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The use of notable protagonists in dermatology clinical cases: A quasi-randomized controlled trial

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Abstract

Background: Educators have attempted several methods to create more entertaining problem-based learning (PBL) experiences and more engaging PBL patients. To this end, our study compared the use of unique, memorable PBL characters with generic, unmemorable characters.

Methods: This prospective quasi-randomized controlled study utilized 476 university students. All subjects read ten medical cases that focused on dermatological illnesses. Cases were identical for everyone except subjects were allocated to have notable protagonists (NP) (i.e. cartoon characters or celebrities) or generic protagonists (GP) as patients in their cases. Surveys and tests were completed immediately, 7-10 days later, and 28-31 days later.

Results: There were no significant differences in post-test scores at any point between the groups. The only significant difference with regard to the subjective learning experience was for the entertainment level of the cases. The NP mean was 64.1±24.2, whereas the GP mean was 56.0±24.6 (t[444]=3.52, P=0.0005). The NP group also had a significantly higher proportion of subjects who researched dermatology/medicine topics after reading the cases (10.6% versus 2.7%, χ^2(1,N=215)=5.47, P=0.02). Conclusions: The current study found that cases utilizing NPs, while still preserving the same educational value as cases using GPs, can provide a more entertaining learning experience and stimulate outside learning.

Introduction

Problem-based learning (PBL) has become common among medical schools and revolves around clinical cases that all start with a patient narrative that sparks discussion and learning. Narratives can play a pivotal role in remembering new knowledge [1, 2]. Central to any narrative is the protagonist, the main character, who suffers misfortune or faces an obstacle [3]. Character and plot can play an important role in learner involvement and the learning experience. In fact, the absence of a coherent story can actually be an inhibitor of learning [1]. Cases with a "thin narrative" — which present just the facts — can depersonalize the patient and physician and cause the reader to detach him or herself from the patient [4].

"Thick narratives" are defined as those that more thoroughly develop their characters. Because these narratives better engage the reader, they tend to be more memorable [4]. In PBL, the characters in thick narratives create a stronger context for the illness discussed in the case. Indeed, context has been found to be important for recall, because one often remembers a fact within the context of how it was first learned. For example, a physician will remember a patient's clinical problem along with the other features of the patient such as his or her hair or clothing [5].

Problem-based learning creates the opportunity for clinical facts to be learned in the context of a patient encounter. Researchers have tried several methods to make the process of PBL more entertaining, such

as role playing [6] and games [7-9]. Participants in a game-based learning exercise gained the same amount of knowledge as participants in a typical PBL exercise, but the game participants found their experience more satisfying [7].

Additionally, educators have employed several methods to create more engaging patients in PBL cases. For example, an interactive web-based medical learning software called StepStone Interactive advertises virtual patients that are meant to "personify the disease" with "humanistic elements responsible for long-term recollection of real-life patient encounters" [10]. A randomized-controlled trial comparing this software versus traditional lectures found significantly better retention post-intervention and 22 days later [11]. In Sweden, a similar interactive clinical reasoning program that included images of real patients and providers found that the vast majority of students tested felt the program facilitated their learning to a large/very large extent [12].

Researchers have also used videos to create more realistic and memorable PBL narratives [13]. In one study, both students and facilitators found a video-only case more interesting and preferable compared with paper-only cases [14]. In another randomized-control trial, Takkunen et al. had one group of students actually interview and examine a real patient with the illness from a case study, in addition to reading the paper case. In comparison with students only reading the paper case, the in-person students were more interested in the case and became more motivated to study educational material related to the case [15].

Following this aim of creating a more entertaining learning experience and more engaging PBL patients, in the current study we replaced generic, unmemorable character names with unique, memorable characters with which most students would be familiar (e.g. famous cartoon characters or celebrities). With a notable protagonist (NP) patient, the patient can come to life through the student's own prior knowledge of the character. In comparison to cases with generic protagonists (GP), it was hypothesized that these NPs would facilitate better

recall of case medical facts, enhance the subjective learning experience, and inspire outside learning.

Design and Participants

A prospective, quasi-randomized study was conducted between January to May 2014 using participants who were Harvard University students enrolled in undergraduate-level psychology courses. Students received course credit as compensation for participation. Students were recruited via an online listing of available studies. The participants were a desirable testing group because the majority of students were undergraduates, who presumably did not have prior medical training in dermatology topics that could confound analyses.

The study was approved by the Harvard University institutional review board and informed consent was obtained from all participants. All parts of the study were completed in the privacy of one's home via the internet. A total of 476 students completed Part 1 of the study. Participants received equal compensation regardless of the amount of time and effort they put into the study. Thus in order to weed out "slackers," participants were discarded from analysis if their scores were not at least twice that of random guessing (at least 40% correct). Therefore, 446 students were included for analysis and were invited to complete Parts 2 and 3.

Seven days after Part 1, participants were emailed notifying them of their eligibility to complete Part 2 of the study in order to receive additional course credit. Participants could complete Part 2 at any point during days seven to ten post-Part 1. Twenty-eight days post-Part 1, participants were emailed notifying them of their eligibility to complete Part 3 at any point during days 28 to 31 post-Part 1. A total of 215 and 100 participants completed Parts 2 and 3, respectively.

Instructional Materials

Part 1 contained ten short medical case studies, which were created by the first two authors. Each case covered a separate dermatological illness that a primary care physician might encounter in clinical practice. The cases were written with an intended audience that had no medical background. Each case started with a brief clinical vignette and then

"Captain Hook, a 54 year-old man, has spent many years of his life as a captain on the high seas. Although he owned a wide-brimmed hat to protect his face from the sun, he often did not wear the hat and still received a lot of sun exposure and frequent sunburns. A month ago he noticed a sore on the side of his nose. Sometimes when he touches the sore, he notices that it oozes a few drops of blood. When Captain Hook arrives on shore, he decides to get the opinion of a dermatologist. The dermatologist diagnoses Captain Hook's lesion as basal cell carcinoma."

Box 1. *Excerpt from a notable protagonist case.*

transitioned into a discussion of the illness' epidemiology, pathophysiology, symptoms, diagnostic testing, treatment, and prognosis.

Subjects were blinded to group assignment. The study employed a quasi-randomization strategy, which sorted subjects into the experimental and control groups based on the last digit of his or her phone number (0-4 versus 5-9). This allocation method was used because the online survey tool did not lend itself to the use of a random number generator. It was believed that the last digit of a phone number was a fair proxy for a random number generator given that the former is often randomly selected and is unlikely to be related to covariates.

The experimental group had cases with NPs (i.e. famous cartoon characters and celebrities) (Supplemental File 1). The control group had the exact same cases, except with the names of the NPs replaced with GPs (i.e. generic John Doe-type names). The cases were designed to make sense with the assigned NP (e.g. Lex Luthor had alopecia areata), but all cases also read well with a GP. An excerpted vignette from one case with a NP is shown in Box 1.

Survey and Assessment Materials
In Part 1, after reading the cases, participants completed a survey inquiring about their sex, age, year, SAT score (rounded to the nearest hundred to better protect anonymity), intended/declared major, and premedical status. Participants then used sliders ranging from (Not At All) 0 to 100 (Extremely) to answer six subjective questions regarding their learning experience with the cases. After the survey, participants completed a post-test consisting of 30 multiple-choice questions about clinical facts from the cases (Supplemental File 2).

Part 2 consisted of the same 30-question post-test from Part 1 and also asked whether in the interim the participant had researched any dermatology or medicine topics. Part 3 consisted of the same 30-question post-test from Part 1.

Data Analysis
Unpaired t-tests with unequal variances were used to compare the mean test scores between the NP and GP groups and also to compare age, SAT score, and the subjective learning experience scores. Pearson's chi-square test was used to compare between the groups the other demographic proportions and to compare the proportions of students who researched dermatology/medicine topics in-between Parts 1 and 2. A *P value* of less than 0.05 was considered significant for all tests.

Results
Participant enrollment, allocation, and retention are depicted in Figure 1. The demographic information for the participants in each group is shown in Table 1. There were no significant differences between the groups regarding sex, age, year, SAT score, intended/declared major, and premedical status.

There were no significant differences in post-test scores at any point between the groups (Table 2). Out of a maximum score of 30, during Part 1 the mean post-test scores were 21.9±4.7 and 22.0±4.8 for the NP and GP groups, respectively (t[444]=0.25, P=0.80). Seven to ten days after Part 1, the mean test scores were 19.1±5.2 and 19.9±5.9 for the NP and GP groups, respectively (t[213]=1.08, P=0.28). Twenty-eight to 31 days after Part 1, the mean test scores were 18.2±4.6 and 19.5±5.7 for the NP and GP groups, respectively (t[98]=1.30, P=0.20).

Among the six questions regarding each participant's subjective learning experience (Table 3), the only significant difference was for the question "How entertaining did you find the cases?" The NP mean was 64.1±24.2, whereas the GP mean was 56.0±24.6 (t[444]=3.52, P=0.0005).

CONSORT 2010 Flow Diagram
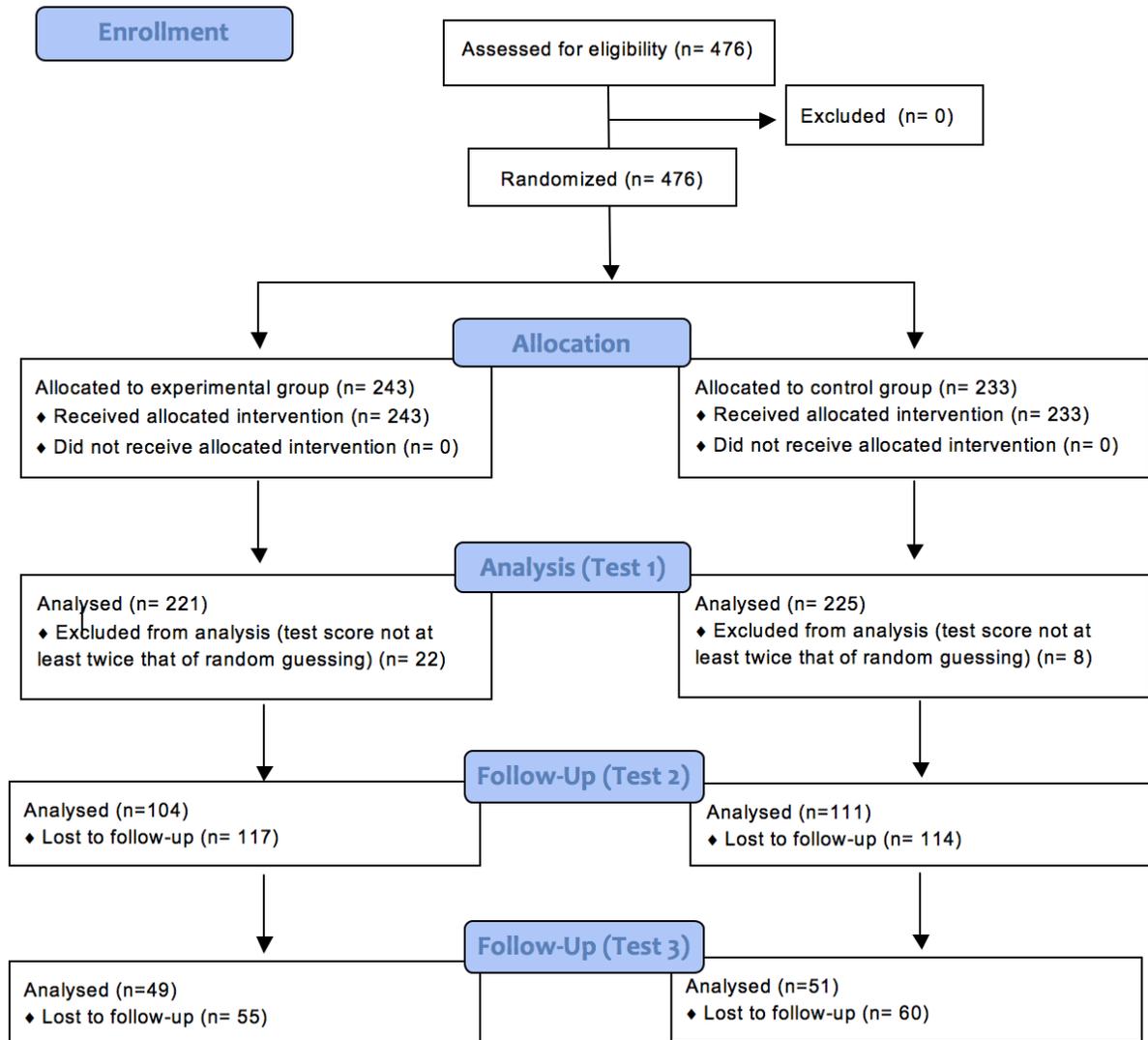
Figure 1. *CONSORT flow diagram.*

Table 4 compares the proportion of participants in-between Parts 1 and 2 that researched dermatology/medicine topics after reading the cases. The NP group had a significantly higher proportion than the GP group (10.6% versus 2.7%, χ^2(1, N=215)=5.47, P=0.02).

Discussion

Harrison encourages case-writers to not forget the value of entertainment in a case, because it can **pique a student's interest and imagination. She writes that "well-**developed characters enliven the **case study and increase student engagement"** [16].

Takahashi and Oku describe ways to enhance student learning from PBL cases. They advise writing cases in such a way that students are personally and/or emotionally involved in the case [17]. One way of engaging the students personally and emotionally is through use of NPs.

The current study found that cases utilizing NPs can provide a more entertaining learning experience while still preserving the same educational value as cases using GPs. Moffat et al. studied medical students in a PBL curriculum and found them to have increasing psychological morbidity during medical school [18]. In simple terms, medical school can be a

Table 1. *Subject demographics (n = 446).*

	Notable Protagonist Group	Generic Protagonist Group		
No. of Subjects	221	225		
	Mean (SD)	Mean (SD)	t	P-Value[a]
Age[b]	19.8 (1.7)	20.0 (2.0)	1.31	.19
SAT Score[b,c]	2216 (143)	2212 (147)	0.30	.76
	# (%)	# (%)	x^2	P-Value[d]
Gender			0.03	.87
Male	96 (43.4)	96 (42.7)		
Female	125 (56.6)	129 (57.3)		
Year[b]			7.09	.21
Freshman	86 (39.1)	71 (31.6)		
Sophomore	64 (29.1)	70 (31.1)		
Junior	40 (18.2)	40 (17.8)		
Senior	24 (10.9)	41 (18.2)		
Graduate Student	4 (1.8)	2 (0.9)		
Other	2 (0.9)	1 (0.4)		
Intended/Declared Major			1.51	.22
Science	56 (25.3)	46 (20.4)		
Other	165 (74.7)	179 (79.6)		
Premedical Student			1.20	.27
Yes	42 (19.0)	34 (15.1)		
No	179 (81.0)	191 (84.9)		

a: Based on a two-sample t-test assuming unequal variances.
b: Subject data were missing for Age (1 subject for NP), Year (1 subject for NP), and SAT (2 subjects for NP; 5 subjects for GP).
c: SAT scores were rounded to the nearest hundred by subjects to better protect their anonymity.
d: Based on Pearson's chi-square test.

very taxing period. Therefore, implementing education in an entertaining and enjoyable fashion is desirable, and NP cases can serve this purpose.

In addition to being entertained, participants reading the NP cases were more likely to look up dermatology/medicine topics afterwards. Outside, elective learning such as this may be a marker of increased interest in the topics covered in the cases and thus the NP cases may have sparked excitement regarding learning that extended outside the classroom.

Test scores from the NP group were not higher than the scores from the GP group and there may be multiple explanations for this. First, although the NPs were more entertaining, it is possible to some degree that the NPs distracted slightly from the medical facts. Alternatively, the names of the NPs may not

have been sufficient to serve as a memory aid; pictures of the NPs might help participants better visualize the NPs with the diseases. Also, despite the test instructions prohibiting it, subjects may have used the internet to look up answers, thus diminishing the difference in test scores between the groups. Finally, the mean scores at each follow-up test were relatively high (> 80% of the original score) and testing at more distant time periods, such as three months post-Part 1, may be necessary to better differentiate recall between the two groups.

Aside from being more entertaining, the NP cases were not significantly better in the other five subjective areas. This could be explained by the fact that about two-thirds of each case was spent discussing the facts pertaining to the illness and was identical between groups. The NP/GP vignettes were

only a small part of each case (roughly one third). Therefore, in isolation the NP *vignettes* may have been more interesting or enjoyable than the GP *vignettes*, but this was not surveyed. The cases were compared in their entirety. Moreover, most of the participants were not science majors or premedical students, and thus the learning experience of the cases may have been overshadowed by the challenge of learning material filled with new medical terms and scientific facts outside of their chosen discipline.

The cases should be further tested among first-year medical students, who make up a self-selected group that is inherently interested in learning medical topics. In such a sample, the focus might be less on learning foreign material outside of their chosen discipline and more on the NPs with their associated illnesses. We envision that NPs could be helpful during medical school PBL cases by making them more entertaining and motivating students to learn more about dermatology. Again, visual

representations of the NPs, such as photographs or videos, may amplify the effect of using an NP and create an enhanced learning experience. Other limitations of the study include the fact that it was conducted online and with multiple short cases. Problem-based learning is typically conducted in-person in interactive small groups with one or two long cases. Therefore, researchers should conduct further studies in more typical PBL settings to see if the merits of NPs persist.

Conclusion

This study illustrates that cases with NPs have the potential to be successfully used as a substitute for cases with GPs. Because medical students must learn to work with and develop respect for real patients, we would of course not recommend NP cases as a new standard. Rather, educators can use NP cases as an occasional fun alternative, tailoring them to reinforce a specific aspect of a disease in an entertaining and stimulating way.

References

1. Laurillard D. Multimedia and the learner's experience of narrative. *Comput Educ.* 1998;31(2):229-42. [DOI: 10.1016/S0360-1315(98)00041-4].
2. Mott BW, Callaway CB, Zettlemoyer LS, Lee SY, Lester JC, editors. Towards narrative-centered learning environments. Proceedings of the 1999 AAAI Fall Symposium on Narrative Intelligence; 1999. http://www.aaai.org/Papers/Symposia/Fall/1999/FS-99-01/FS99-01-013.pdf. Accessed on July 26, 2014.
3. Aristotle. Poetics. Internet Classics Archive; 335 B.C. Translated by S.H. Butcher. http://classics.mit.edu. Accessed on July 26, 2014.
4. Bizzocchi J, Schell R. Rich-narrative case study for online PBL in medical education. *Acad Med.* 2009;84(10):1412-8.[PMID: 19881435].
5. Norman GR, Schmidt HG. The psychological basis of problem-based learning: a review of the evidence. *Acad Med.* 1992;67(9):557-65. [PMID: 1520409].
6. Chan ZC. Role-playing in the problem-based learning class. *Nurse Educ Pract.* 2012;12(1):21-7. [PMID: 21601528].
7. Telner D, Bujas-Bobanovic M, Chan D, Chester B, Marlow B, Meuser J, Rothman A, Harvey B. Game-based versus traditional case-based learning: comparing effectiveness in stroke continuing medical education. *Can Fam Physician.* 2010;56(9):e345-51. [PMID: 20841574].
8. Patel J. Using game format in small group classes for pharmacotherapeutics case studies. *Am J Pharm Educ.* 2008;72(1):21. [PMID: 18322582].
9. Akl EA, Kairouz VF, Sackett KM, Erdley WS, Mustafa RA, Fiander M, Gabriel C, Schunemann H. Educational games for health professionals. *Cochrane Database Syst Rev.* 2013;3:CD006411. [PMID: 23543543].
10. StepStone Interactive. 2013. www.stepstonemed.com. Accessed on October 20, 2013.
11. Subramanian A, Timberlake M, Mittakanti H, Lara M, Brandt ML. Novel educational approach for medical students: improved retention rates using interactive medical software compared with traditional lecture-based format. *J Surg Educ.* 2012;69(4):449-52. [PMID: 22677580].
12. Wahlgren CF, Edelbring S, Fors U, Hindbeck H, Stahle M. Evaluation of an interactive case simulation system in dermatology and venereology for medical students. *BMC Med Educ.* 2006;6:40. [PMID: 16907972].
13. de Leng B, Dolmans D, van de Wiel M, Muijtjens A, van der Vleuten C. How video cases should be used as authentic stimuli in problem-based medical education. *Med Educ.* 2007;41(2):181-8. [PMID: 17269952].
14. Chan LK, Patil NG, Chen JY, Lam JC, Lau CS, Ip MS. Advantages of video trigger in problem-based learning. *Med Teach.* 2010;32(9):760-5.[PMID: 20795807].
15. Takkunen M, Turpeinen H, Viisanen H, Wigren HK, Aarnio M, Pitkaniemi J. Introduction of real patients into problem-based learning in preclinical first-year anatomy curriculum. *Med Teach.* 2011;33(10):854-6. [PMID: 21592021].
16. Harrison E. How to develop well-written case studies: the essential elements. *Nurse Educ.* 2012;37(2):67-70. [PMID: 22327529]. Takahashi Y, Oku SA. Attractive scenario writing. *Kaohsiung J Med Sci.* 2009;25(5):250-3. [PMID: 19502145].
17. Moffat KJ, McConnachie A, Ross S, Morrison JM. First year medical student stress and coping in a problem-based learning medical curriculum. *Med Educ.* 2004;38(5):482-91. [PMID: 15107082].

Table 2. *Comparison of group test scores sorted by time of testing (n=446; n=215; n=100).*

	Notable Protagonist Group	Generic Protagonist Group	t	P-Value[a]
Immediate Post-Test Results				
Subjects	221	225		
Mean (SD) Score[b]	21.9 (4.7)	22.0 (4.8)	0.25	0.80
Median	23	23		
Interquartile Range	19-26	18-26		
7-10 Days Post-Test Results				
Subjects	104	111		
Mean (SD) Score[b]	19.1 (5.2)	19.9 (5.9)	1.08	0.28
Median	20	21		
Interquartile Range	14-23	14-25		
28-31 Days Post-Test Results				
Subjects	49	51		
Mean (SD) Score[b]	18.2 (4.6)	19.5 (5.7)	1.30	0.20
Median	19	19		
Interquartile Range	14-22	16-25		

a: Based on a two-sa: Based on a two-sample t-test assuming unequal variances.
b: A perfect score is 30.

Table 3. *Comparison of scores for subjective questions regarding the learning experience (n = 446).*

Question	Notable Protagonist Group Mean (SD)[a]	Generic Protagonist Group Mean (SD)[a]	Difference Mean (95% CI)	t	P-Value
1. How interesting did you find the cases?	67.6 (21.3)	66.2 (22.1)	1.5 (-2.6 to 5.5)	0.71	0.48
2. How much did you enjoy learning from the cases?	63.6 (22.5)	61.4 (24.7)	2.2 (-2.2 to 6.6)	1.00	0.32
3. How entertaining did you find the cases?	64.1 (24.2)	56.0 (24.6)	8.1 (3.6 to 12.7)	3.52	0.0005***
4. How much did the cases teach you?	62.6 (22.1)	64.5 (21.8)	-1.9 (-6.0 to 2.2)	0.93	0.35
5. After doing the cases, how interested are you in learning more about the fields of dermatology/medicine?	39.4 (27.4)	39.4 (28.7)	0.0 (-5.3 to 5.2)	0.02	0.99
6. How much did the cases motivate you to study on your own some dermatology/medicine topics?	35.2 (27.8)	33.9 (28.1)	1.3 (-3.9 to 6.5)	0.48	0.63

***: Significant at P < .001.
a: Subjects used sliders ranging from 0 (Not At All) to 100 (Extremely) to answer each question.

Table 4. *Comparison of outside learning between the two groups (n=215).*

	Notable Protagonist Group # (%)	Generic Protagonist Group # (%)	x^2	P-Value[a]
Researched Dermatology/Medicine Topics After Reading Cases[b]			5.47	0.02*
Yes	11 (10.6)	3 (2.7)		
No	93 (89.4)	108 (97.3)		

*: Significant at P < .05.
a: Based on Pearson's chi-square test.
b: The period of analysis was the 7-10 days in-between Parts 1 and 2 of the study.

Supplemental File 1. *Cases with notable protagonists.*

You will now read 10 dermatology cases. After reading the 10 cases, you will answer a brief survey about the cases, and then you will answer 30 multiple-choice questions about facts from the cases. It should take less than 1 hour to complete all parts.

All of the following cases are purely fictional and are meant for educational purposes only.

1. Angelina Jolie, a 38 year-old woman, is on a humanitarian visit to Sierra Leone. She is at a local market and buys an inexpensive necklace that is nickel-plated. That night at a gala for her NGO, she wears her new necklace. A couple days later Angelina Jolie develops the following very itchy rash on the back of her neck.

Soon after, little blisters begin to form on the back of her neck. Upon returning to the U.S., she sees a dermatologist, who diagnoses Angelina Jolie with allergic contact dermatitis.

Allergic contact dermatitis is caused by a T-cell mediated hypersensitivity reaction to a substance to which the person was previously sensitized. Some examples of materials that can cause an allergic reaction in certain individuals include jewelry containing nickel, creams containing neomycin, cosmetics containing propylene glycol, and shoe polish containing turpentine. The skin reaction appears about two days after exposure and is typically restricted to the site of exposure. The reaction is very itchy and can include redness, bumps, scaling, swelling, and blisters. After repeated exposure and scratching, the skin can undergo lichenification, which means it becomes very thick with accentuated skin markings.

In order to determine what substances Angelina Jolie is allergic to, the dermatologist recommends patch testing, where many chemicals in small amounts are applied to Angelina's skin to see which ones cause a reaction. Angelina Jolie is then prescribed a steroid ointment to help with her symptoms, and within a week enjoys a full recovery.

2. Captain Hook, a 54 year-old man, has spent many years of his life as a captain on the high seas. Although he owned a wide-brimmed hat to protect his face from the sun, he often did not wear the hat and still received a lot of sun exposure and frequent sunburns. A month ago he noticed a sore on the side of his nose. Sometimes when he touches the sore, he notices that it oozes a few drops of blood. When Captain Hook arrives on shore, he decides to get the opinion of a dermatologist. The dermatologist diagnoses Captain Hook's lesion as basal cellcarcinoma.
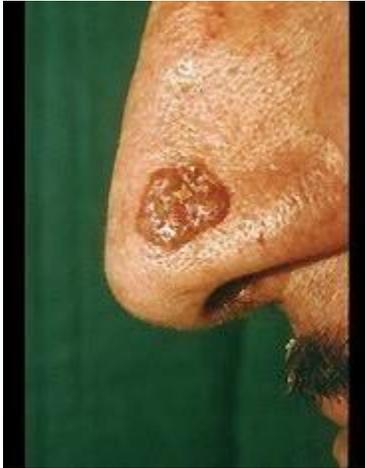
Basal cell carcinoma is a skin cancer and is actually the most common of all types of cancer. It is most common in people who have light skin types and are older than 40. More than 90% of basal cell carcinoma occurs on the face. The main risk factor is UV radiation, such as from the sun or tanning beds. The UV rays cause mutations in the genes that block cell proliferation, so with a defective gene, the basal cells can proliferate uncontrolledly. The nodular form of basal cell carcinoma typically presents with a shiny nodule that may show dilated blood vessels or eroded skin. Bleeding after minimal irritation is often the first symptom of basal cell carcinoma.

To confirm the diagnosis of basal cell carcinoma, the doctor obtains a biopsy, or sample, of the lesion. When the biopsy comes back positive for the carcinoma, the doctor recommends that Captain Hook undergo a procedure called Mohs surgery to remove the carcinoma. Because basal cell carcinoma does not metastasize to other parts of the body, the doctor tells Captain Hook to expect a full recovery.

3. Michael Jackson, a 28 year-old man, is at home with his family for Thanksgiving. Michael is asked to do the honor of **cutting the turkey. As he is cutting the turkey, his father comments that Michael's** hands look different than normal. The tips of several of his fingers symmetrically on both hands are much lighter than the rest of his skin. Michael says that he noticed this about a month ago but was hoping it would go away on its own. His father recommends that he see a doctor about this. **Michael schedules a doctor's appointment for three weeks later. By that time, his elbows and knees have lost their tan as well.** The doctor diagnoses Michael Jackson withvitiligo.

Vitiligo is characterized by the T-cell-induced destruction of melanocytes, the cells in the skin that create pigmentation. It affects about 1% of the population worldwide and affects all races, but it is more likely to cause major psychological distress in dark-skinned individuals. The main symptom of the disease is complete loss of pigmentation in the affected areas. The distribution of depigmentation may be focused in certain areas or it may become generalized throughout the body. In addition to around the eyes and mouth, the fingers, elbows, and knees are common areas for depigmentation.

The doctor diagnoses Michael Jackson based on the clinical exam alone. She recommends attempting repigmentation using topical steroids, but if the white spots get bigger, she recommends UV phototherapy for Michael Jackson. The doctor tells him **that many patients don't respond to the repigmentation and choose to either coverup the spots with makeup, or if** widespread, chemically bleach their skin to even out their skin color.

4. Elmer Fudd is returning home from hunting rabbits and other game in Connecticut. As is typically the case for him, he returned home empty-handed without any big catches. However, about a week later he notices a red rash on hisarm:

Over a couple days, Elmer Fudd notices the rash expanding and seeming to move up his arm. A couple weeks later he also starts to feel fatigued, feverish, and achy. He decides to go to the emergency room. The doctor diagnoses Elmer Fudd with Lyme disease.

Lyme disease is a bacterial infection caused by the bacterium *Borellia burgdorferi*. The bacterium is transmitted to humans via a tick bite. Tick bites often are associated with hiking, camping, or hunting in wooded areas. Lyme disease is most common in the summer and in northeastern states. While some patients discover the tick still implanted in their skin, many patients never see the tick that bit them.

The characteristic rash shown above, called erythema migrans, typically appears 3-32 days after the bite and often resembles a bull's eye. It can go on to expand and migrate across one's skin. Systemic symptoms such as malaise, fever, chills, muscle aches, nausea, and vomiting can occur weeks after the initial bite. If left untreated, Lyme disease can also affect one's nervous system, heart, and joints.

Elmer Fudd's doctor makes the diagnosis of Lyme disease based on the clinical findings and confirms the diagnosis with blood tests. He prescribes an oral antibiotic for Elmer Fudd and tells him to expect a full recovery.

5.   A 32 year-old homeless man, Aladdin, is soliciting for money and food near the local market. He manages to get away with a fresh loaf of bread. He goes back to the abandoned house he's squatting in. It is crowded with other homeless squatters and is poorly ventilated. He sits down with another homeless companion to enjoy the loaf of bread together. Although he enjoys the bread, he has to constantly scratch at an itch on his back. The itch has been bothering him for about a month. When he looks at his back in the mirror, he sees thefollowing:

He decides to go to a local free health clinic. The doctor diagnoses Aladdin with tinea corporis.

Tinea corporis, also known as ringworm, is a superficial fungal infection of the skin on the trunk or extremities. *Trichophyton rubrum* is the most common cause of fungal skin infections. It is a fungus with a branching, tube-like structure and it invades the stratum corneum of the epidermis. It is more common in crowded, hot or humid climates and can be transferred from person-to-person. The fungus can also be spread from one part of a person's body to another part via autoinoculation, or a person can get it from contact with animals. The infection normally presents as an itchy, scaly round lesion with central clearing.

Aladdin's doctor takes a few scrapings of the lesion with a scalpel and puts it under a microscope along with a potassium hydroxide solution. He observes a branching, tube-like fungus, which confirms the diagnosis of tinea corporis. He prescribes a topical antifungal cream for Aladdin and tells him to expect a full recovery.

6.   Pinocchio, a 30-year-old man, works at the Tuscany Woodshop. His boss mentions to Pinocchio that he's noticed a change in Pinocchio's face over the past few months. His cheeks have become redder, and it seems like his nose has been getting bigger and redder. Concerned, Pinocchio goes to his local dermatologist. The dermatologist diagnoses him with rosacea.

Rosacea is a chronic inflammatory acneiform disorder of the hair follicles and sebaceous glands on the face. Symptoms typically include flushing of the face and a rubbery thickening of the nose and/or other parts of the face. Rosacea is common in fair-skinned people between the ages of 30 and 50 years-old. Although women are more likely to experience rosacea, the enlarged nose (rhinophyma) mostly occurs in men. The redness is caused by many tiny dilated blood vessels, which are called telangiectasias. Papules – small raised bumps – and pustules are common.

The dermatologist makes the diagnosis of rosacea based on his visual assessment of the patient. She prescribes a topical antibiotic for Pinocchio's face. She advises Pinocchio that while the disease may go away on its own in some patients, most patients have rosacea for the rest of their life.

7.   A 25 year-old model, Kim Kardashian, is trying on a new designer dress on at a local store. The dress comes down to just above her knees. In the mirror, on both of her knees she notices some redness. Over the next several weeks, her knees begin

to itch and eventually become painful. Several weeks later, she notices in the mirror that the redness has become a silvery, scaly rash on both of her knees. Her rashes look similar to the belowpicture:

When modeling, she now chooses to wear dresses that cover up her knees. However, while walking down the runway, Kim Kardashian notices that her feet feel stiffer than they did in the past and are more swollen. Concerned over her new symptoms, she decides to take a break from her busy modeling schedule to see her dermatologist. The dermatologist diagnoses Kim Kardashian with psoriasis.

Psoriasis is an immune-mediated disease. It is a polygenic disease, meaning that many genes interact to determine who will get psoriasis. Psoriasis is equally common among men and women, and it typically has an onset in early adulthood or middle-age. Psoriasis lesions are associated with thickening of the upper layers of the skin which is driven by an immunologic response involving T cells. Formation of a lesion can be triggered by bacterial infection, stress, skin trauma, or medications. The rash associated with psoriasis commonly affects the knees, elbows, scalp, and lower back. The rash normally presents as a well-circumscribed rash with silvery scales and it can be itchy and painful. In up to 25% of psoriasis patients, arthritis also occurs. Psoriasis is also associated with a higher rate of metabolic syndrome, which includes obesity and high bloodpressure.

Kim Kardashian's dermatologist makes the diagnosis of psoriasis based on the clinical exam. He prescribes a topical steroid for Kim. He advises Kim Kardashian that although it can go into remission, psoriasis can be a lifelong disease.

8.   A 28 year-old man, Gaston, enjoys going out and trying to pick-up women. He does this every weekend with varying degrees of success. One night after facing a tough rejection from a woman named Belle, he goes home to go to bed. While going to the bathroom, Gaston notices for the first time a sore in his genital area. It does not hurt at all, so he ignores it and goes to sleep. Five weeks later, the sore has gone away, but he starts to feel sick with a fever, sore throat, and headache. Gaston also notices little red scaly spots on his skin throughout his body, including his palm and soles.

He decides to go to his primary care doctor for an evaluation. The doctor diagnoses Gaston with syphilis.

Syphilis is a chronic systemic infection caused by the bacterium *Treponema pallidum.* It is most often transferred during sexual contact and is most common in males ages 20-39. Syphilis first appears as a painless genital ulcer. If untreated, after several weeks or months, some patients will develop a red scaly rash like the one pictured above throughout their body, including the palms and soles. At that point, systemic symptoms such as fever, sore throat, weight loss, malaise, loss of appetite, and headache are common. If left untreated, syphilis can go on to affect one's brain and nervous system.

Gaston's doctor obtains some fluid from one of his skin lesions and performs dark-field microscopy. Under the microscope, he observes spiral-shaped bacteria, which confirms the diagnosis of syphilis. He prescribes an oral antibiotic for Gaston and tells him to expect a complete recovery.

9. Charlie Sheen, a 45 year-old man, goes to a friend's party one weekend. He drinks the whole night and consumes more alcohol than he's ever had before at a party. With great difficulty he finds his way home in the morning, but he has no other problems for the next few days. However, Charlie Sheen eventually notices large blisters on his hands and feet. The skin on his hands and feet seems fragile and very sensitive to pain. He also notices that all of his skin seems to now have a bronze coloration. In addition, when he goes to the bathroom Charlie Sheen notices that his urine is reddish-brown in color. He is very concerned and rushes to his primary care doctor. The doctor diagnoses Charlie Sheen with porphyria cutanea tarda.

Porphyria cutanea tarda is caused by low levels of an enzyme necessary for the synthesis of hemoglobin, the molecule that carries oxygen in the blood. The disease is exacerbated by certain chemicals and drugs. Alcohol is one of the main chemicals known to exacerbate porphyria cutanea tarda in certain individuals. The disease most commonly begins between 30 and 50 years of age and affects sun- exposed areas, such as the hands and feet, with blisters and fragile skin. Excess iron in the blood can cause bronzing of the skin. In addition, because of the build-up of porphyrins, the urine can turn red or brown.

In order to confirm the diagnosis, the doctor orders a urinary porphyrin level for Charlie Sheen. When the urine comes back positive for elevated urinary porphyrins, the doctor advises Charlie Sheen to abstain from drinking alcohol and orders weekly blood draws to remove excess iron from the blood. Following his recommendations, the doctor expects remission of the disease within a year.

10.   A 24 year-old entrepreneur, Lex Luthor, is the mastermind behind a new business venture. He is working hard on the new project, but is disturbed when in the shower he notices that patches of hair on his head are falling out. At first he noticed that little round patches of hair were missing. Then eventually his whole scalp started to lose hair. After a couple months, all the

hair on his head was gone, including his eyebrows and eyelashes. He is very distressed by this and goes to see a dermatologist. The dermatologist diagnoses Lex Luthor with alopecia areata.

Alopecia areata is an autoimmune disease that causes areas of hair loss on the scalp. It is caused by T cells that attack the **patient's own hair follicles. The hair loss can occur over weeks to months. Whereas most people will only lose patches of hair**, some will lose all of the hair on their head (alopecia areata totalis). In the areas of hair loss, all that remain are short, broken-off hair shafts. It is most common in young adults less than 25 years of age.

The dermatologist makes the diagnosis of alopecia areata with her clinical exam. She advises Lex Luthor that with extensive hair loss like his, there is only a small chance that the hair will regrow. She mentions that many patients with this condition use a wig or hairpiece. Lex Luthor is very frustrated by this information.

Supplemental File 2. *Test questions.*

30 Case Questions

Using your memory only and NO OTHER RESOURCES, please answer the following 30 questions.

1. In which part of the United States is Lyme disease most common?
a. Northwest
b. Northeast
c. Southwest
d. Southeast
e. Alaska

2. Patch testing is a test to confirm the diagnosis of which of the following diseases?
a. Vitiligo
b. Allergic contact dermatitis
c. Syphilis
d. Porphyria cutanea tarda
e. Rosacea

3. Which of the following parts of the body is commonly affected by vitiligo?
a. Scalp
b. Back
c. Fingers
d. Toes
e. Nose

4. Which of the following diseases can be associated with the appearance of bronze-colored skin?
a. Rosacea
b. Allergic contact dermatitis
c. Porphyria cutanea tarda
d. Syphilis
e. Vitiligo

5.   The below rash is caused by which of the following?

a. Sexually transmitted disease
b. Melanocyte destruction
c. Fungus
d. Cancer cells
e. Tick

6.   Which of the following is a common cause of allergic contact dermatitis?
a. Tick bite
b. Sexual contact
c. Jewelry
d. Sun exposure
e. Alcohol

7.   The diagnosis of porphyria cutanea tarda is confirmed by analyzing the levels of porphyrin inwhat?
a. Urine
b. Blood
c. Skin
d. Blisters
e. Hair

8.   Vitiligo causes the most suffering in which of the following groups of people?
a. Women
b. Individuals older than 40
c. Obese individuals

d. Dark-skinned individuals

e. Low-income individuals

9.   Which of the following diseases is most often curable?

a. Basal cell carcinoma

b. Psoriasis

c. Rosacea

d. Vitiligo

e. Alopecia areata totalis

10.   UV phototherapy is a treatment for which of the following diseases?

a. Tinea corporis

b. Rosacea

c. Syphilis

d. Basal cell carcinoma

e. Vitiligo

11.   Alopecia areata is caused by which of the following?

a. Bacteria

b. T cells

c. Fungi

d. Cancer cells

e. Ticks

12.   What is the primary treatment for allergic contact dermatitis?

a. Steroids

b. Antifungals

c. Antibiotics

d. Surgery

e. Alcohol avoidance

13.   Which of the following is a major risk factor for Lyme disease?

a. Male gender

b. Age older than 50

c. Outdoor activity

d. Dark skin

e. Family history of Lyme disease

14.   Which of the following diseases is more common in fair-skinned individuals?

a. Allergic contact dermatitis

b. Lyme disease

c. Rosacea

d. Syphilis

e. Alopecia areata

15. The below picture shows which of the following diseases?

a. Lyme disease

b. Tinea corporis

c. Syphilis

d. Basal cell carcinoma

e. Psoriasis

16. What is the most common location of basal cell carcinoma?

a. Arms

b. Legs

c. Genitals

d. Face

e. Back

17. Which of the following diseases is more likely to occur in people living in crowded, hot living conditions?

a. Vitiligo

b. Porphyria cutanea tarda

c. Syphilis

d. Tinea corporis

e. Rosacea

18. Which of the following is a common treatment for rosacea?

a. Antibiotics

b. Steroids

c. Surgery

d. Antifungals

e. Currently there is no treatment for rosacea

19. Which of the following diseases typically presents with an itchy rash?

a. Vitiligo

b. Basal cell carcinoma

c. Rosacea

d. Syphilis

e. Tinea corporis

20. Which of the following diseases is associated with arthritis?

a. Vitiligo

b. Tinea corporis

c. Allergic contact dermatitis

d. Porphyria cutanea tarda

e. Psoriasis

21. Which of the following diagnoses is confirmed with dark field microscopy?

a. Psoriasis

b. Porphyria cutanea tarda

c. Alopecia areata

d. Syphilis

e. Tinea corporis

22. Who is most likely to be affected by alopecia areata?

a. Infants

b. Children

c. Young adults

d. Middle-aged adults

e. Elderly

23. Which of the following diseases is often a chronic, lifelong disease?

a. Psoriasis

b. Syphilis

c. Tinea corporis

d. Basal cell carcinoma

e. None of the above

24. Which of the following is the best method of prevention of basal cell carcinoma?

a. Using safe sex practices

b. Using topical steroids

c. Using topical antibiotics

d. Wearing protective clothing

e. Eating a balanced diet

25. Alcohol can exacerbate which of the following diseases?

a. Syphilis

b. Alopecia areata

c. Porphyria cutanea tarda

d. Allergic contact dermatitis

e. Vitiligo

26. Which of the following diseases can be associated with an enlarged nose (rhinophyma)?

a. Psoriasis

b. Alopecia areata

c. Syphilis

d. Porphyria cutanea tarda

e. Rosacea

27. The below picture shows a rash from which of the following diseases?

a. Syphilis

b. Allergic contact dermatitis

c. Tinea corporis

d. Psoriasis

e. Basal cell carcinoma

28. Which of the following diseases often affects the palms and soles?

a. Alopecia areata

b. Syphilis

c. Psoriasis

d. Rosacea

e. Basal cell carcinoma

29. Which part of the body is most often affected by alopecia areata?

a. Hands

b. Head

c. Feet

d. Genital area

e. Back

30. Which of the following diseases is more common in men?

a. Basal cell carcinoma

b. Allergic contact dermatitis

c. Tinea corporis

d. Psoriasis

e. Syphilis