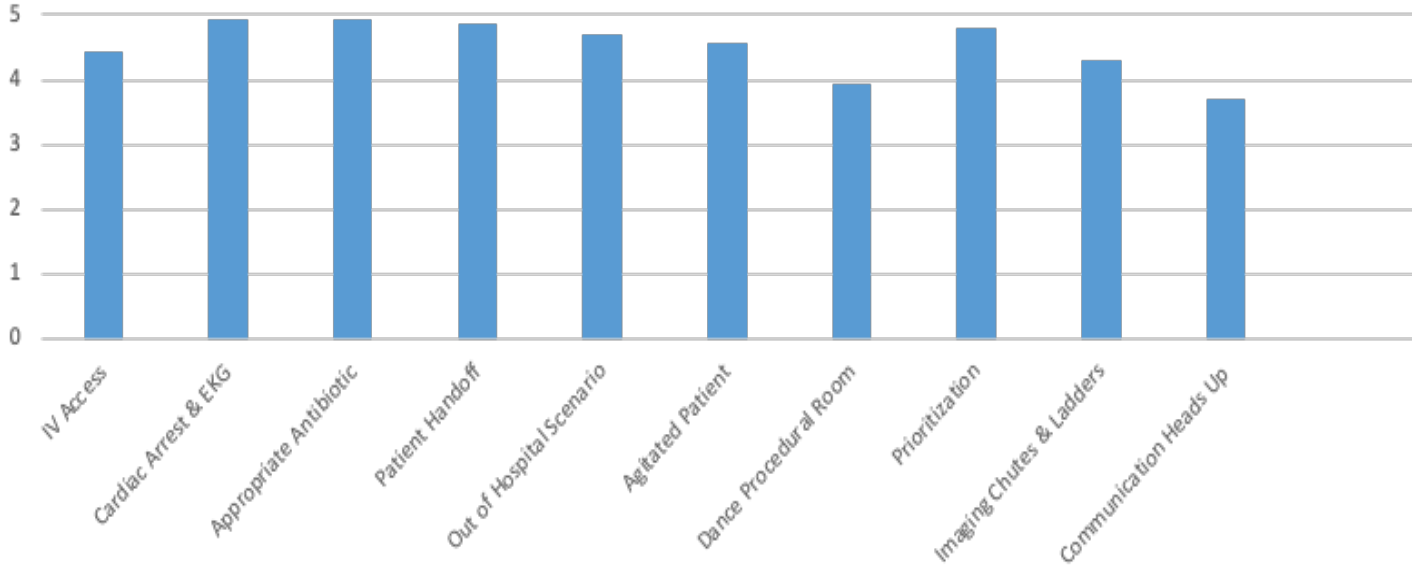
In the free response portion of the post-game survey, the students noted their favorite aspects of the "Night on Call" escape room game, including: "Not knowing what to expect," "the realism," "applying useful concepts," "making decisions, feeling the pressure," "team-work approach needed," "fun, interactive & clinically relevant," "the competitive aspect," "actually being looked to to provide answers and direction," "Being forced to make decisions," and "Best part of the Transition Course."

Students also listed ideas for improvement, including presenting to attendings as an aspect in some rooms, having them use their physical exam skills, using real phones or pager, and also wanting even harder challenges.

Table 4: Overall feedback for "Night On Call" escape room challenge.

	The Night on Call Escape Room was a fun way to end the Transition to Residency Course.	Education games like the escape room challenge help with knowledge retention.	Education games like the escape room challenge help with knowledge application.	The challenges in the escape room reflect tasks I will encounter during intern year.	I think that a team-based game like this escape room challenge is valuable in the Transition to Residency Course.
Average Score (Scored out of 5)	5	5	4.93	4.93	5

Table 5: Individual challenge ratings on a 5-point Likert Scale.



Discussion

Serious games are an educational learning tool increasing learner satisfaction and knowledge.[3] Games offer an engaging situation and force the student to apply knowledge in out-of-the-box or unexpected situations.[3,4] Not only do games offer a safe environment for learners to practice,[4] but the interactivity and competition in games are motivating factors. Well-designed games can introduce motivational factors and cognitive scaffolds, helping keep the learner engaged and motivated.[3]

Our "Night on Call" escape-room-style game offers a unique, engaging, and safe manner to challenge students to apply their knowledge gained throughout medical school and the Transition to Residency course. The structure of the ten-room game allowed the planning team of teaching faculty and senior residents to plan a variety of challenges representing many expected and unexpected aspects of the intern year. The time allotted for each room generally allowed for two to three minutes of feedback from the proctor as well. In this game, students enjoyed working through completely unanticipated problems and challenges as a team in a safe and supportive manner.

Students overall thought the escape room was a fun way to end the Transition to Residency course and helped with knowledge retention. Students also felt that the challenges helped with knowledge application and reflected tasks they will encounter in intern year, but to a lesser degree. When reviewing the feedback from the ten individual rooms, students ranked rooms that more heavily reflected advanced skills, such as medical decision-making, critical care scenarios, and prioritization, higher when compared to rooms that reflected procedural skills or communication. The imaging interpretation room received a moderate score when compared to the other rooms. Although the concept for this game was quite simple, students had to recognize and interpret a variety of images including X-ray, CT, and ultrasound images. Students did provide feedback to make some of the challenges more difficult. In future games, it will be important to continue to develop challenges that incorporate the higher-level skills such as decision-making and prioritization as well as critical scenarios in which students may feel more pressure.

Engaging clinical faculty and senior residents interested in teaching was a critical first step in game development as well as setting the parameters for each challenge. Incorporating a team of planners who teach medical students and interns allowed for a variety of challenges representing tasks or patient presentations interns may encounter, or skills important to success during the intern year. Given the large scale of this game, it was important to start

planning months ahead of the actual event. This allowed ample time to identify any gaps in volunteer staffing, schedule conflicts, and other unforeseen obstacles and adjust accordingly.

Key steps for implementation included designing the overarching structure and theme of the game and then bringing together a planning team to execute the chosen design. We also realized we would need faculty and residents to help proctor the rooms. These were not necessarily the same individuals who planned each room but rather could be there the day of the game. Although the game was four hours in duration, it was divided up into two separate two-hour blocks for faculty or residents who could only participate for a short period of time. Another key to a successful game was having a core team to review all the proposed games and ensure preparation of equipment, rooms, and personnel.

For planning and execution, it was critical to give deadlines for each room design and maintain open communication with the planning team and clear instructions for the proctors.

During the actual game, it was also important to have a member of the core team act as a ringmaster and oversee the progress of the entire game including timing, taking room proctors any additional equipment, collecting score sheets, and trouble-shooting any problems that may arise.

Following the game, it was important to get feedback from the students regarding the overall experience, what worked well, and areas for improvement. We suggest having an anonymous survey with a free response section as well as a group debrief. Overall, our students were very engaged in the game and felt the teamwork, the competitive nature, and the unexpected aspects of each room made the experience great. One limitation in this first iteration of the "Night on Call" escape-room-style game was that faculty and residents were not directly queried for feedback or satisfaction with each aspect of the game. Informal feedback from faculty and residents was verbally solicited and reflected a high level of satisfaction. Faculty and resident feedback were queried through a Google Form in subsequent years.

The escape-room-style game was developed as a capstone to a larger Transition to Residency course and represented material from both third and fourth years of medical school, as well as material reviewed in the Transition to Residency course. Students underwent a pre-test prior to the start of the transition course and a post-test immediately following the escape room challenge on the last day of the course. The multiple-choice test incorporated material from all of the didactics and workshops in the transition course. Both the question order and answer order were scrambled for the post-test. When compared to the pre-test scores (mean 73.5%, SD 7.7%), participants' post-test scores (mean 81.5%, SD 7.8%) were higher (mean of differences 7.9%, CI 3.4-12.4%, p=0.0022). One limitation of this study is that the pre- and post-test did not directly assess the impact of the game, but rather the entire transition to residency course. In the overall knowledge assessment for the transition course, 19/30 questions were on material or concepts that were in the escape room challenge.

Although this game was planned at the end of the Transition to Residency course, serious games can be incorporated throughout the medical education experience. Limitations encountered when planning a comprehensive game in this style may include having a large enough creative team to develop rooms and act as proctors. We found involving residents from several different specialties helped in developing a creative, well-rounded game representing different aspects of medicine. This format for game creation is generalizable to many different concepts and educational points in medical education. Our team had planned a new set of challenges for the "Night on Call" game as part of the 2020 Transition to Residency course including an acid-base challenge and an appropriate precautions/PPE relay race. However, this game was cancelled due to the COVID-19 pandemic. The COVID-19 pandemic has highlighted a new limitation with this game: it is designed to be in-person. However, we do feel certain challenges or aspects of this game could be done virtually utilizing web-based technology such as Zoom or WebEx. Although the 2020 game was cancelled due to the COVID-19 pandemic, a completely Zoom-based game was designed and implemented for 2021 which allowed the students to participate remotely and

maintain social distancing. Our team is currently planning to implement a 2022 game at our branch campus as well as a larger campus in North Carolina. To implement at other campuses, branch or main campuses, we recommend working with fourth-year medical school leadership to plan timing and space, as well as recruiting faculty and interested residents. We have a core team this year that will be present at the larger main campus to assist with game rollout.

Disclaimer: The opinions and assertations contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the U.S. Navy, Department of Defense, or the U.S. government.

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Appendix A: Individual challenges/rooms for "Night On Call"

"Night On Call" escape room challenge	
Timing	Max 18 minutes per room. Each station is timed by proctor. Students may be given a "delay" or bonus "time off".
Teams	15 students, 3 teams of 5. Each start at a different spot.
Winner	Winning team is the team with the least amount of total time.
General Instructions	After each task is complete, the team will be given location or clue to next task.

Room: 2	**Antibiotic Scramble**
Room Creator	
Day-Of Proctor	
Location	
Equipment Needed	Use labels from SnagIt and order bottles. Can also use saline syringes for injectable meds. ● CAP – azithromycin 500mg PO QDx 3 days + Augmentin 875mg PO BID x 5 days. Clue: baseball cap. ● UTI – nitrofurantoin 500mg PO BID x 5 days. Clue: nametag "Yooti I. Burnes" ● Cellulitis – Bactrim 800-160mg PO BID x 7 days and Keflex 500mg PO Q12H x 7 days. Clue: room proctor will have arm painted a faint red. ● Cervicitis – Azithromycin 1g PO once and ceftriaxone 250mg IM once. Clue: Broken condom ● Prophylaxis for PJP – Bactrim DS twice daily. Clue: Four CDs. ● Meningitis – Ceftriaxone, vancomycin. Clue: Keurig cup (sounds like Kernig) ● Primary lesion of Lyme disease – Doxycycline 200mg PO once. Clue: a lime. ● Otitis media – Amoxicillin. Clue: picture of an Incus, mallet, and stirrup ● Prostatitis – Cipro 500mg PO QD x 6 weeks. Clue: Picture of asterix + glove + lube
Scoring Additions	NA

General Instructions	You've had too many lectures and your brain can't take it anymore! You can't remember which infectious disease your patients had. Luckily, you left yourself clues to remember which infection they have. When you determine which infection each patient has, give them the correct first-line medication! Remember, some infections require multiple medications to adequately treat. Use the antibiotics available to treat your patients. You will use all the antibiotics. When you think everyone is adequately treated, notify the attending and he/she will round with you and check your work.

Room 5	**Is there a Doctor on the Plane?**
Room Creator	
Day-Of Proctor	
Location	
Equipment Needed	Equipment: purse, diabetic bracelet & other bracelets, insulin syringe, glucometer, spritz bottle, airplane medical equipment (blood pressure cuff, stethoscope, D50, epinephrine, normal saline, oxygen tubing, bag-valve-mask, oral airways, tourniquet and IV start supplies, IV tubing, aspirin, Benadryl, nitroglycerin. Personnel: room proctor (captain of plane), 4 "passengers"
Scoring Additions	• 3 min delay: not recognizing anaphylaxis • 2 min delay: giving Benadryl only • 1 min bonus: treating with epi first • 3 min delay: do not land plane for chest pain • 2 min bonus: start IV and have IVF ready to go in case BP drops and patient needs a bolus. MacGyver Award for student who is able to figure everything out quickly and put together not often used equipment for treatment purposes (room proctor discretion)
General Instructions	You are on a cross-country plane trip and all the passengers get sick! *Hypoglycemia* - Altered female patient, looks ill and sweaty. Look at patient and decide what's going on. Clues: multiple bracelets, one is diabetic bracelet, insulin syringe in purse. Ask other passengers for glucometer. If one is not found, then determine if you just want to treat. Is she too altered to drink? Then decide to place IV and give dextrose. If there is delay in recognition or treating then patient will seize.

	Anaphylaxis: Patient complains throat feels tingly. Patient feels itchy. Red skin underneath a long sleeve shirt. Patient having trouble talking. Must see open bag of nuts/trail mix lying in next to patient. Make decision to treat anaphylaxis. *Chest Pain:* 66 y/o male becomes diaphoretic, and clutches chest. Obtain hx of COPD/tobacco abuse, HTN. If they get BP it is 220/110, pulse 98. Skin exam: clammy, wet/diaphoretic. Must give nitro, put on O2, give aspirin. Must decide to land plane (Pilot/proctor will give pushback). *Red Herring Patient*: - she is eating a bag of peanut trail mix. She happens to have a glucometer and Benadryl which she will supply if asked.

Appendix B: Post-game anonymous survey (Likert Scale and free response).

UNC Transition to Residency Course
Night on Call Survey

1.) The Night on Call escape room was a fun way to end the Transition to Residency course.

No	Not Really	Neutral	It was fun	Absolutely
1	2	3	4	5

2.) Education games like the escape room challenge help with knowledge retention

No	Not Really	Neutral	Somewhat	Absolutely
1	2	3	4	5

3.) Education games like the escape room challenge help with knowledge application

No	Not Really	Neutral	Somewhat	Absolutely
1	2	3	4	5

4.) The challenges in the escape room challenge reflect tasks I will encounter during intern year?

No	Not Really	Neutral	Somewhat	Absolutely
1	2	3	4	5

5.) I think that a team-based game like this escape room challenge is valuable in the Transition to Residency course?

No	Not Really	Neutral	Somewhat	Absolutely
1	2	3	4	5

6.) The following rooms/situations were valuable:

a.) IV access room

No	Not Really	Neutral	Somewhat	Absolutely
1	2	3	4	5

b.) Cardiac arrest & EKG room

No	Not Really	Neutral	Somewhat	Absolutely
1	2	3	4	5

c.) Appropriate antibiotic room

No	Not Really	Neutral	Somewhat	Absolutely
1	2	3	4	5

d.) Patient hand-offs & phone call challenge room

No	Not Really	Neutral	Somewhat	Absolutely
1	2	3	4	5

e.) Out of Hospital Scenario Room

No	Not Really	Neutral	Somewhat	Absolutely
1	2	3	4	5

f.) Agitated Patient room

No	Not Really	Neutral	Somewhat	Absolutely
1	2	3	4	5

g.) Dance Dance Revolution - procedural room

No	Not Really	Neutral	Somewhat	Absolutely
1	2	3	4	5

h.) Prioritization room

No	Not Really	Neutral	Somewhat	Absolutely
1	2	3	4	5

i.) Imaging room (Chutes & Ladders)

No	Not Really	Neutral	Somewhat	Absolutely
1	2	3	4	5

j.) Communication room (Heads Up game)

No	Not Really	Neutral	Somewhat	Absolutely
1	2	3	4	5

7.) My favorite aspects of the Night on Call escape room challenge:

8.) Ideas for improvement in the Night on Call escape room challenge:

9.) General comments/feedback on the Night on Call escape room challenge: